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GRADUATE APTITUDE TEST IN ENGINEERING(GATE)

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INTRODUCTION:

The Graduate Aptitude Test in Engineering (GATE) is an All-India Examination conducted by the five IITs and IISC, Bangalore, on behalf of the Ministry of Human Resources Development (MHRD), Government of India. The objectives of GATE is to identify meritorious and motivated candidates for admission to Postgraduate Programs Engineering at the National level. Every year one IIT or IISc is selected as the Organizing Institute.

Why should we take GATE:

To pursue M.Tech program in a leading institute of the country. The benefits of M.Tech are:

- More and better companies are coming for Campus Placement in leading Institutes
- Higher salaries are being offered for M.Tech as compared to B.E.
- M.Tech degree leads to specialization and furthering of interest in a certain area which may lead to Ph.D
- M.Tech degree is a must for those wishing to apply for Faculty/Research positions in educational Institutes/R&D centers.
- Scholarship is paid during M.Tech, so no headache to parents for financial requirements.
- The M.Tech program is a 3 semester (18 months) program; so get more time to work out career opportunities.
- MOST IMPORTANTLY to get to be a part of any Nationally reputed Educational Institute and enjoy learning and research.

Important Dates:

- Availability of GATE forms: October, 1st week
- Last Date for filling up forms: November, 1st week
- Exam Date: 2nd Sunday of February
- Results: March 31st

General Information and Results are also published on the Web.

Examination Details:

- The examination is a single paper of 3 hours duration and generally consists of Section A (Objective Type) which is of 75 marks and Section B (Problem Type) which is of 75 marks. Total: 150 marks.

- You have to opt for your subject and study as per the syllabus mentioned in the GATE brochure (available in the Library).
- The subjects of our interest are Computer Science and Engineering, Electronics & Communication Engineering., Electrical Engineering and Instrumentation Engineering. Other subjects are also available such as Mathematics, Physics, etc (consult the GATE brochure).
- Generally a large number of students appear for the Computer Science subject in order to do a M.Tech in Computer Science.
- Old question papers are available in the shops.
- Results of qualified candidates in GATE will give All India Rank and indicate percentile score. For example, a percentile score of 99 means you are in the top 1% category of the candidates who appeared for GATE.
- Candidates who get less than 70 percentile get no score card.
- GATE scores are valid for 2 years. You may reappear the GATE exam if you are not satisfied with the earlier score and the new score (if better than the old one) will be used for admission purposes.

After the Exam, what next:

- After publication of GATE results, students must apply to individual Institutes to get their application forms.
- Institutes advertise M.Tech admissions in leading newspapers from 1st April till end July. However some Institutes do not advertise and therefore students have to get the forms themselves.
- In the application forms, you have to mention your GATE score alongwith other details.
- The concerned Institute may conduct written test and/or interview for the purpose of admission.
- General thumb rules: If your Gate score in Computer Science is 96 percentile or more then you can try for IITs, if between 85 - 96 percentile, then apply for top RECs, JADAVPUR, SHIBPUR, ROORKEE, etc. If less than 85, you have to look for appropriate institutes.

Scholarship:

During the pursuit of M.Tech, you are paid a scholarship of Rs. 5000.00 per month by the Government of India. This amount is enough for living expenses including purchase of books, etc. The scholarship is paid for the entire 18 months M.Tech period.

GATE Coaching:

For those interested in GATE coaching, the following organizations offer correspondence courses:

- Brilliant Tutorials
- Elite Academy
- Master's Academy

Fees is generally in the range of Rs. 3000 - Rs 5000 for the entire course.

SPECIAL:

I encourage 3rd year students to also appear GATE alongwith Final Year students since:

- GATE score is valid for 2 years.

The syllabus as required by GATE is generally over by 5th semester. Anyway, it will be a good try ! If it is a bad score you can always try again.

SYLLABUS:

AG - AGRICULTURAL ENGINEERING

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

FARM MACHINERY AND POWER:

Sources of power on the farm-human, animal, mechanical, electrical, wind, solar and biomass; design and selection of machine elements - gears, pulleys, chains and sprockets and belts; overload safety devices used in farm machinery; measurement of force, torque, speed, displacement and acceleration on machine elements.

Soil tillage; forces acting on a tillage tool; hitch systems and hitching of tillage implements; functional requirements, principles of working, construction and operation of manual, animal and power operated equipment for tillage. sowing, planting, fertilizer application, inter-cultivation, spraying, mowing, chaff cutting, harvesting, threshing and transport; testing of agricultural machinery and equipment; calculation of performance parameters -field capacity, efficiency, application rate and losses; cost analysis of implements and tractors.

Thermodynamic principles of I.C. engines; I.C. engine cycles; engine components; fuels and combustion; lubricants and their properties; I.C. engine systems - fuel, cooling, lubrication, ignition, electrical, intake and exhaust; selection, operation, maintenance and repair of I.C. engines; power efficiencies and measurement; calculation of power, torque, fuel consumption, heat load and power losses.

Tractors and power tillers - type, selection, maintenance and repair; tractor clutches and brakes; power transmission systems - gear trains, differential, final drives and power take-off; mechanics of tractor chassis; traction theory; three point hitches- free link and restrained link operations; mechanical steering and hydraulic control systems used in tractors; human engineering and safety in tractor design; tractor tests and performance.

SOIL AND WATER CONSERVATION ENGINEERING:

Ideal and real fluids, properties of fluids; hydrostatic pressure and its measurement; hydrostatic forces on plane and curved surface; continuity equation; Bernoulli's theorem; laminar and turbulent flow in pipes, Darcy-Weisbach and Hazen-Williams equations, Moody's diagram; flow through orifices and notches; flow in open channels.

Engineering properties of soils, fundamental definitions and relationships; index properties of soils; permeability and seepage analysis; shear strength, Mohr's circle of stresses; active and passive earth pressures; stability of slopes.

Hydrological cycle; precipitation measurement, analysis of precipitation data; abstraction from precipitation; runoff; hydrograph analysis, unit hydrograph theory and application; stream flow measurement; flood routing, hydrological reservoir and channel routing.

Mechanics of soil erosion, factors affecting erosion; soil loss estimation; biological and engineering measures to control erosion, terraces and bunds; vegetative waterways; gully control structures, drop, drop inlet and chute spillways; farm ponds; earthen dams; principles of watershed management.

Water requirement of crops; consumptive use and evapo-transpiration; irrigation scheduling; irrigation efficiencies; design of prismatic and silt loaded channels; methods of irrigation water application; design and evaluation of irrigation methods; drainage coefficient; surface and subsurface drainage systems; leaching requirement and salinity control; irrigation and drainage water quality; classification of pumps; pump characteristics; pump selection; types of aquifer; evaluation of aquifer properties; well hydraulics; ground water recharge.

AGRICULTURAL PROCESSING AND FOOD ENGINEERING:

Steady state heat transfer in conduction, convection and radiation; transient heat transfer in simple geometry; condensation and boiling heat transfer; working principles of heat exchangers; diffusive and convective mass transfer; simultaneous heat and mass transfer in agricultural processing operations.

Material and energy balances in food processing systems; water activity, sorption and desorption isotherms; centrifugal separation of solids, liquids and gases; kinetics of microbial death - pasteurisation and sterilization of liquid foods; preservation of food by cooling and freezing; psychrometry - properties of air-vapour mixture; concentration and dehydration of liquid foods - evaporators, tray, drum and spray dryers.

Mechanics and energy requirement in size reduction of granular solids; particle size analysis for comminuted solids; size separation by screening; fluidisation of granular solids; cleaning and grading efficiency and effectiveness of grain cleaners; conditioning and hydrothermal treatments for grains; dehydration of food grains; processes and machines for processing of cereals, pulses and oilseeds; design considerations for grain silos.

AR - ARCHITECTURE AND PLANNING

City planning: Historical development of cities; principles of city planning; new towns; survey methods, site planning, planning regulations and building bye-laws.

Housing: Concept of shelter; housing policies and design; community planning; role of government agencies; finance and management.

Landscape Design: Principles of landscape design and site planning; history and landscape styles; landscape elements and materials; planting design.

Computer Aided Design: Application of computers in architecture and planning; understanding elements of hardware and software; computer graphics; programming languages - C and Visual Basic and usage of packages such as AutoCAD.

Environmental and Building Science: Elements of environmental science; ecological principles concerning environment; role of micro-climate in design; climatic control through design elements; thermal comfort; elements of solar architecture; principles of lighting and illumination; basic principles of architectural acoustics; air pollution, noise pollution and their control.

Visual and Urban Design: Principles of visual composition; proportion, scale, rhythm, symmetry, harmony, balance, form and colour; sense of place and space, division of space; focal point, vista, imageability, visual survey.

History of Architecture: Indian - Indus valley, Vedic, Buddhist, Indo-Aryan, Dravidian and Mughal periods; European - Egyptian, Greek, Roman, medieval and renaissance periods.

Development of Contemporary Architecture: Architectural developments and impacts on society since industrial revolution; influence of modern art on architecture; works of national and international architects; post modernism in architecture.

Building Services: Water supply, Sewerage and Drainage systems; Sanitary fittings and fixtures; principles of electrification of buildings; elevators, their standards and uses; air-conditioning systems; fire fighting systems.

Building Construction and Management: Building construction techniques, methods and details; building systems and prefabrication of building elements; principles of modular coordination; estimation, specification, valuation, professional practice; project management, PERT, CPM.

Materials and Structural Systems: Behavioural characteristics of all types of building materials e.g. mud, timber, bamboo, brick, concrete, steel, glass, FRP; principles of strength of materials; design of structural elements in wood, steel and RCC; elastic and limit state design; complex structural systems; principles of pre-stressing.

Planning Theory: Planning process; multilevel planning; comprehensive planning; central place theory; settlement pattern; land use and land utilization.

Techniques of Planning: Planning surveys; Preparation of urban and regional structure plans, development plans, action plans; site planning principles and design; statistical methods; application of remote sensing techniques in urban and regional planning.

Traffic and Transportation Planning: Principles of traffic engineering and transportation planning; methods of conducting surveys; design of roads, intersections and parking areas; hierarchy of roads and levels of services; traffic and transport management in urban areas; traffic safety and traffic laws; public transportation planning; modes of transportation.

Services and Amenities: Principles and design of water supply systems, sewerage systems, solid waste disposal systems, power supply and communication systems; Health, education, recreation and demography related standards at various levels of the settlements.

Development Administration and Management: Planning laws; development control and zoning regulations; laws relating to land acquisition; development enforcements, land ceiling; regional and urban plan preparations; planning and municipal administration; taxation, revenue resources and fiscal management; public participation and role of NGO.

CE - CIVIL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

STRUCTURAL ENGINEERING

Mechanics: Bending moments and shear forces in statically determinate beams; simple stress and strain: relationship; stress and strain in two dimensions, principal stresses, stress transformation, Mohr's circle; simple bending theory; flexural shear stress; thin-walled pressure vessels; uniform torsion.

Structural Analysis: Analysis of statically determinate trusses, arches and frames; displacements in statically determinate structures and analysis of statically indeterminate structures by force/energy methods; analysis by displacement methods (slope-deflection and moment-distribution methods); influence lines for determinate and indeterminate structures; basic concepts of matrix methods of structural analysis.

Concrete Structures: Basic working stress and limit states design concepts; analysis of ultimate load capacity and design of members subject to flexure, shear, compression and torsion (beams, columns and isolated footings); basic elements of prestressed concrete: analysis of beam sections at transfer and service loads.

Steel Structures: Analysis and design of tension and compression members, beams and beam-columns, column bases; connections - simple and eccentric, beam-column connections, plate girders and trusses; plastic analysis of beams and frames.

GEOTECHNICAL ENGINEERING

Soil Mechanics: Origin of soils; soil classification; three-phase system, fundamental definitions, relationship and inter-relationships; permeability and seepage; effective stress principle: consolidation, compaction; shear strength.

Foundation Engineering: Sub-surface investigation - scope, drilling bore holes, sampling, penetrometer tests, plate load test; earth pressure theories, effect of water table, layered soils; stability of slopes - infinite slopes, finite slopes; foundation types - foundation design requirements; shallow foundations; bearing capacity, effect of shape, water table and other factors, stress distribution, settlement analysis in sands and clays; deep foundations - pile types, dynamic and static formulae, load capacity of piles in sands and clays.

WATER RESOURCES ENGINEERING

Fluid Mechanics and Hydraulics: Hydrostatics, applications of Bernoulli equation, laminar and

turbulent flow in pipes, pipe networks; concept of boundary layer and its growth; uniform flow, critical flow and gradually varied flow in channels, specific energy concept, hydraulic jump; forces on immersed bodies; flow measurement in channels; tanks and pipes; dimensional analysis and hydraulic modeling. Applications of momentum equation, potential flow, kinematics of flow; velocity triangles and specific speed of pumps and turbines.

Hydrology: Hydrologic cycle; rainfall; evaporation infiltration, unit hydrographs, flood estimation, reservoir design, reservoir and channel routing, well hydraulics.

Irrigation: Duty, delta, estimation of evapo-transpiration; crop water requirements; design of lined and unlined canals; waterways; head works, gravity dams and Ogee spillways. Designs of weirs on permeable foundation, irrigation methods.

ENVIRONMENTAL ENGINEERING

Water requirements; quality and standards, basic unit processes and operations for water treatment, distribution of water. Sewage and sewerage treatment: quantity and characteristic of waste water sewerage; primary and secondary treatment of waste water; sludge disposal; effluent discharge standards.

TRANSPORTATION ENGINEERING

Highway planning; geometric design of highways; testing and specifications of paving materials; design of flexible and rigid pavements.

CH - CHEMICAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

CHEMICAL ENGINEERING

Process Calculations and Thermodynamics: Laws of conservation of mass and energy; use of tie components; recycle, bypass and purge calculations; degree of freedom analysis.

First and Second laws of thermodynamics and their applications; equations of state and thermodynamic properties of real systems; phase equilibria; fugacity, excess properties and

correlations of activity coefficients; chemical reaction equilibria.

Fluid Mechanics and Mechanical Operations: Fluid statics, Newtonian and non-Newtonian fluids, Bernoulli equation, Macroscopic friction factors, energy balance, dimensional analysis, shell balances, flow through pipeline systems, flow meters, pumps and compressors, packed and fluidized beds, elementary boundary layer theory, size reduction and size separation; free and hindered settling; centrifuge and cyclones; thickening and classification, filtration, mixing and agitation; conveying of solids.

Heat Transfer: Conduction, convection and radiation, heat transfer coefficients, steady and unsteady heat conduction, boiling, condensation and evaporation; types of heat exchangers and evaporators and their design.

Mass Transfer: Fick's law, molecular diffusion in fluids, mass transfer coefficients, film, penetration and surface renewal theories; momentum, heat and mass transfer analogies; stagewise and continuous contacting and stage efficiencies; HTU & NTU concepts design and operation of equipment for distillation, absorption, leaching, liquid-liquid extraction, crystallization, drying, humidification, dehumidification and adsorption.

Chemical Reaction Engineering: Theories of reaction rates; kinetics of homogeneous reactions, interpretation of kinetic data, single and multiple reactions in ideal reactors, non-ideal reactors; residence time; non-isothermal reactors; kinetics of heterogeneous catalytic reactions; diffusion effects in catalysis.

Instrumentation and Process Control: Measurement of process variables; sensors, transducers and their dynamics, dynamics of simple systems, dynamics such as CSTRs, transfer functions and responses of simple systems, process reaction curve, controller modes (P, PI, and PID); control valves; analysis of closed loop systems including stability, frequency response (including Bode plots) and controller tuning, cascade, feed forward control.

Plant Design and Economics: Design and sizing of chemical engineering equipment such as compressors, heat exchangers, multistage contactors; principles of process economics and cost estimation including total annualized cost, cost indexes, rate of return, payback period, discounted cash flow, optimization in Design.

Chemical Technology: Inorganic chemical industries; sulfuric acid, NaOH, fertilizers (Ammonia, Urea, SSP and TSP); natural products industries (Pulp and Paper, Sugar, Oil, and Fats); petroleum refining and petrochemicals; polymerization industries; polyethylene, polypropylene, PVC and polyester synthetic fibers.

CS - COMPUTER SCIENCE AND ENGINEERING

ENGINEERING MATHEMATICS

Mathematical Logic: Propositional Logic; First Order Logic.

Probability: Conditional Probability; Mean, Median, Mode and Standard Deviation; Random Variables; Distributions; uniform, normal, exponential, Poisson, Binomial.

Set Theory & Algebra: Sets; Relations; Functions; Groups; Partial Orders; Lattice; Boolean Algebra.

Combinatorics: Permutations; Combinations; Counting; Summation; generating functions; recurrence relations; asymptotics.

Graph Theory: Connectivity; spanning trees; Cut vertices & edges; covering; matching; independent sets; Colouring; Planarity; Isomorphism.

Linear Algebra: Algebra of matrices, determinants, systems of linear equations, Eigen values

and Eigen vectors.

Numerical Methods: LU decomposition for systems of linear equations; numerical solutions of non linear algebraic equations by Secant, Bisection and Newton-Raphson Methods; Numerical integration by trapezoidal and Simpson's rules.

Calculus: Limit, Continuity & differentiability, Mean value Theorems, Theorems of integral calculus, evaluation of definite & improper integrals, Partial derivatives, Total derivatives, maxima & minima.

THEORY OF COMPUTATION

Formal Languages and Automata Theory: Regular languages and finite automata, Context free languages and Push-down automata, Recursively enumerable sets and Turing machines, Un-decidability;

Analysis of Algorithms and Computational Complexity: Asymptotic analysis (best, worst, average case) of time and space, Upper and lower bounds on the complexity of specific problems, NP-completeness.

COMPUTER HARDWARE

Digital Logic: Logic functions, Minimization, Design and synthesis of Combinational and Sequential circuits; Number representation and Computer Arithmetic (fixed and floating point);

Computer Organization: Machine instructions and addressing modes, ALU and Data-path, hardwired and micro-programmed control, Memory interface, I/O interface (Interrupt and DMA mode), Serial communication interface, Instruction pipelining, Cache, main and secondary storage.

SOFTWARE SYSTEMS

Data structures: Notion of abstract data types, Stack, Queue, List, Set, String, Tree, Binary search tree, Heap, Graph;

Programming Methodology: C programming, Program control (iteration, recursion, Functions), Scope, Binding, Parameter passing, Elementary concepts of Object oriented, Functional and Logic Programming;

Algorithms for problem solving: Tree and graph traversals, Connected components, Spanning trees, Shortest paths; Hashing, Sorting, Searching; Design techniques (Greedy, Dynamic Programming, Divide-and-conquer);

Compiler Design: Lexical analysis, Parsing, Syntax directed translation, Runtime environment, Code generation, Linking (static and dynamic); Operating Systems: Classical concepts (concurrency, synchronization, deadlock), Processes, threads and Inter-process communication, CPU scheduling, Memory management, File systems, I/O systems, Protection and security.

Databases: Relational model (ER-model, relational algebra, tuple calculus), Database design (integrity constraints, normal forms), Query languages (SQL), File structures (sequential files, indexing, B+ trees), Transactions and concurrency control;

Computer Networks: ISO/OSI stack, sliding window protocol, LAN Technologies (Ethernet, Token ring), TCP/UDP, IP, Basic concepts of switches, gateways, and routers.

CH - CHEMISTRY

PHYSICAL CHEMISTRY

Structure: Quantum theory - principles and techniques; applications to particle in a box, harmonic oscillator, rigid rotor and hydrogen atom; valence bond and molecular orbital theories and Huckel approximation, approximate techniques: variation and perturbation; symmetry, point groups; rotational, vibrational, electronic, NMR and ESR spectroscopy.

Equilibrium: First law of thermodynamics, heat, energy and work; second law of thermodynamics and entropy; third law and absolute entropy; free energy; partial molar quantities; ideal and non-ideal solutions; phase transformation: phase rule and phase diagrams- one, two, and three component systems; activity, activity coefficient, fugacity and fugacity coefficient ; chemical equilibrium, response of chemical equilibrium to temperature and pressure; colligative properties; kinetic theory of gases; thermodynamics of electrochemical cells; standard electrode potentials: applications - corrosion and energy conversion; molecular partition function (translational, rotational, vibrational and electronic).

Kinetics: Rates of chemical reactions, theories of reaction rates, collision and transition state theory; temperature dependence of chemical reactions; elementary reactions, consecutive elementary reactions; steady state approximation, kinetics of photochemical reactions and free radical polymerization, homogenous and heterogeneous catalysis.

INORGANIC CHEMISTRY

Non-Transition Elements: General characteristics, structure and reactions of simple and industrially important compounds, boranes, carboranes, silicates, silicones, diamond and graphite; hydrides, oxides and oxoacids of N, P, S and halogens; boron nitride, borazines and phosphazenes; xenon compounds. Shapes of molecules, hard-soft acid base concept.

Transition Elements: General characteristics of d and f block elements; coordination chemistry: structure and isomerism, stability, theories of metal-ligand bonding (CFT and LFT), electronic spectra and magnetic properties of transition metal complexes and lanthanides; metal carbonyls, metal-metal bonds and metal atom clusters, metallocenes; transition metal complexes with bonds to hydrogen, alkyls, alkenes, and arenes; metal carbenes; use of organometallic compounds as catalysts in organic synthesis; mechanisms of substitution and electron transfer reactions of coordination complexes. Role of metals with special reference to Na, K, Mg, Ca, Fe, Co, Zn, and Mo in biological systems.

Solids: Crystal systems and lattices, Miller planes, crystal packing, crystal defects; Bragg's Law; ionic crystals, band theory, metals and semiconductors. Spinels.

Instrumental methods of analysis: atomic absorption, UV-visible spectrometry, chromatographic and electro-analytical methods.

ORGANIC CHEMISTRY

Synthesis, reactions and mechanisms involving the following: Alkenes, alkynes, arenes, alcohols, phenols, aldehydes, ketones, carboxylic acids and their derivatives; halides, nitro compounds and amines; stereochemical and conformational effects on reactivity and specificity; reactions with diborane and peracids. Michael reaction, Robinson annulation, reactivity umpolung, acyl anion equivalents; molecular rearrangements involving electron deficient atoms.

Photochemistry: Basic principles, photochemistry of olefins, carbonyl compounds, arenes, photo oxidation and reduction.

Pericyclic reactions: Cycloadditions, electrocyclic reactions, sigmatropic reactions; Woodward-Hoffmann rules.

Heterocycles: Structural properties and reactions of furan, pyrrole, thiophene, pyridine, indole.

Biomolecules: Structure, properties and reactions of mono- and di-saccharides, physico-chemical properties of amino acids, structural features of proteins and nucleic acids.

Spectroscopy: Principles and applications of IR, UV-visible, NMR and mass spectrometry in the determination of structures of organic compounds.

EC - ELECTRONICS AND COMMUNICATION ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix Algebra, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Mean value theorems, Theorems of integral calculus, Evaluation of definite and improper integrals, Partial Derivatives, Maxima and minima, Multiple integrals, Fourier series. Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equation (linear and nonlinear), Higher order linear differential equations with constant coefficients, Method of variation of parameters, Cauchy's and Euler's equations, Initial and boundary value problems, Partial Differential Equations and variable separable method.

Complex variables: Analytic functions, Cauchy's integral theorem and integral formula, Taylor's and Laurent' series, Residue theorem, solution integrals.

Probability and Statistics: Sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Discrete and continuous distributions, Poisson, Normal and Binomial distribution, Correlation and regression analysis.

Numerical Methods: Solutions of non-linear algebraic equations, single and multi-step methods for differential equations.

Transform Theory: Fourier transform, Laplace transform, Z-transform.

ELECTRONICS & COMMUNICATION ENGINEERING

Networks: Network graphs: matrices associated with graphs; incidence, fundamental cut set and fundamental circuit matrices. Solution methods: nodal and mesh analysis. Network theorems: superposition, Thevenin and Norton's maximum power transfer, Wye-Delta transformation. Steady state sinusoidal analysis using phasors. Linear constant coefficient differential equations; time domain analysis of simple RLC circuits, Solution of network equations using Laplace transform: frequency domain analysis of RLC circuits. 2-port network parameters: driving point and transfer functions. State equations for networks.

Electronic Devices: Energy bands in silicon, intrinsic and extrinsic silicon. Carrier transport in silicon: diffusion current, drift current, mobility, resistivity. Generation and recombination of carriers. p-n junction diode, Zener diode, tunnel diode, BJT, JFET, MOS capacitor, MOSFET, LED, p-I-n and avalanche photo diode, LASERs. Device technology: integrated circuits fabrication process, oxidation, diffusion, ion implantation, photolithography, n-tub, p-tub and twin-tub CMOS process.

Analog Circuits: Equivalent circuits (large and small-signal) of diodes, BJTs, JFETs, and MOSFETs. Simple diode circuits, clipping, clamping, rectifier. Biasing and bias stability of transistor and FET amplifiers. Amplifiers: single-and multi-stage, differential, operational, feedback and power. Analysis of amplifiers; frequency response of amplifiers. Simple op-amp circuits. Filters. Sinusoidal oscillators; criterion for oscillation; single-transistor and op-amp configurations. Function generators and wave-shaping circuits. Power supplies.

Digital circuits: Boolean algebra, minimization of Boolean functions; logic gates digital IC families (DTL, TTL, ECL, MOS, CMOS). Combinational circuits: arithmetic circuits, code converters, multiplexers and decoders. Sequential circuits: latches and flip-flops, counters and shift-registers. Sample and hold circuits, ADCs, DACs. Semiconductor memories. Microprocessor(8085): architecture, programming, memory and I/O interfacing.

Signals and Systems: Definitions and properties of Laplace transform, continuous-time and discrete-time Fourier series, continuous-time and discrete-time Fourier Transform, z-transform. Sampling theorems. Linear Time-Invariant (LTI) Systems: definitions and properties; casuality, stability, impulse response, convolution, poles and zeros frequency response, group delay, phase delay. Signal transmission through LTI systems. Random signals and noise: probability, random variables, probability density function, autocorrelation, power spectral density.

Controls Systems: Basic control system components; block diagrammatic description, reduction of block diagrams. Open loop and closed loop (feedback) systems and stability analysis of these systems. Signal flow graphs and their use in determining transfer functions of systems; transient and steady state analysis of LTI control systems and frequency response. Tools and techniques for LTI control system analysis: root loci, Routh-Hurwitz criterion, Bode and Nyquist plots. Control system compensators: elements of lead and lag compensation, elements of Proportional-Integral-Derivative(PID) control. State variable representation and solution of state equation of LTI control systems.

Communications: Analog communication systems: amplitude and angle modulation and demodulation systems, spectral analysis of these operations, superheterodyne receivers; elements of hardware, realizations of analog communication systems; signal-to-noise ratio (SNR) calculations for amplitude modulation (AM) and frequency modulation (FM) for low noise conditions. Digital communication systems: pulse code modulation (PCM), differential pulse code modulation (DPCM), delta modulation (DM); digital modulation schemes-amplitude, phase and frequency shift keying schemes (ASK, PSK, FSK), matched filter receivers, bandwith consideration and probability of error calculations for these schemes.

Electromagnetics: Elements of vector calculus: divergence and curl; Gauss' and Stokes' theorems, Maxwell's equations: differential and integral forms. Wave equation, Poynting vector. Plane waves: propagation through various media; reflection and refraction; phase and group velocity; skin depth. Transmission lines: characteristic impedance; impedance transformation; Smith chart; impedance matching; pulse excitation. Waveguides: modes in rectangular waveguides; boundary conditions; cut-off frequencies; dispersion relations. Antennas: Dipole antennas; antenna arrays; radiation pattern; reciprocity theorem, antenna gain.

EE - ELECTRICAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix Algebra, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Mean value theorems, Theorems of integral calculus, Evaluation of definite and improper integrals, Partial Derivatives, Maxima and minima, Multiple integrals, Fourier series. Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equation (linear and nonlinear), Higher order linear differential equations with constant coefficients, Method of variation of parameters, Cauchy's and Euler's equations, Initial and boundary value problems, Partial Differential Equations and variable separable method.

Complex variables: Analytic functions, Cauchy's integral theorem and integral formula, Taylor's and Laurent' series, Residue theorem, solution integrals.

Probability and Statistics: Sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Discrete and continuous distributions, Poisson, Normal and Binomial distribution, Correlation and regression analysis.

Numerical Methods: Solutions of non-linear algebraic equations, single and multi-step methods for differential equations.

Transform Theory: Fourier transform, Laplace transform, Z-transform.

ELECTRICAL ENGINEERING

Electrical Circuits and Fields: Network graph, KCL, KVL, node/ cut set, mesh/ tie set analysis, transient response of d.c. and a.c. networks; sinusoidal steady-state analysis; resonance in electrical circuits; concepts of ideal voltage and current sources, network theorems, driving point, immittance and transfer functions of two port networks, elementary concepts of filters; three phase circuits; Fourier series and its application; Gauss theorem, electric field intensity and potential due to point, line, plane and spherical charge distribution, dielectrics, capacitance calculations for simple configurations; Ampere's and Biot-Savart's law, inductance calculations for simple configurations.

Electrical Machines: Single phase transformer - equivalent circuit, phasor diagram, tests, regulation and efficiency; three phase transformers - connections, parallel operation; auto transformer and three-winding transformer; principles of energy conversion, windings of rotating machines: D. C. generators and motors - characteristics, starting and speed control, armature reaction and commutation; three phase induction motors-performance characteristics, starting and speed control; single-phase induction motors; synchronous generators-performance, regulation, parallel operation; synchronous motors - starting, characteristics, applications, synchronous condensers; fractional horse power motors; permanent magnet and stepper motors.

Power Systems: Electric power generation - thermal, hydro, nuclear; transmission line parameters; steady-state performance of overhead transmission lines and cables and surge propagation; distribution systems, insulators, bundle conductors, corona and radio interference effects; per-unit quantities; bus admittance and impedance matrices; load flow; voltage control and power factor correction; economic operation; symmetrical components, analysis of symmetrical and unsymmetrical faults; principles of over current, differential and distance protections; concept of solid state relays and digital protection; circuit breakers; concept of system stability-swing curves and equal area criterion; basic concepts of HVDC transmission.

Control Systems: Principles of feedback; transfer function; block diagrams: steady-state errors; stability-Routh and Nyquist criteria; Bode plots; compensation; root loci; elementary state variable formulation; state transition matrix and response for Linear Time Invariant systems.

Electrical and Electronic Measurements: Bridges and potentiometers, PMMC, moving iron, dynamometer and induction type instruments; measurement of voltage, current, power, energy and power factor; instrument transformers; digital voltmeters and multimeters; phase, time and frequency measurement; Q-meter, oscilloscopes, potentiometric recorders, error analysis.

Analog and Digital Electronics: Characteristics of diodes, BJT, FET, SCR; amplifiers-biasing, equivalent circuit and frequency response; oscillators and feedback amplifiers, operational amplifiers- characteristics and applications; simple active filters; VCOs and timers; combinational and sequential logic circuits, multiplexer, Schmitt trigger, multivibrators, sample and hold circuits, A/D and D/A converters; microprocessors and their applications.

Power Electronics and Electric Drives: Semiconductor power devices-diodes, transistors,

thyristors, triacs, GTOs, MOSFETs and IGBTs - static characteristics and principles of operation; triggering circuits; phase control rectifiers; bridge converters-fully controlled and half controlled; principles of choppers and inverters, basic concepts of adjustable speed dc and ac drives.

GG - GEOLOGY AND GEOPHYSICS

PART - I

Earth and planetary system; size, shape, internal structure and composition of the earth; atmosphere and greenhouse effect; isostasy; elements of seismology; continents and continental processes; physical oceanography; palaeomagnetism, continental drift plate tectonics, geothermal energy.

Weathering; soil formation; action of river, wind and glacier; oceans and oceanic features; earthquakes, volcanoes, orogeny and mountain building; elements of structural geology; crystallography; classification, composition and properties of minerals and rocks; engineering properties of rocks and soils, role of geology in the construction of engineering structures.

Processes of ore formation, occurrence and distribution of ores on land and on ocean floor; coal and petroleum resources in India; ground water geology including well hydraulics, geological time scale and geochronology; stratigraphic principles and stratigraphy of India; basics concepts of gravity, magnetic and electrical prospecting for ores and ground water.

PART - IIA: GEOLOGY

Crystal symmetry, forms, twinning; crystal chemistry; optical mineralogy, classification of minerals, diagnostic properties of rock minerals.

Mineralogy, structure, texture and classification of igneous, sedimentary and metamorphic rock, their origin and evolution; application of thermodynamics; structure and petrology of sedimentary rocks; sedimentary processes and environments, sedimentary facies, basin studies; basement cover relationship;

Primary and secondary structures; geometry and genesis of folds, faults, joints, unconformities, cleavage, schistosity and lineation; methods of projection. Tectonites and their significance; shear zone; superposed folding.

Morphology, classification and geological significance of important invertebrates, vertebrates, microfossils and palaeoflora; stratigraphic principles and Indian stratigraphy; geomorphic processes and agents; development and evolution of landforms; slope and drainage; processes on deep oceanic and near-shore regions; quantitative and applied geomorphology; air photo interpretation and remote sensing; chemical and optical properties of ore minerals; formation and localization of ore deposits; prospecting and exploration of economic minerals; coal and petroleum geology; origin and distribution of mineral and fuel deposits in India; ore dressing and mineral economics.

Cosmic abundance; meteorites; geochemical evolution of the earth; geochemical cycles; distribution of major, minor and trace elements; isotope geochemistry; geochemistry of waters including solution equilibria and water rock interaction.

Engineering properties of rocks and soils; rocks as construction material; geology of dams, tunnels and excavation sites; natural hazards; the fly ash problem; ground water geology and exploration; water quality; impact of human activity; Remote sensing techniques for the interpretation of landforms and resource management.

PART - II B: GEOPHYSICS

The earth as a planet; different motions of the earth; gravity filed of the earth and its shape;

geochronology; isostasy, seismology and interior of the earth; variation of density, velocity, pressure, temperature, electrical and magnetic properties inside the earth; earthquakes-causes and measurements; zonation and seismic hazards; geomagnetic field, palaeomagnetism; oceanic and continental lithosphere; plate tectonics; heat flow; upper and lower atmospheric phenomena.

Theories of scalar and vector potential fields; Laplace, Maxwell and Helmholtz equations for solution of different types of boundary value problems for Cartesian, cylindrical and spherical polar coordinates; Green's theorem; Image theory; integral equations and conformal transformations in potential theory; Eikonal equation and ray theory.

'G' and 'g' units of measurement, density of rocks, gravimeters, preparation, analysis and interpretation of gravity maps; derivative maps, analytical continuation; gravity anomaly type curves; calculation of mass.

Earth's magnetic field, units of measurement, magnetic susceptibility of rocks, magnetometers, corrections, preparation of magnetic maps, magnetic anomaly type curve, analytical continuation, interpretation and application; magnetic well logging.

Conduction of electricity through rocks, electrical conductivities of metals, metallic, non-metallic and rock forming minerals, D.C. resistivity units and methods of measurement, electrode configuration for sounding and profiling, application of filter theory, interpretation of resistivity field data, application; self potential origin, classification, field measurement, interpretation of induced polarization time frequency, phase domain; IP units and methods of measurement, interpretation and application; ground-water exploration.

Origin of electromagnetic field elliptic polarization, methods of measurement for different source-receiver configuration components in EM measurements, interpretation and applications; earth's natural electromagnetic field, tellurics, magneto-tellurics; geomagnetic depth sounding principles, methods of measurement, processing of data and interpretation.

Seismic methods of prospecting: Reflection, refraction and CDP surveys; land and marine seismic sources, generation and propagation of elastic waves, velocity increasing with depth, geophones, hydrophones, recording instruments (DFS), digital formats, field layouts, seismic noises and noise profile analysis, optimum geophone grouping, noise cancellation by shot and geophone arrays, 2D and 3D seismic data acquisition and processing, CDP stacking charts, binning, filtering, dip-moveout, static and dynamic corrections, deconvolution, migration, signal processing, Fourier and Hilbert transforms, attribute analysis, bright and dim spots, seismic stratigraphy, high resolution seismics, VSP.

Principles and techniques of geophysical well-logging, SP, resistivity, induction, micro gamma ray, neutron, density, sonic, temperature, dip meter, caliper, nuclear magnetic, cement bond logging. Quantitative evaluation of formations from well logs; well hydraulics and application of geophysical methods for groundwater study; application of bore hole geophysics in ground water, mineral and oil exploration. Remote sensing techniques and application of remote sensing methods in geophysics.

IN - INSTRUMENTATION ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix Algebra, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Mean value theorems, Theorems of integral calculus, Evaluation of definite and improper integrals, Partial Derivatives, Maxima and minima, Multiple integrals, Fourier series. Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equation (linear and nonlinear), Higher order linear

differential equations with constant coefficients, Method of variation of parameters, Cauchy's and Euler's equations, Initial and boundary value problems, Partial Differential Equations and variable separable method.

Complex variables: Analytic functions, Cauchy's integral theorem and integral formula, Taylor's and Laurent' series, Residue theorem, solution integrals.

Probability and Statistics: Sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Discrete and continuous distributions, Poisson, Normal and Binomial distribution, Correlation and regression analysis.

Numerical Methods: Solutions of non-linear algebraic equations, single and multi-step methods for differential equations.

Transform Theory: Fourier transform, Laplace transform, Z-transform.

INSTRUMENTATION ENGINEERING

Measurement Basics and Metrology: Static and dynamic characteristics of measurement systems. Standards and calibration. Error and uncertainty analysis, statistical analysis of data, and curve fitting. Linear and angular measurements; Measurement of straightness, flatness, roundness and roughness.

Transducers, Mechanical Measurements and Industrial Instrumentation: Transducers - elastic, resistive, inductive, capacitive, thermo-electric, piezoelectric, photoelectric, electro-mechanical, electro-chemical, and ultrasonic. Measurement of displacement, velocity (linear and rotational), acceleration, shock, vibration, force, torque, power, strain, stress, pressure, flow, temperature, humidity, viscosity, and density. energy storing elements, suspension systems and dampers.

Analog Electronics: Characteristics of diodes, BJTs, JFETs and MOSFETs; Diode circuits; Amplifiers: single and multi-stage, feedback; Frequency response; Operational amplifiers - design, characteristic, linear and non-linear applications: difference amplifiers; instrumentation amplifiers; precision rectifiers, I-to-V converters, active filters, oscillators, comparators, signal generators, wave shaping circuits.

Digital Electronics: Combinational logic circuits, minimization of Boolean functions; IC families (TTL, MOS, CMOS), arithmetic circuits, multiplexer and decoders. Sequential circuits: flip-flops, counters, shift registers. Schmitt trigger, timers, and multivibrators. Analog switches, multiplexers, S/H circuits. Analog-to-digital and digital-to-analog converters. Basics of computer organization and architecture. 8-bit microprocessor (8085), applications, memory, I/O interfacing, and microcontrollers.

Signals and Systems: Vectors and matrices; Fourier series; Fourier transforms; Ordinary differential equations. Impulse and frequency responses of first and second order systems. Laplace transform and transfer function, convolution and correlation. Amplitude and frequency modulations and demodulations. Discrete time systems, difference equations, impulse and frequency responses; Z-transforms and transfer functions; IIR and FIR filters.

Electrical and Electronic Measurements: Measurement of R, L and C; bridges and potentiometers. Measurement of voltage, current, power, power factor, and energy; Instrument transformers; Q meter, waveform analyzers. Digital volt-meters and multi-meters. Time, phase and frequency measurements; Oscilloscope. Noise and interference in instrumentation.

Control Systems & Process Control: Principles of feedback; transfer function, signal flow graphs. Stability criteria, Bode plots, root-loci, Routh and Nyquist criteria. Compensation techniques; State space analysis. System components: mechanical, hydraulic, pneumatic, electrical and electronic; Servos and synchros; Stepper motors. On-off, cascade, P, PI, PID

and feed-forward controls. Controller tuning and general frequency response.

Analytical, Optical and Biomedical Instrumentation: Principles of spectrometry, UV, visible, IR mass spectrometry, X-ray methods; nuclear radiation measurements, gas, solid and semi conductor lasers and their characteristics, interferometers, basics of fibre optics, transducers in biomedical applications, cardiovascular system measurements, instrumentation for clinical laboratory.

MA - MATHEMATICS

Linear Algebra: Finite dimensional vector spaces. Linear transformations and their matrix representations, rank; systems of linear equations, eigenvalues and eigenvectors, minimal polynomial, Cayley-Hamilton theorem, diagonalisation, Hermitian, Skew-Hermitian and unitary matrices. Finite dimensional inner product spaces, self-adjoint and Normal linear operators, spectral theorem, Quadratic forms.

Complex Analysis: Analytic functions, conformal mappings, bilinear transformations, complex integration: Cauchy's integral theorem and formula, Liouville's theorem, maximum modulus principle, Taylor and Laurent's series, residue theorem and applications for evaluating real integrals.

Real Analysis: Sequences and series of functions, uniform convergence, power series, Fourier series, functions of several variables, maxima, minima, multiple integrals, line, surface and volume integrals, theorems of Green, Stokes and Gauss; metric spaces, completeness, Weierstrass approximation theorem, compactness. Lebesgue measure, measurable functions; Lebesgue integral, Fatou's lemma, dominated convergence theorem.

Ordinary Differential Equations: First order ordinary differential equations, existence and uniqueness theorems, systems of linear first order ordinary differential equations, linear ordinary differential equations of higher order with constant coefficients; linear second order ordinary differential equations with variable coefficients, method of Laplace transforms for solving ordinary differential equations, series solutions; Legendre and Bessel functions and their orthogonality, Sturm Liouville system, Greeen's functions.

Algebra: Normal subgroups and homomorphisms theorems, automorphisms. Group actions, sylow's theorems and their applications groups of order less than or equal to 20, Finite p-groups. Euclidean domains, Principal ideal domains and unique factorizations domains. Prime ideals and maximal ideals in commutative rings.

Functional Analysis: Banach spaces, Hahn-Banach theorems, open mapping and closed graph theorems, principle of uniform boundedness; Hilbert spaces, orthonormal sets, Riesz representation theorem, self-adjoint, unitary and normal linear operators on Hilbert Spaces.

Numerical Analysis: Numerical solution of algebraic and transcendental equations; bisection, secant method, Newton-Raphson method, fixed point iteration, interpolation: existence and error of polynomial interpolation, Lagrange, Newton, Hermite(osculatory)interpolations; numerical differentiation and integration, Trapezoidal and Simpson rules; Gaussian quadrature; (Gauss-Legendre and Gauss-Chebyshev), method of undetermined parameters, least square and orthonormal polynomial approximation; numerical solution of systems of linear equations: direct and iterative methods, (Jacobi Gauss-Seidel and SOR) with convergence; matrix eigenvalue problems: Jacobi and Given's methods, numerical solution of ordinary differential equations: initial value problems, Taylor series method, Runge-Kutta methods, predictor-corrector methods; convergence and stability.

Partial Differential Equations: Linear and quasilinear first order partial differential equations, method of characteristics; second order linear equations in two variables and their classification; Cauchy, Dirichlet and Neumann problems, Green's functions; solutions of Laplace, wave and diffusion equations in two variables Fourier series and transform methods of solutions of the above equations and applications to physical problems.

Mechanics: Forces in three dimensions, Poinsot central axis, virtual work, Lagrange's equations for holonomic systems, theory of small oscillations, Hamiltonian equations;

Topology: Basic concepts of topology, product topology, connectedness, compactness, countability and separation axioms, Urysohn's Lemma, Tietze extension theorem, metrization theorems, Tychonoff theorem on compactness of product spaces.

Probability and Statistics: Probability space, conditional probability, Bayes' theorem, independence, Random variables, joint and conditional distributions, standard probability distributions and their properties, expectation, conditional expectation, moments. Weak and strong law of large numbers, central limit theorem. Sampling distributions, UMVU estimators, sufficiency and consistency, maximum likelihood estimators. Testing of hypotheses, Neyman-Pearson tests, monotone likelihood ratio, likelihood ratio tests, standard parametric tests based on normal, X2 ,t, F-distributions. Linear regression and test for linearity of regression. Interval estimation.

Linear Programming: Linear programming problem and its formulation, convex sets their properties, graphical method, basic feasible solution, simplex method, big-M and two phase methods, infeasible and unbounded LPP's, alternate optima. Dual problem and duality theorems, dual simplex method and its application in post optimality analysis, interpretation of dual variables. Balanced and unbalanced transportation problems, unimodular property and u-v method for solving transportation problems. Hungarian method for solving assignment problems.

Calculus of Variations and Integral Equations: Variational problems with fixed boundaries; sufficient conditions for extremum, Linear integral equations of Fredholm and Volterra type, their iterative solutions. Fredholm alternative.

ME - MECHANICAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

APPLIED MECHANICS AND DESIGN

Engineering Mechanics: Equivalent force systems, free-body concepts, equations of

equilibrium, trusses and frames, virtual work and minimum potential energy. Kinematics and dynamics of particles and rigid bodies, impulse and momentum (linear and angular), energy methods, central force motion.

Strength of Materials: Stress and strain, stress-strain relationship and elastic constants, Mohr's circle for plane stress and plane strain, shear force and bending moment diagrams, bending and shear stresses, deflection of beams, torsion of circular shafts, thin and thick cylinders, Euler's theory of columns, strain energy methods, thermal stresses.

Theory of Machines: Displacement, velocity and acceleration, analysis of plane mechanisms, dynamic analysis of slider-crank mechanism, planar cams and followers, gear tooth profiles, kinematics of gears, governors and flywheels, balancing of reciprocating and rotating masses.

Vibrations: Free and forced vibration of single degree freedom systems, effect of damping, vibration isolation, resonance, critical speed of rotors.

Design of Machine Elements: Design for static and dynamic loading, failure theories, fatigue strength; design of bolted, riveted and welded joints; design of shafts and keys; design of spur gears, rolling and sliding contact bearings; brakes and clutches; belt, rope and chain drives.

FLUID MECHANICS AND THERMAL SCIENCES

Fluid Mechanics: Fluid properties, fluid statics, manometry, buoyancy; control-volume analysis of mass, momentum and energy; fluid acceleration; differential equations of continuity and momentum; Bernoulli's equation; viscous flow of incompressible fluids; boundary layer; elementary turbulent flow; flow through pipes, head losses in pipes, bends etc.

Heat-Transfer: Modes of heat transfer; one dimensional heat conduction, resistance concept, electrical analogy, unsteady heat conduction, fins; dimensionless parameters in free and forced convective heat transfer, various correlations for heat transfer in flow over flat plates and through pipes; thermal boundary layer; effect of turbulence; radiative heat transfer, black and grey surfaces, shape factors, network analysis; heat exchanger performance, LMTD and NTU methods.

Thermodynamics: Zeroth, First and Second laws of thermodynamics; thermodynamic system and processes; irreversibility and availability; behaviour of ideal and real gases, properties of pure substances, calculation of work and heat in ideal processes; analysis of thermodynamic cycles related to energy conversion; Carnot, Rankine, Otto, Diesel, Brayton and vapour compression cycles.

Power Plant Engineering: Steam generators; steam power cycles; steam turbines; impulse and reaction principles, velocity diagrams, pressure and velocity compounding; reheating and reheat factor; condensers and feed heaters.

I.C. Engines: Requirements and suitability of fuels in IC engines, fuel ratings, fuel-air mixture requirements; normal combustion in SI and CI engines; engine performance calculations.

Refrigeration and air-conditioning: Refrigerant compressors, expansion devices, condensers and evaporators; properties of moist air, psychrometric chart, basic psychometric processes.

Turbomachinery: Components of gas turbines; compression processes, centrifugal and axial flow compressors; axial flow turbines, elementary theory; hydraulic turbines; Euler-turbine equation; specific speed, Pelton-wheel, Francis and Kaplan turbines; centrifugal pumps.

MANUFACTURING AND INDUSTRIAL ENGINEERING

Engineering Materials: Structure and properties of engineering materials and their applications, heat treatment.

Metal Casting: Casting processes (expendable and non-expendable) -pattern, moulds and cores, heating and pouring, solidification and cooling, gating design, design considerations, defects.

Forming Processes: Stress-strain diagrams for ductile and brittle material, Plastic deformation and yield criteria, fundamentals of hot and cold working processes, Bulk metal forming processes (forging, rolling, extrusion, drawing), sheet metal working processes (punching, blanking, bending, deep drawing, coining, spinning, load estimation using homogeneous deformation methods, defects). processing of powder metals- atomization, compaction, sintering, secondary and finishing operations. forming and shaping of plastics- extrusion, injection moulding.

Joining Processes: Physics of welding, fusion and non-fusion welding processes, brazing and soldering, adhesive bonding, design considerations in welding, weld quality defects.

Machining and Machine Tool Operations: Mechanics of machining, single and multi-point cutting tools, tool geometry and materials, tool life and wear, cutting fluids, machinability, economics of machining, non-traditional machining processes.

Metrology and Inspection: Limits, fits and tolerances, linear and angular measurements, comparators, gauge design, interferometry, form and finish measurement, measurement of screw threads, alignment and testing methods.

Tool Engineering: Principles of work holding, design of jigs and fixtures.

Computer Integrated Manufacturing: Basic concepts of CAD, CAM and their integration tools.

Manufacturing Analysis: Part-print analysis, tolerance analysis in manufacturing and assembly, time and cost analysis.

Work-Study: Method study, work measurement, time study, work sampling, job evaluation, merit rating.

Production Planning and Control: Forecasting models, aggregate production planning, master scheduling, materials requirements planning.

Inventory Control: Deterministic and probabilistic models, safety stock inventory control systems.

Operations Research: Linear programming, simplex and duplex method, transportation, assignment, network flow models, simple queuing models, PERT and CPM

MN - MINING ENGINEERING

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace,

heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

MINING ENGINEERING

Mechanics: Equivalent force systems, equations of equilibrium, two dimensional frames and trusses, free body diagrams, friction forces, particle kinematics and dynamics.

Mine Development, Geomechanics and Strata Control: Drivages for underground mine development, drilling methods and machines, explosives, blasting devices and practices, shaft sinking. Physico-mechanical properties of rocks, rock mass classification, ground control instrumentation and stress measurement techniques, theories of rock failure, ground vibrations, stress distribution around mine openings, subsidence, design of supports in roadways and workings, stability of open pits, slopes.

Mining Methods and Machinery: Surface mining - layout, development, loading, transportation and mechanization, continuous surface mining systems. Underground coal mining - bord and pillar system, longwall mining, thick seam mining methods. Underground metal mining: different stoping methods, stope mechanization, ore handling systems, mine filling. Generation and transmission of mechanical, hydraulic, and pneumatic power. Materials handling - haulages, conveyors, ropeways, face and development machinery, hoisting systems, and pumps.

Ventilation, Underground Hazards and Surface Environment: Underground atmosphere, heat load sources and thermal environment, air cooling, mechanics of air flow distribution, natural and mechanical ventilation, mine fans and their usage, auxiliary ventilation. Subsurface hazards from fires, explosions, gases, dust, and inundation, rescue apparatus and practices, safety in mines, accident analysis, noise, mine lighting. Air and water pollution: causes, dispersion, quality standards, and control.

Surveying, Mine Planning and Systems Engineering: Fundamentals of engineering surveying, Levels and levelling, Theodolite, tacheometry, triangulation, contouring, errors and adjustments, correlation, underground surveying, curves, photogrammetry, field astronomy, GPS fundamentals. Principles of planning - Sampling methods and practices, reserve estimation techniques, basics of geostatistics, optimization of facility location, cash flow concepts and mine valuation, open pit design. Work study, concepts of reliability, reliability of series and parallel systems. Linear programming, transportation and assignment problems, queueing, network analysis, inventory control.

MT - METALLURGICAL ENGINEERING

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace,

heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

METALLURGICAL ENGINEERING

Thermodynamics and Rate Processes: Laws of thermodynamics, activity, equilibrium constant, applications to metallurgical systems, solutions, phase equilibria, basic kinetic laws, order of reactions, rate constants and rate limiting steps principles of electro chemistry, aqueous, corrosion and protection of metals, oxidation and high temperature corrosion - characterization and control; momentum transfer - concepts of viscosity, shell balances, Bernoulli's equation; heat transfer - conduction, convection and heat transfer coefficient relations, radiation, mass transfer - diffusion and Fick's laws.

Extractive Metallurgy: Flotation, gravity and other methods of mineral processing; agglomeration, pyro-hydro-and electro-metallurgical processes; material and energy balances; principles and processes for the extraction of non-ferrous metals - aluminium, copper, zinc, lead, magnesium, nickel, titanium and other rare metals; iron and steel making - principles, blast furnace, direct reduction processes, primary and secondary steel making, deoxidation and inclusion in steel; ingot and continuous casting; stainless steel making, design of furnaces; fuels and refractories.

Physical Metallurgy: Crystal structure and bonding characteristics of metals, alloys, ceramics and polymers; solid solutions; solidification; phase transformation and binary phase diagrams; principles of heat treatment of steels, aluminum alloys and cast irons; recovery, recrystallization and grain growth; industrially important ferrous and non-ferrous alloys; elements of X-ray and electron diffraction; principles of scanning and transmission electron microscopy; elements of ceramics, composites and electronic materials; electronic basis of thermal, optical, electrical and magnetic properties of materials.

Mechanical Metallurgy: Elements of elasticity and plasticity; defects in crystals; elements of dislocation theory - types of dislocations, slip and twinning, stress fields of dislocations, dislocation interactions and reactions, methods of seeing dislocations; strengthening mechanisms; tensile, fatigue and creep behaviour; superplasticity; fracture - Griffith theory, ductile to brittle transition, fracture toughness; failure analysis; mechanical testing - tension, compression, torsion, hardness, impact, creep, fatigue, fracture toughness and formability tests.

Manufacturing Processes: Metal casting - patterns, moulds, melting, gating, feeding and casting processes, defects and castings, hot and cold working of metals; Metal forming - fundamentals of metal forming, rolling wire drawing, extrusion, forming, sheet metal forming processes, defects in forming; Metal joining - soldering, brazing and welding, common welding processes, welding metallurgy, problems associated with welding of steels and aluminium alloys, defects in welding, powder metallurgy; NDT methods - ultrasonic, radiography, eddy current, acoustic emission and magnetic.

PH - PHYSICS

Mathematical Physics: Linear vector space, matrices; vector calculus; linear differential equations; elements of complex analysis; Laplace transforms, Fourier analysis, elementary ideas about tensors.

Classical Mechanics: Conservation laws; central forces; collisions and scattering in laboratory and centre of mass reference frames; mechanics of system of particles; rigid body dynamics; moment of inertia tensor; noninertial frames and pseudo forces; variational principle;

Lagrange's and Hamilton's formalisms; equation of motion, cyclic coordinates, Poisson bracket; periodic motion, small oscillations, normal modes; wave equation and wave propagation; special theory of relativity - Lorentz transformations, relativistic kinematics, mass-energy equivalence.

Electromagnetic Theory: Laplace and Poisson equations; conductors and dielectrics; boundary value problems; Ampere's and Biot-Savart's laws; Faraday's law; Maxwell's equations; scalar and vector potentials; Coulomb and Lorentz gauges; boundary conditions at interfaces; electromagnetic waves; interference, diffraction and polarization; radiation from moving charges.

Quantum Mechanics: Physical basis of quantum mechanics; uncertainty principle; Schrodinger equation; one and three dimensional potential problems; Particle in a box, harmonic oscillator, hydrogen atom; linear vectors and operators in Hilbert space; angular momentum and spin; addition of angular momentum; time independent perturbation theory; elementary scattering theory.

Atomic and Molecular Physics: Spectra of one-and many-electron atoms; LS and jj coupling; hyperfine structure; Zeeman and Stark effects; electric dipole transitions and selection rules; X-ray spectra; rotational and vibrational spectra of diatomic molecules; electronic transition in diatomic molecules, Franck-Condon principle; Raman effect; NMR and ESR; lasers.

Thermodynamics and Statistical Physics: Laws of thermodynamics; macrostates, phase space; probability ensembles; partition function, free energy, calculation of thermodynamic quantities; classical and quantum statistics; degenerate Fermi gas; black body radiation and Planck's distribution law; Bose-Einstein condensation; first and second order phase transitions, critical point.

Solid State Physics: Elements of crystallography; diffraction methods for structure determination; bonding in solids; elastic properties of solids; defects in crystals; lattice vibrations and thermal properties of solids; free electron theory; band theory of solids; metals, semiconductors and insulators; transport properties; optical, dielectric and magnetic properties of solids; elements of superconductivity.

Nuclear and Particle Physics: Rutheford scattering; basic properties of nuclei; radioactive decay; nuclear forces; two nucleon problem; nuclear reactions; conservation laws; fission and fusion; nuclear models; particle accelerators, detectors; elementary particles; photons, baryons, mesons and leptons; Quark model.

Electronics: Network analysis; semiconductor devices; bipolar transistors; FETs; power supplies, amplifier, oscillators; operational amplifiers; elements of digital electronics; logic circuits.

PI - PRODUCTION AND INDUSTRIAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

GENERAL ENGINEERING:

Engineering Materials: Structure and properties of engineering materials and their applications; effect of strain, strain rate and temperature on mechanical properties of metals and alloys; heat treatment of metals and alloys.

Applied Mechanics: Engineering mechanics - equivalent force systems, free body concepts, equations of equilibrium, virtual work and minimum potential energy; strength of materials- stress, strain and their relationship, Mohr's circle, deflection of beams, bending and shear stress, Euler's theory of columns.

Theory of Machines and Design: Analysis of planar mechanisms, plane cams and followers; governers and fly wheels; design of elements-failure theories; design of bolted, riveted and welded joints; design of shafts, keys, belt drives, brakes and clutches.

Thermal Engineering: Fluid machines - fluid statics, Bernoulli's equation, flow through pipes, equations of continuity and momentum; Thermodynamics - zeroth, First and Second laws of thermodynamics, thermodynamic system and processes, calculation of work and heat for systems and control volumes; Heat transfer - fundamentals of conduction, convection and radiation.

PRODUCTION ENGINEERING

Metal Casting: Casting processes; patterns-materials; allowances; moulds and cores - materials, making and testing; melting and founding of cast iron, steels and nonferrous metals and alloys; solidification; design of casting, gating and risering; casting defects and inspection.

Metal working: Stress-strain in elastic and plastic deformation; deformation mechanisms; hot and cold working-forging, rolling, extrusion, wire and tube drawing; sheet metal working; analysis of rolling, forging, extrusion and wire /rod drawing; metal working defects, high energy rate forming processes-explosive, magnetic, electro and electrohydraulic.

Metal Joining Processes: Welding processes - gas shielded metal arc, TIG, MIG, submerged arc, electroslag, thermit, resistance, pressure and forge welding; thermal cutting; other joining processes - soldering, brazing, braze welding; welding codes, welding symbols, design of welded joints, defects and inspection; introduction to modern welding processes - friction, ultrasonic, explosive, electron beam, laser and plasma.

Machining and Machine Tool Operations: Machining processes-turning, drilling, boring, milling, shaping, planing, sawing, gear cutting, thread production, broaching, grinding, lapping, honing super finishing; mechanics of cutting- Merchant's analysis, geometry of cutting tools, cutting forces, power requirements; selection of process parameters; tool materials, tool wear and tool life, cutting fluids, machinability; nontraditional machining processes and hybrid processes- EDM, CHM, ECM, USM, LBM, EBM, AJM, PAM AND WJM; economics of machining.

Metrology and Inspection: Limits and fits, linear and angular measurements by mechanical and optical methods, comparators; design of limit gauges; interferometry; measurement of straightness, flatness, roundness, squareness and symmetry; surface finish measurement; inspection of screw threads and gears; alignment testing.

Powder Metallurgy and Processing of Plastics: Production of powders, compaction, sintering; Polymers and composites; injection, compression and blow molding, extrusion, calendaring and thermoforming; molding of composites.

Tool Engineering: Work-holding-location and clamping; principles and methods; design of jigs and fixtures; design of press working tools, forging dies.

Manufacturing Analysis: Sources of errors in manufacturing; process capability; part-print analysis; tolerance analysis in manufacturing and assembly; process planning; parameter selection and comparison of production alternatives; time and cost analysis; Issues in choosing manufacturing technologies and strategies.

Computer Integrated Manufacturing: Basic concepts of CAD, CAM, CAPP, group technology, NC, CNC, DNC, FMS, Robotics and CIM.

INDUSTRIAL ENGINEERING

Product Design and Development: Principles of good product design, component and tolerance design; efficiency, quality and cost considerations; product life cycle; standardization, simplification, diversification, value analysis, concurrent engineering.

Engineering Economy and Costing: Financial statements; elementary cost accounting, methods of depreciation; break-even analysis, techniques for evaluation of capital investments.

Work System Design: Taylor's scientific management, Gilbreths's contributions; productivity concepts and measurements; method study, micro-motion study, principles of motion economy; human factors engineering, ergonomics; work measurement - time study, PMTS, work sampling; job evaluation, merit rating, wage administration, incentive systems; business process reengineering.

Logistics and Facility Design: Facility location factors, evaluation of alternatives, types of plant layout, evaluation; computer aided layout; assembly line balancing; material handling systems; supply chain management.

Production Planning and Inventory Control: Inventory Function costs, classifications - deterministic and probabilistic models; quantity discount; safety stock; inventory control system; Forecasting techniques - causal and time series models, moving average, exponential smoothing; trend and seasonality; aggregate production planning; master scheduling; bill of materials and material requirement planning; order control and flow control, routing, scheduling and priority dispatching; JIT; Kanban PULL systems; bottleneck scheduling and theory of constraints.

Operation Research: Linear programming - problem formulation, simplex method, duality and sensitivity analysis; transportation; assignment; network flow models, constrained optimization and Lagrange multipliers; simple queuing models; dynamic programming; simulation; PERT and CPM, time-cost trade-off, resource leveling.

Quality Control: Taguchi method; design of experiments; quality costs, statistical quality assurance, process control charts, acceptance sampling, zero defects; quality circles, total quality management.

Reliability and Maintenance: Reliability, availability and maintainability; probabilistic failure and repair times; system reliability; preventive maintenance and replacement, TPM.

Management Information System: Value of information; information storage and retrieval system - database and data structures; interactive systems; knowledge based systems.

Intellectual Property System: Definition of intellectual property, importance of IPR; TRIPS, and its implications, WIPO and Global IP structure, and IPS in India; patent, copyright, industrial design and trademark; meanings, rules and procedures, terms, infringements and remedies.

PY - PHARMACEUTICAL SCIENCES

Natural Products: Pharmacognosy & Phytochemistry - Chemistry, tests, isolation, characterization and estimation of phytopharmaceuticals belonging to the group of Alkaloids, Glycosides, Terpenoids, Steroids, Bioflavanoids, Purines, Guggul lipids. Pharmacognosy of crude drugs which contain the above constituents. Standardisation of raw materials and herbal products. WHO guide lines. Quantitative microscopy including modern techniques used for evaluation. Biotechnological principles and techniques for plant development Tissue culture.

Pharmacology: General pharmacological principles including Toxicology. Drug interaction. Pharmacology of drugs acting on Central nervous system, Cardiovascular system, Autonomic nervous system, Gastro intestinal system and Respiratory system. Pharmacology of Autocoids, Hormones, Chemotherapeutic agents including anticancer drugs. Bioassays. Immuno Pharmacology.

Medicinal Chemistry: Structure, nomenclature, classification, synthesis, SAR and metabolism of the following category of drugs which are official in Indian Pharmacopoeia and British Pharmacopoeia Hypnotics and Sedatives, Analgesics, NSAIDS, Neuroleptics, Antidepressants, Anxiolytics, Anticonvulsants, Antihistaminics, Local anaesthetics, Cardio Vascular drugs - Antianginal agents Vasodilators, Adrenergic & cholinergic drugs, Cardiotonic agents, Diuretics, Antihypertensive drugs, Hypoglycemic agents, Antilipedmic agents, Coagulants, Anticoagulants, Antiplatelet agents. Chemotherapeutic agents - Antibiotics, Antibacterials, Sulphadrugs. Antiproliozoal drugs, Antiviral, Antitubercular, Antimalarial, Anticancer, Antiamoebic drugs. Diagnostic agents. Preparation and storage and uses of official Radiopharmaceuticals. Vitamins and Hormones.

Pharmaceutics: Development, manufacturing standards, labeling, packing as per the pharmacopoeal requirements, Storage of different dosage forms and new drug delivery systems. Biopharmaceutics and Pharmacokinetics and their importance in formulation. Formulation and preparation of cosmetics - lipstick, shampoo, creams, nail preparations and dentifrices. Pharmaceutical calculations.

Pharmaceutical Jurisprudence: Legal aspects of manufacture, storage, sale of drugs. D and C act and rules. Pharmacy act.

Pharmaceutical Analysis: Principles, instrumentation and applications of the following. Absorption spectroscopy (UV, visible & IR), Fluorimetry, Flame photometry, Potentiometry, Conductometry and Plarography. Pharmacopoeial assays. Principles of NMR, ESR, Mass spectroscopy, X-ray diffraction analysis and different chromatographic methods.

Biochemistry and Clinical Pharmacy: Biochemical role of hormones, Vitamins, Enzymes, Nucleic acids. Bioenergetics. General principles of immunology. Immunological techniques. Adverse drug interaction.

Microbiology: Principles and methods of microbiological assays of the Pharmacopoeia. Methods of preparation of official sera and vaccines. Serological and diagnostic tests. Applications of microorganisms in Bio Conversions and in Pharmaceutical industry.

TF - TEXTILE ENGINEERING AND FIBRE SCIENCE

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

TEXTILE ENGINEERING & FIBRE SCIENCE

Textile Fibres: Classification of textile fibres according to their nature and origin; general characteristics of textile fibres-their chemical and physical structures and their properties; essential characteristics of fibre forming polymers; uses of natural and man-made fibres; physical and chemical methods of fibre and blend identification and blend analysis.

Melt Spinning processes with special reference to polyamide and polyester fibres; wet and dry spinning of viscose and acrylic fibres; post spinning operations-drawing, heat setting, texturing- false twist and air-jet, tow-to-top conversion. Methods of investigating fibre structure e.g. X-ray diffraction, birefringence, optical and electron microscopy, I.R. absorption, thermal methods; structure and morphology and principal natural and man-made fibres, mechanical properties of fibres, moisture sorption in fibres; fibre structure and property correlation.

Textile Testing: Sampling techniques, sample size and sampling errors; measurement of fibre length, fineness, crimp, strength and reflectance; measurement of cotton fibre maturity ad trash content; HVI and AFIS for fibre testing. Measurement of yarn count, twist and hairiness; tensile testing of fibres, yarn and fabrics; evenness testing of slivers, rovings and yarns; testing equipment for measurement test methods of fabric properties like thickness, compressibility, air permeability, drape, crease recovery, tear strength bursting strength and abrasion resistance. Correlation analysis, significance tests and analysis of variance; frequency distributions and control charts.

Yarn Manufacture and Yarn Structure: Modern methods of opening, cleaning and blending of fibrous materials; the technology of carding with particular reference to modern developments; causes of irregularity introduced by drafting, the development of modern drafting systems; principles and techniques of preparing material for combing; recent development in combers; functions and synchronization of various mechanisms concerned with roving production; forces acting on yarn and traveller, ring and traveller designs; causes of end breakages; properties of doubles yarns; new methods of yarn production such as rotor spinning, air jet spinning and friction spinning.

Yarn diameter; specific volume, packing coefficient; twist-strength relationship; fibre orientation in yarn; fibre migration.

Fabric Manufacture and Fabric Structure: Principles of cheese and cone winding processes and machines; random and precision winding; package faults and their remedies; yarn clearers and tensioners; different systems of yarn splicing; features of modern cone winding machines; different types of warping creels; features of modern beam and sectional warping machines; different sizing systems, sizing of spun and filament yarns, modern sizing machines; principles of pirn winding processes and machines; primary and secondary motions of loom, effect of their settings and timings on fabric formation, fabric appearance and weaving performance;

dobby and jacquard shedding; mechanics of weft insertion with shuttle; warp and weft stop motions, warp protection, weft replenishment; functional principles of weft insertion systems of shuttleless weaving machines, principles of multiphase and circular looms. Principles of weft and warp knitting; basic weft and warp knitted structures; classification, production and areas of application of nonwoven fabrics.

Basic woven fabric constructions and their derivatives; crepe, cord, terry, gauze, lino and double cloth constructions.

Peirce's equations for fabric geometry; thickness, cover and maximum sett of woven fabrics

Textile Chemical Processing: Preparatory processes for natural-and and their blends; mercerization of cotton; machines for yarn and fabric mercerization.

Dyeing and printing of natural- and synthetic- fibre fabrics and their blends with different dye classes; dyeing and printing machines; styles of printing; fastness properties of dyed and printed textile materials.

Finishing of textile materials, wash and wear, durable press, soil release, water repellent, flame retardant and antistatic finishes; shrink-resistance finish for wool; heat setting of synthetic-fibre fabrics, finishing machines; energy efficient processes; pollution control.

XE - ENGINERING SCIENCES

The syllabi of the sections of this paper are as follows:

SECTION A. ENGINEERING MATHEMATICS (Compulsory)

Linear Algebra : Determinates, algebra of matrices, rank, inverse, system of linear equations, symmetric, skew-symmetric and orthogonal matrices. Hermitian, skew-hermitian and unitary matrices. eigenvalues and eigenvectors, diagonalisation of matrices, Cayley-Hamiltonian, quadratic forms.

Calculus : Functions of single variables, limit, continuity and differentiability, Mean value theorems, Intermediate forms and L'Hospital rule, Maxima and minima, Taylor's series, Fundamental and mean value-theorems of integral calculus. Evaluation of definite and improper integrals, Beta and Gamma functions, Functions of two variables, limit, continuity, partial derivatives, Euler's theorem for homogeneous functions, total derivatives, maxima and minima, Lagrange method of multipliers, double and triple integrals and their applications, sequence and series, tests for convergence, power series, Fourier Series, Fourier integrals.

Complex variable: Analytic functions, Cauchy's integral theorem and integral formula without proof. Taylor's and Laurent' series, Residue theorem (without proof) with application to the evaluation of real integarls.

Vector Calculus: Gradient, divergence and curl, vector identities, directional derivatives, line, surface and volume integrals, Stokes, Gauss and Green's theorems (without proofs) with applications.

Ordinary Differential Equations: First order equation (linear and nonlinear), higher order linear differential equations with constant coefficients, method of variation of paramaters, Cauchy's and Euler's equations, initial and boundary value problems, power series solutions, Legendre polynomials and Bessel's functions of the first kind.

Partial Differential Equations: Variables separable method, solutions of one dimensional heat, wave and Laplace equations.

Probability and Statistics: Definitions of probability and simple theorems, conditional probability, mean, mode and standard deviation, random variables, discrete and continuous

distributions, Poisson, normal and Binomial distribution, correlation and regression

Numerical Methods: L-U decomposition for systems of linear equations,Newton-Raphson method, numerical integration(trapezoidal and Simpson's rule), numerical methods for first order differential equation (Euler method)

SECTION B. COMPUTATIONAL SCIENCE

Numerical Methods: Truncation errors, round off errors and their propagation; Interpolation; Lagrange, Newton's forward, backward and divided difference formulas, least square curve fitting, solution of non-linear equations of one variables using bisection, false position, secant and Newton Raphson methods; Rate of convergence of these methods, general iterative methods. Simple and multiple roots of polynomials. Solutions of system of linear algebraic equations using Gauss elimination methods, Jacobi and Gauss-Seidel iterative methods and their rate of convergence; ill conditioned and well conditioned system. eigen values and eigen vectors using power methods. Numerical integration using trapezoidal, Simpson's rule and other quadrature formulas. Numerical Differentiation. Solution of boundary value problems. Solution of initial value problems of ordinary differential equations using Euler's method, predictor corrector and Runge Kutta method.

Programming : Elementary concepts and terminology of a computer system and system software, Fortran77 and C programming.

Fortran : Program organization, arithmetic statements, transfer of control, Do loops, subscripted variables, functions and subroutines.

C language : Basic data types and declarations, flow of control- iterative statement, conditional statement, unconditional branching, arrays, functions and procedures.

SECTION C. ELECTRICAL SCIENCES

Electric Circuits: Ideal voltage and current sources; RLC circuits, steady state and transient analysis of DC circuits, network theorems; alternating currents and voltages, single-phase AC circuits, resonance; three-phase circuits.

Magnetic circuits: Mmf and flux, and their relationship with voltage and current; transformer, equivalent circuit of a practical transformer, three-phase transformer connections.

Electrical machines: Principle of operation, characteristics, efficiency and regulation of DC and synchronous machines; equivalent circuit and performance of three-phase and single-phase induction motors.

Electronic Circuits: Characteristics of p-n junction diodes, zener diodes, bipolar junction transistors (BJT) and junction field effect transistors (JFET); MOSFET's structure, characteristics, and operations; rectifiers, filters, and regulated power supplies; biasing circuits, different configurations of transistor amplifiers, class A, B and C of power amplifiers; linear applications of operational amplifiers; oscillators; tuned and phase shift types.

Digital circuits: Number systems, Boolean algebra; logic gates, combinational circuits, flip-flops (RS, JK, D and T) counters.

Measuring instruments: Moving coil, moving iron, and dynamometer type instruments; shunts, instrument transformers, cathode ray oscilloscopes; D/A and A/D converters.

SECTION D. FLUID MECHANICS

Fluid Properties: Relation between stress and strain rate for Newtonian fluids

Hydrostatics, buoyancy, manometry

Concept of local and convective accelerations; control volume analysis for mass, momentum and energy conservation.

Differential equations of continuity and momentum (Euler's equation of motion); concept of fluid rotation, stream function, potential function; Bernoulli's equation and its applications.

Qualitative ideas of boundary layers and its separation; streamlined and bluff bodies; drag and lift forces.

Fully-developed pipe flow; laminar and turbulent flows; friction factor; Darcy Weisbach relation; Moody's friction chart; losses in pipe fittings; flow measurements using venturimeter and orifice plates.

Dimensional analysis; similitude and concept of dynamic similarity; importance of dimensionless numbers in model studies.

SECTION E. MATERIALS SCIENCE

Atomic structure and bonding in materials: metals, ceramics and polymers.

Structure of materials: Crystal systems, unit cells and space lattice; determination of structures of simple crystals by X-ray diffraction; Miller indices for planes and directions. Packing geometry in metallic, ionic and covalent solids.

Concept of amorphous, single and polycrystalline structures and their effects on properties of materials.

Imperfections in crystalline solids and their role in influencing various properties.

Fick´s laws of diffusion and applications of diffusion in sintering, doping of semiconductors and surface hardening of metals.

Alloys: solid solution and solubility limit. Binary phase diagram, intermediate phases and intermetallic compounds; iron-iron carbide phase diagram. Phase transformation in steels. Cold and hot working of metals, recovery, recrystallization and grain growth.

Properties and applications of ferrous and nonferrous alloys.

Structure, properties, processing and applications of traditional and advanced ceramics.

Polymers: classification, polymerization, structure and properties, additives for polymer products, processing and application.

Composites: properties and application of various composites.

Corrosion and environmental degradation of materials (metals, ceramics and polymers).

Mechanical properties of materials: Stress-strain diagrams of metallic, ceramic and polymeric materials, modulus of elasticity, yield strength, plastic deformation and toughness, tensile strength and elongation at break; viscoelasticity, hardness, impact strength. ductile and brittle fracture. creep and fatigue properties of materials.

Heat capacity, thermal conductivity, thermal expansion of materials.

Concept of energy band diagram for materials; conductors, semiconductors and insulators in terms of energy bands. Electrical conductivity, effect of temperature on conductivity in materials, intrinsic and extrinsic semiconductors, dielectric properties of materials.

Refraction, reflection, absorption and transmission of electromagnetic radiation in solids.

Origin of magnetism in metallic and ceramic materials, paramagnetism, diamagnetism, antiferromagnetism, ferromagnetism, ferrimagnetism in materials and magnetic hysteresis.

Advanced materials: Smart materials exhibiting ferroelectric, piezoelectric, optoelectronic, semiconducting behaviour; lasers and optical fibers; photoconductivity and superconductivity in materials.

SECTION F. SOLID MECHANICS

Equivalent force systems; free-body diagrams; equilibrium equations; analysis of determinate and indeterminate trusses and frames; friction.

Simple relative motion of particles; force as function of position, time and speed; force acting on a body in motion; laws of motion; law of conservation of energy; law of conservation of momentum

Stresses and strains; principal stresses and strains; Mohr's circle; generalized Hooke's Law; equilibrium equations; compatibility conditions; yield criteria.

Axial, shear and bending moment diagrams; axial, shear and bending stresses; deflection (for symmetric bending); torsion in circular shafts; thin cylinders; energy methods (Castigliano's Theorems); Euler buckling.

SECTION G. THERMODYNAMICS

Basic Concepts: Continuum, macroscopic approach, thermodynamic system (closed and open or control volume); thermodynamic properties and equilibrium; state of a system, state diagram, path and process; different modes of work; Zeroth law of thermodynamics; concept of temperature; heat.

First Law of Thermodynamics: Energy, enthalpy, specific heats, first law applied to systems and control volumes, steady and unsteady flow analysis.

Second Law of Thermodynamics: Kelvin-Planck and Clausius statements, reversible and irreversible processes, Carnot theorems, thermodynamic temperature scale, Clausius inequality and concept of entropy, principle of increase of entropy; availability and irreversibility.

Properties of Pure Substances: Thermodynamic properties of pure substances in solid, liquid and vapour phases, P-V-T behaviour of simple compressible substances, phase rule, thermodynamic property tables and charts, ideal and real gases, equations of state, compressibility chart.

Thermodynamic Relations: T-ds relations, Maxwell equations, Joule-Thomson coefficient, coefficient of volume expansion, adiabatic and isothermal compressibilities, Clapeyron equation.

Ideal Gas Mixtures: Dalton's and Amagat's laws, calculations of properties, air-water vapour mixtures.

XL - LIFE SCIENCES

The syllabi of the Sections of this paper are as follows:

SECTION H. CHEMISTRY (Compulsory)

Atomic structure and periodicity: Quantum chemistry; Planck's quantum theory, wave particle

duality, uncertainty principle, quantum mechanical model of hydrogen atom; electronic configuration of atoms; periodic table and periodic properties; ionization energy, election affinity, electronegativity, atomic size.

Structure and bonding: Ionic and covalent bonding M.O. and V.B. approaches for diatomic molecules, VSEPR theory and shape of molecules, hybridisation, resonance, dipole moment, structure parameters such as bond length, bond angle and bond energy, hydrogen bonding, van der Waals interactions. Ionic solids; ionic radii, lattice energy (Born-Haber Cycle).

s.p. and d Block Elements: Oxides, halides and hydrides of alkali and alkaline earth metals, B, Al, S, N, P and S, silicones, general characteristics of 3d elements, coordination complexes: valence bond and crystal field theory, color, geometry and magnetic properties.

Chemical Equilibria: Colligative properties of solutions, ionic equilibria in solution, solubility product, common ion effect, hydrolysis of salts, pH, buffer and their applications in chemical analysis.

Electrochemistry: Conductance, Kohlrausch law, Half Cell potentials, emf, Nernst equation, galvanic cells, thermodynamic aspects and their applications.

Reaction Kinetics: Rate constant, order of reaction, molecularity, activation energy, zero, first and second order kinetics, equilibrium constants (Kc, Kp and Kx) for homogeneous reactions, catalysis and elementary enzyme reactions.

Thermodynamics: First law, reversible and irreversible processes, internal energy, enthalpy, Kirchoff's equation, heat of reaction, Hess law, heat of formation, Second law, entropy, free energy, and work function. Gibbs-Helmholtz equation, Clausius-Clapeyron equation, free energy change and equilibrium constant, Troutons rule, Third law of thermodynamics.

Mechanistic Basis of Organic Reactions: Elementary treatment of SN1, SN2, E1 and E2 reactions, Hoffmann and Saytzeff rules, Addition reactions, Markonikoff rule and Kharash effect, Diels-Alder reaction, aromatic electrophilic substitution, orientation effect as exemplified by various functional groups.

Structure-Reactivity Correlations: Acids and bases, electronic and steric effects, optical and geometrical isomerism, tautomerism, concept of aromaticity

SECTION I. BIOCHEMISTRY

Organization of life. Importance of water. Cell structure and organelles. Structure and function of biomolecules: Carbohydrates, Lipids, Proteins and Nucleic acids. Biochemical separation techniques. Spectroscopic methods; UV-visible and fluorescence. Protein structure, folding and function: Myoglobin, Hemoglobin, Lysozyme, ribonuclease A, Carboxypeptidase and Chymotrypsin. Enzyme kinetics and regulation, Coenzymes.

Metabolism and bioenergitics. Generation and utilization of ATP. Photosynthesis. Major metabolic pathways and their regulation. Biological membranes. Transport across membranes. Signal transduction; hormones and neurotransmitters.

DNA replication, transcription and translation. Biochemical regulation of gene expression. Recombinant DNA technology and applications. Genomics and Proteomics.

The immune system. Active and passive immunity. Complement system. Antobody structure, function and diversity. Cells of the immune system: T, B and macrophages. T and B cell activation. Major histocompatibilty complex. T cell receptor. Immunological techniques: Immunodiffusion, immunoelectrophoresis, RIA and ELISA.

SECTION J. BIOTECHNOLOGY

Recombinant DNA technology for the production of therapeutic proteins. Micro array technology. Heterologous protein expression systems in bacteria, yeast etc.

Architecture of plant genome; plant tissue culture techniques; methods of gene transfer into plant cells; manipulation of phenotypic traits in plants; plant cell fermentations and production of secondary metabolites using suspension/ immobilized cell culture; methods for plant micro propagation; crop improvement and development of transgenic plants. Expression of animal proteins in plants.

Animal cell metabolism and regulation; cell cycle; primary cell culture; nutritional requirements for animal cell culture; techniques for the mass culture of animal cell lines; production of vaccines; growth hormones and interferons using animal cell culture; cytokines-production and therapeutic uses; hybridoma technology; vectors for gene transfer and expression in animal cells. Transgenic animals and molecular pharming.

Microbial production of industrial enzymes; methods for immobilization of enzymes; kinetics of soluble and immobilized enzymes; application of soluble and immobilized enzymes; enzyme-based sensors.

Microbial growth kinetics; batch, fed batch and continuous culture of microbial cells; media for industrial fermentations; sterilization of air and media; design features and operation of stirred tank, air-lift and fluidized bed reactors; aeration and agitation in aerobic fermentations; recovery and purification of fermentation products- filtration, centrifugation, cell disintegration, solvent extraction and chromatographic separations; industrial fermentations for the production of ethanol, citric acid, lysine, penicillin and other biomolecules; simple calculations based on material and energy balance of fermentation processes; application of microbes in the management of domestic and industrial wastes.

SECTION K. BOTANY

Anatomy: Roots, stem and leaves of land plants, meristems, vascular system, their ontogeny, structure and functions. Plant cell structure, organisation, organelles, cytoskeleton, cell wall and membranes.

Development: Cell cycle, cell division, senescence, hormonal regulation of growth; life cycle of an angiosperm, pollination, fertilization, embryogenesis, seed formation, seed storage proteins, seed dormancy and germination. Concept of cellular totipotency, organogenesis and somatic embryogenesis, somaclonal variation, embryo culture, in vitro fertilization.

Physiology and Biochemistry: Plant water relations, transport of minerals and solutes, N2 metabolism, proteins and nucleic acid, respiration, photophysiology, photosynthesis, photorespiration; biosynthesis, mechanism of action and physiological effects of plant growth regulators.

Genetics: Principles of Mendelian inheritance, linkage, recombination and genetic mapping; extrachromosomal inheritance; eukaryotic genome organization (chromatin structure) and regulation of gene expression, gene mutation, chromosome aberrations (numerical and structural), transposons.

Plant Breeding: Principles, methods - selection, hybridization, heterosis; male sterility, self and inter-specific incompatibility; haploidy; somatic cell hybridization; molecular marker-assisted selection; gene transfer methods viz. direct and vector-mediated, transgenic plants and their applications in agriculture.

Economic Botany: Economically important plants - cereals, pulses, plants yielding fiber, timber, sugar, beverages, oils, rubber, dyes, gums, drugs and narcotics - a general account.

Systematics: Systems of classification (non-phylogenetic vs. phylogenetic - outline), plant groups, molecular systematics.

Plant Pathology: Nature and classification of plant diseases, diseases of important crops caused by fungi, bacteria and viruses, and their control measures, mechanism(s) of pathogenesis and resistance, molecular detection of pathogens; plant-microbe beneficial interactions.

Ecology and Plant Geography: Ecosystems - types, dynamics, degradation, ecological succession; food chains; vegetation types of the world; pollution and global warming; speciation and extinction, conservation strategies, cryopreservation.

SECTION L. MICROBIOLOGY

Historical perspective - Discovery of the microbial world; Controversy over spontaneous generation; Role of microorganisms in transformation of organic matter and in the causation of diseases.

Methods in microbiology - Pure culture techniques; Theory and practice of sterilization; Principles of microbial nutrition; Construction of culture media; Enrichment culture techniques for isolation of chemoautotrophs, chemoheterotrophs and photosynthetic microorganisms.

Microbial evolution, systematics and taxonomy - Evolution of earth and earliest life forms; Primitive organisms and their metabolic strategies; New approaches to bacterial taxonomic classification including ribotyping; Nomenclature.

Microbial diversity - Bacteria, archea and their broad classification; Eukaryotic microbes, yeast, fungi, slime mold and protozoa; Viruses and their classification.

Microbial growth -The definition of growth, mathematical expression of growth, growth curve, measurement of growth and growth yields; Synchronous growth; Continuous culture.

Nutrition and metabolism - Overview of metabolism; Microbial nutrition; Energy classes of microorganisms; Culture media; Energetics, modes of ATP generation; ATP generation by heterotrophs; Fermentation; Glycolysis; Respiration; The citric acid cycle; Electron transport systems; Alternate modes of energy generation; Pathways (anabolism) in the biosynthesis of amino acids, purines, pyrimidines and fatty acids.

Metabolic diversity among microorganisms - Photosynthesis in microorganisms; Role of chlorophylls, carotenoids and phycobilins; Calvin cycle; Chemolithotrophy; Hydrogen- iron- nitrite-oxidizing bacteria; Nitrate and sulfate reduction; Methanogenesis and acetogenesis.

Prokaryotic cells: structure-function - Cells walls of eubacteria (peptidoglycan) and related molecules; Outer-membrane of gram-negative bacteria; Cell wall and cell membrane synthesis; Flagella and motility; Cell inclusions like endospores, gas vesicles.

Microbial diseases and host parasite relationships - Normal microflora of skin; Oral cavity; Gastrointestinal tract; Entry of pathogens into the host; Infectious disease transmission; Respiratory infections caused by bacteria and viruses; Tuberculosis; Sexually transmitted diseases including AIDS; Diseases transmitted by animals (Rabies, plague), insects and ticks (rikettsias, Lyme disease, malaria); Food and water borne diseases; Public health and water quality; Pahtogenic fungi; Emerging and resurgent infectious diseases.

Chemotherapy/Antibiotics - Antimicrobial agents; Sulfa drugs; Antibiotics; Pencillins and cephalosporins; Broad-spectrum antibiotics; Antibiotics from prokaryotes; Antifungal antibiotics; Mode of action; Resistance to antibiotics.

Microbial genetics - Genes, mutation and mutagenesis - UV and chemical mutagnes; Types of mutations; Ames test for mutagenesis; Methods of genetic analysis. Bacterial genetic system - Transformation; Conjugation; Transduction; Recombination; Plasmids and Transposons; Bacterial genetic map with reference to E. coli. Viruses and their genetic system - Phage ? and

its life cycle; RNA phages; RNA viruses; Retroviruses; Genetic systems of yeast and Neurospora; Extrachromosomal inheritance and mitochondrial genetics; Basic concept of genomics.

SECTION M. ZOOLOGY

Animal world: Animal diversity, distribution, systematic and classification of animals, the phylogenetic relationship.

Evolution: Origin of life, history of life on earth, evolutionary theories, natural selection, adaptation, speciation.

Genetics: Principles of inheritance, molecular basis of heredity, the genetic material, transmission of genetic material, mutations, cytoplasmic inheritance.

Biochemistry and Molecular Biology: Nucleic acids, proteins and other biological macromolecules. Replication, transcription and translation, regulation of gene expression, organization of genome, Kreb's cycle, glycolysis, enzyme catalysis, hormones and their action.

Cell Biology: Structure of cell, cellular organelles and their structure and function, cell cycle, cell division, cellular differentiation, chromosome and chromatin structure. Eukaryotic gene organisation and expression.

Animal Anatomy and Physiology: Comparative physiology, the respiratory system, circulatory system, digestive system, the nervous system, the excretory system, the endocrine system, the reproductive system, the skeletal system, osmoregulation.

Parasitology and Immunology: Nature of parasite, host-parasite relation, protozoan and helminthic parasites, the immune response, cellular and humoral immune response, evolution of the immune system.

Development Biology: Embryonic development, cellular differentiation, organogenesis, metamorphosis, genetic basis of development.

Ecology: The ecosystem, habitats the food chain, population dynamics, species diversity, zoogeography, biogeochemical cycles, conservation biology.

Animal Behaviour: Types of behaviours, courtship, mating and territoriality, instinct, learning and memory, social behaviour across the animal taxa, communication, pheromones, evolution of animal behaviour.

IT - INFORMATION TECHNOLOGY

ENGINEERING MATHEMATICS

Mathematical Logic: Propositional Logic; First Order Logic.

Probability: Conditional Probability; Mean, Median, Mode and Standard Deviation; Random Variables; Distributions; uniform, normal, exponential, Poisson, Binomial.

Set Theory & Algebra: Sets; Relations; Functions; Groups; Partial Orders; Lattice; Boolean Algebra.

Combinatorics: Permutations; Combinations; Counting; Summation; generating functions; recurrence relations; asymptotics.

Graph Theory: Connectivity; spanning trees; Cut vertices & edges; covering; matching; independent sets; Colouring; Planarity; Isomorphism.

Linear Algebra: Algebra of matrices, determinants, systems of linear equations, Eigen values and Eigen vectors.

Numerical Methods: LU decomposition for systems of linear equations; numerical solutions of non linear algebraic equations by Secant, Bisection and Newton-Raphson Methods; Numerical integration by trapezoidal and Simpson's rules.

Calculus: Limit, Continuity & differentiability, Mean value Theorems, Theorems of integral calculus, evaluation of definite & improper integrals, Partial derivatives, Total derivatives, maxima & minima.

FORMAL LANGUAGES AND AUTOMATA

Regular Languages: finite automata, regular expressions, regular grammar.

Context free languages: push down automata, context free grammars

COMPUTER HARDWARE

Digital Logic: Logic functions, minimization, design and synthesis of combinatorial and sequential circuits, number representation and computer arithmetic (fixed and floating point)

Computer organization: Machine instructions and addressing modes, ALU and data path, hardwired and microprogrammed control, memory interface, I/O interface (interrupt and DMA mode), serial communication interface, instruction pipelining, cache, main and secondary storage

SOFTWARE SYSTEMS

Data structures and Algorithms: the notion of abstract data types, stack, queue, list, set, string, tree, binary search tree, heap, graph, tree and graph traversals, connected components, spanning trees, shortest paths, hashing, sorting, searching, design techniques (greedy, dynamic, divide and conquer), asymptotic analysis (best, worst, average cases) of time and space, upper and lower bounds, intractability

Programming Methodology: C programming, program control (iteration, recursion, functions), scope, binding, parameter passing, elementary concepts of object oriented programming

Operating Systems (in the context of Unix): classical concepts (concurrency, synchronization, deadlock), processes, threads and interprocess communication, CPU scheduling, memory management, file systems, I/O systems, protection and security

Information Systems and Software Engineering: information gathering, requirement and feasibility analysis, data flow diagrams, process specifications, input/output design, process life cycle, planning and managing the project, design, coding, testing, implementation, maintenance.

Databases: relational model, database design, integrity constraints, normal forms, query languages (SQL), file structures (sequential, indexed), b-trees, transaction and concurrency control

Data Communication: data encoding and transmission, data link control, multiplexing, packet switching, LAN architecture, LAN systems (Ethernet, token ring), Network devices: switches, gateways, routers

Networks: ISO/OSI stack, sliding window protocols, routing protocols, TCP/UDP, application layer protocols & systems (http, smtp, dns, ftp), network security

Web technologies: three tier web based architecture; JSP, ASP, J2EE, .NET systems; html, XML

GATE 2006 Structure changed!! <2006-paperstructure.htm>

The Graduate Aptitude Test in Engineering (**GATE - 2006**) is administered and conducted in eight zones across the country by the GATE Committee. The zones and the corresponding administrative institutes are

Zone 1 <http://www.iitk.ac.in/gate/links/contact_us.html>- Indian Institute of Science Bangalore Zone 2 <http://www.iitk.ac.in/gate/links/contact_us.html>- Indian Institute of Technology Bombay Zone 3 <http://www.iitk.ac.in/gate/links/contact_us.html>- Indian Institute of Technology Delhi Zone 4 <http://www.iitk.ac.in/gate/links/contact_us.html>- Indian Institute of Technology GuwahatiZone 5 <http://www.iitk.ac.in/gate/links/contact_us.html>- Indian Institute of Technology Kanpur Zone 6 <http://www.iitk.ac.in/gate/links/contact_us.html>- Indian Institute of Technology Kharagpur Zone 7 <http://www.iitk.ac.in/gate/links/contact_us.html>- Indian Institute of Technology Madras Zone 8 <http://www.iitk.ac.in/gate/links/contact_us.html>- Indian Institute of Technology Roorkee The overall coordination and responsibility lies with **Indian Institute of Technology Kharagpur**, designated as the **Organizing Institute for GATE 2006.**

The GATE Committee is the sole authority for regulating the examination and declaring results.

- Eligibility
- About the Examination
- Application/Registration Process

GATE Qualification

Admission to postgraduate programmes, with MHRD and other government scholarship/assistantship, in Engineering/Technology/ Architecture/ Pharmacy/Science at engineering colleges/institutes in the country will be open only to those who qualify through GATE.

Some engineering colleges/institutes specify GATE as mandatory qualification even for admission of self-financing students to postgraduate programmes.

However, GATE qualification in itself does not guarantee either admission or scholarship/assistantship.

Candidates are required to find out the procedure of final selection and award of Scholarship/Assistantship from the institutions in which they seek admission.

<http://www.iitk.ac.in/gate/links/general_information.html>**Eligibility**

The following categories of candidates are eligible to appear in GATE 2006:

Bachelor's degree holders in Engineering/Technology/Architecture/Pharmacy and those who are in the final or pre-final year of such programmes.

Master's degree holders in any branch of Science/Mathematics/Statistics/Computer Applications or equivalent and those who are in the final or pre-final year of such programmes.

Candidates in the second or higher year of the Four-year Integrated Master's degree programme (Post-B.Sc.) in Engineering/Technology or in the third or higher year of Five-year Integrated Master's degree programme and Dual Degree programme in Engineering/Technology.

Candidates with qualifications obtained through examination conducted by professional societies recognised by UPSC/AICTE (e.g. AMIE) as equivalent to B.E./B.Tech. Those who have completed Section A or equivalent of such professional courses are also eligible.

About the Examination

Candidates will be required to appear in a single paper of three hours duration. The examination will be held **from 0930 to 1230 hrs on Sunday, February 12, 2006.** The list of papers for GATE 2006 is given under Structure of GATE <http://www.iitk.ac.in/gate/links/gate_structure.html>. The question papers will be in **English only.**

Before applying for GATE 2006, candidates must assure themselves that they have chosen the right paper, which qualifies them to become eligible to seek admission to the specific programme they are interested in. The criteria for postgraduate admission with scholarship/assistantship are different in various Institutes. GATE Offices are not in a position to provide any information in this regard. Some information regarding postgraduate programmes in various institutes is available under Downloads <http://www.iitk.ac.in/gate/links/download.html>. For more details, the candidates are required to contact the Institutes/Universities to which they are interested in seeking admission.

The choice of the paper is the responsibility of the candidate.

The question papers will be in English only. Some information about the pattern of the questions is given under Question Paper Structure <http://www.iitk.ac.in/gate/links/paper_structure.html>.
<http://www.iitk.ac.in/gate/links/general_information.html>

Application/Registration Process

There are two different processes by which a candidate can apply/register for GATE 2006, namely, "offline" and "online". Details of these processes are given under How-to-Apply <http://www.iitk.ac.in/gate/links/how_to_apply.html>. The registration-cum-application fee for offline applications is Rs.1000/- for General candidates and Rs.500/- for SC/ST candidates. The fee for online application is Rs. 900/- for General candidates and Rs. 400/- for SC/ST candidates. The application fee is not refundable.

The zone-wise list of cities, where GATE 2006 will be held, is given under [Exam Cities <http://www.iitk.ac.in/gate/links/exam_cities.html>](http://www.iitk.ac.in/gate/links/exam_cities.html).

[Click here <http://www.iitk.ac.in/gate/links/important_dates.html>](http://www.iitk.ac.in/gate/links/important_dates.html) for Important Dates & Deadlines.

Candidates can appear in the examination only against valid admit cards. Candidates generally receive Admit Cards by last week of January 2006. If they do not receive admit cards by 1st February 2006, they should

AG - AGRICULTURAL ENGINEERING

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

FARM MACHINERY AND POWER:

Sources of power on the farm-human, animal, mechanical, electrical, wind, solar and biomass; design and selection of machine elements - gears, pulleys, chains and sprockets and belts; overload safety devices used in farm machinery; measurement of force, torque, speed, displacement and acceleration on machine elements.

Soil tillage; forces acting on a tillage tool; hitch systems and hitching of tillage implements; functional requirements, principles of working, construction and operation of manual, animal and power operated equipment for tillage. sowing, planting, fertilizer application, inter-cultivation, spraying, mowing, chaff cutting, harvesting, threshing and transport; testing of agricultural machinery and equipment; calculation of performance parameters -field capacity, efficiency, application rate and losses; cost analysis of implements and tractors.

Thermodynamic principles of I.C. engines; I.C. engine cycles; engine components; fuels and combustion; lubricants and their properties; I.C. engine systems - fuel, cooling, lubrication, ignition, electrical, intake and exhaust; selection, operation, maintenance and repair of I.C. engines; power efficiencies and measurement; calculation of power, torque, fuel consumption, heat load and power losses.

Tractors and power tillers - type, selection, maintenance and repair; tractor clutches and brakes; power transmission systems - gear trains, differential, final drives and power take-off; mechanics of tractor chassis; traction theory; three point hitches- free link and restrained link operations; mechanical steering and hydraulic control systems used in tractors; human engineering and safety in tractor design; tractor tests and performance.

SOIL AND WATER CONSERVATION ENGINEERING:

Ideal and real fluids, properties of fluids; hydrostatic pressure and its measurement; hydrostatic forces on plane and curved surface; continuity equation; Bernoulli's theorem; laminar and turbulent flow in pipes, Darcy-Weisbach and Hazen-Williams equations, Moody's diagram; flow through orifices and notches; flow in open channels.

Engineering properties of soils, fundamental definitions and relationships; index properties of soils; permeability and seepage analysis; shear strength, Mohr's circle of stresses; active and passive earth pressures; stability of slopes.

Hydrological cycle; precipitation measurement, analysis of precipitation data; abstraction from precipitation; runoff; hydrograph analysis, unit hydrograph theory and application; stream flow measurement; flood routing, hydrological reservoir and channel routing.

Mechanics of soil erosion, factors affecting erosion; soil loss estimation; biological and engineering measures to control erosion, terraces and bunds; vegetative waterways; gully control structures, drop, drop inlet and chute spillways; farm ponds; earthen dams; principles of watershed management.

Water requirement of crops; consumptive use and evapo-transpiration; irrigation scheduling; irrigation efficiencies; design of prismatic and silt loaded channels; methods of irrigation water application; design and evaluation of irrigation methods; drainage coefficient; surface and subsurface drainage systems; leaching requirement and salinity control; irrigation and drainage water quality; classification of pumps; pump characteristics; pump selection; types of aquifer; evaluation of aquifer properties; well hydraulics; ground water recharge.

AGRICULTURAL PROCESSING AND FOOD ENGINEERING:

Steady state heat transfer in conduction, convection and radiation; transient heat transfer in simple geometry; condensation and boiling heat transfer; working principles of heat exchangers; diffusive and convective mass transfer; simultaneous heat and mass transfer in agricultural processing operations.

Material and energy balances in food processing systems; water activity, sorption and desorption isotherms; centrifugal separation of solids, liquids and gases; kinetics of microbial death - pasteurisation and sterilization of liquid foods; preservation of food by cooling and freezing; psychrometry - properties of air-vapour mixture; concentration and dehydration of liquid foods - evaporators, tray, drum and spray dryers.

Mechanics and energy requirement in size reduction of granular solids; particle size analysis for comminuted solids; size separation by screening; fluidisation of granular solids; cleaning and grading efficiency and effectiveness of grain cleaners; conditioning and hydrothermal treatments for grains; dehydration of food grains; processes and machines for processing of cereals, pulses and oilseeds; design considerations for grain silos.

AR - ARCHITECTURE AND PLANNING

City planning: Historical development of cities; principles of city planning; new towns; survey methods, site planning, planning regulations and building bye-laws.

Housing: Concept of shelter; housing policies and design; community planning; role of government agencies; finance and management.

Landscape Design: Principles of landscape design and site planning; history and landscape styles; landscape elements and materials; planting design.

Computer Aided Design: Application of computers in architecture and planning; understanding elements of hardware and software; computer graphics; programming languages - C and Visual Basic and usage of packages such as AutoCAD.

Environmental and Building Science: Elements of environmental science; ecological principles concerning environment; role of micro-climate in design; climatic control through design elements; thermal comfort; elements of solar architecture; principles of lighting and illumination; basic principles of architectural acoustics; air pollution, noise pollution and their control.

Visual and Urban Design: Principles of visual composition; proportion, scale, rhythm, symmetry, harmony, balance, form and colour; sense of place and space, division of space; focal point, vista, imageability, visual survey.

History of Architecture: Indian - Indus valley, Vedic, Buddhist, Indo-Aryan, Dravidian and Mughal periods; European - Egyptian, Greek, Roman, medieval and renaissance periods.

Development of Contemporary Architecture: Architectural developments and impacts on society since industrial revolution; influence of modern art on architecture; works of national and international architects; post modernism in architecture.

Building Services: Water supply, Sewerage and Drainage systems; Sanitary fittings and fixtures; principles of electrification of buildings; elevators, their standards and uses; air-conditioning systems; fire fighting systems.

Building Construction and Management: Building construction techniques, methods and details; building systems and prefabrication of building elements; principles of modular coordination; estimation, specification, valuation, professional practice; project management, PERT, CPM.

Materials and Structural Systems: Behavioural characteristics of all types of building materials e.g. mud, timber, bamboo, brick, concrete, steel, glass, FRP; principles of strength of materials; design of structural elements in wood, steel and RCC; elastic and limit state design; complex structural systems; principles of pre-stressing.

Planning Theory: Planning process; multilevel planning; comprehensive planning; central place theory; settlement pattern; land use and land utilization.

Techniques of Planning: Planning surveys; Preparation of urban and regional structure plans, development plans, action plans; site planning principles and design; statistical methods; application of remote sensing techniques in urban and regional planning.

Traffic and Transportation Planning: Principles of traffic engineering and transportation planning; methods of conducting surveys; design of roads, intersections and parking areas; hierarchy of roads and levels of services; traffic and transport management in urban areas; traffic safety and traffic laws; public transportation planning; modes of transportation.

Services and Amenities: Principles and design of water supply systems, sewerage systems, solid waste disposal systems, power supply and communication systems; Health, education, recreation and demography related standards at various levels of the settlements.

Development Administration and Management: Planning laws; development control and zoning regulations; laws relating to land acquisition; development enforcements, land ceiling; regional and urban plan preparations; planning and municipal administration; taxation, revenue resources and fiscal management; public participation and role of NGO.

CE - CIVIL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

STRUCTURAL ENGINEERING

Mechanics: Bending moments and shear forces in statically determinate beams; simple stress and strain: relationship; stress and strain in two dimensions, principal stresses, stress transformation, Mohr's circle; simple bending theory; flexural shear stress; thin-walled pressure vessels; uniform torsion.

Structural Analysis: Analysis of statically determinate trusses, arches and frames; displacements in statically determinate structures and analysis of statically indeterminate structures by force/energy methods; analysis by displacement methods (slope-deflection and moment-distribution methods); influence lines for determinate and indeterminate structures; basic concepts of matrix methods of structural analysis.

Concrete Structures: Basic working stress and limit states design concepts; analysis of ultimate load capacity and design of members subject to flexure, shear, compression and torsion (beams, columns and isolated footings); basic elements of prestressed concrete: analysis of beam sections at transfer and service loads.

Steel Structures: Analysis and design of tension and compression members, beams and beam-columns, column bases; connections - simple and eccentric, beam-column connections, plate girders and trusses; plastic analysis of beams and frames.

GEOTECHNICAL ENGINEERING

Soil Mechanics: Origin of soils; soil classification; three-phase system, fundamental definitions, relationship and inter-relationships; permeability and seepage; effective stress principle: consolidation, compaction; shear strength.

Foundation Engineering: Sub-surface investigation - scope, drilling bore holes, sampling, penetrometer tests, plate load test; earth pressure theories, effect of water table, layered soils; stability of slopes - infinite slopes, finite slopes; foundation types - foundation design requirements; shallow foundations; bearing capacity, effect of shape, water table and other factors, stress distribution, settlement analysis in sands and clays; deep foundations - pile types, dynamic and static formulae, load capacity of piles in sands and clays.

WATER RESOURCES ENGINEERING

Fluid Mechanics and Hydraulics: Hydrostatics, applications of Bernoulli equation, laminar and turbulent flow in pipes, pipe networks; concept of boundary layer and its growth; uniform flow, critical flow and gradually varied flow in channels, specific energy concept, hydraulic jump; forces on immersed bodies; flow measurement in channels; tanks and pipes; dimensional analysis and hydraulic modeling. Applications of momentum equation, potential flow, kinematics of flow; velocity triangles and specific speed of pumps and turbines.

Hydrology: Hydrologic cycle; rainfall; evaporation infiltration, unit hydrographs, flood estimation, reservoir design, reservoir and channel routing, well hydraulics.

Irrigation: Duty, delta, estimation of evapo-transpiration; crop water requirements; design of lined and unlined canals; waterways; head works, gravity dams and Ogee spillways. Designs of weirs on permeable foundation, irrigation methods.

ENVIRONMENTAL ENGINEERING

Water requirements; quality and standards, basic unit processes and operations for water treatment, distribution of water. Sewage and sewerage treatment: quantity and characteristic of waste water sewerage; primary and secondary treatment of waste water; sludge disposal; effluent discharge standards.

TRANSPORTATION ENGINEERING

Highway planning; geometric design of highways; testing and specifications of paving materials; design of flexible and rigid pavements.

CH - CHEMICAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

CHEMICAL ENGINEERING

Process Calculations and Thermodynamics: Laws of conservation of mass and energy; use of tie components; recycle, bypass and purge calculations; degree of freedom analysis.

First and Second laws of thermodynamics and their applications; equations of state and thermodynamic properties of real systems; phase equilibria; fugacity, excess properties and correlations of activity coefficients; chemical reaction equilibria.

Fluid Mechanics and Mechanical Operations: Fluid statics, Newtonian and non-Newtonian fluids, Bernoulli equation, Macroscopic friction factors, energy balance, dimensional analysis, shell balances, flow through pipeline systems, flow meters, pumps and compressors, packed and fluidized beds, elementary boundary layer theory, size reduction and size separation; free and hindered settling; centrifuge and cyclones; thickening and classification, filtration, mixing and agitation; conveying of solids.

Heat Transfer: Conduction, convection and radiation, heat transfer coefficients, steady and unsteady heat conduction, boiling, condensation and evaporation; types of heat exchangers and evaporators and their design.

Mass Transfer: Fick's law, molecular diffusion in fluids, mass transfer coefficients, film, penetration and surface renewal theories; momentum, heat and mass transfer analogies; stagewise and continuous contacting and stage efficiencies; HTU & NTU concepts design and operation of equipment for distillation, absorption, leaching, liquid-liquid extraction, crystallization, drying, humidification, dehumidification and adsorption.

Chemical Reaction Engineering: Theories of reaction rates; kinetics of homogeneous reactions, interpretation of kinetic data, single and multiple reactions in ideal reactors, non-ideal reactors; residence time; non-isothermal reactors; kinetics of heterogeneous catalytic reactions; diffusion effects in catalysis.

Instrumentation and Process Control: Measurement of process variables; sensors, transducers and their dynamics, dynamics of simple systems, dynamics such as CSTRs, transfer functions and responses of simple systems, process reaction curve, controller modes (P, PI, and PID); control valves; analysis of closed loop systems including stability, frequency response (including Bode plots) and controller tuning, cascade, feed forward control.

Plant Design and Economics: Design and sizing of chemical engineering equipment such as compressors, heat exchangers, multistage contactors; principles of process economics and cost estimation including total annualized cost, cost indexes, rate of return, payback period, discounted cash flow, optimization in Design.

Chemical Technology: Inorganic chemical industries; sulfuric acid, NaOH, fertilizers (Ammonia, Urea, SSP and TSP); natural products industries (Pulp and Paper, Sugar, Oil, and Fats); petroleum refining and petrochemicals; polymerization industries; polyethylene, polypropylene, PVC and polyester synthetic fibers.

CS - COMPUTER SCIENCE AND ENGINEERING

ENGINEERING MATHEMATICS

Mathematical Logic: Propositional Logic; First Order Logic.

Probability: Conditional Probability; Mean, Median, Mode and Standard Deviation; Random Variables; Distributions; uniform, normal, exponential, Poisson, Binomial.

Set Theory & Algebra: Sets; Relations; Functions; Groups; Partial Orders; Lattice; Boolean Algebra.

Combinatorics: Permutations; Combinations; Counting; Summation; generating functions; recurrence relations; asymptotics.

Graph Theory: Connectivity; spanning trees; Cut vertices & edges; covering; matching; independent sets; Colouring; Planarity; Isomorphism.

Linear Algebra: Algebra of matrices, determinants, systems of linear equations, Eigen values and Eigen vectors.

Numerical Methods: LU decomposition for systems of linear equations; numerical solutions of non linear algebraic equations by Secant, Bisection and Newton-Raphson Methods; Numerical integration by trapezoidal and Simpson's rules.

Calculus: Limit, Continuity & differentiability, Mean value Theorems, Theorems of integral calculus, evaluation of definite & improper integrals, Partial derivatives, Total derivatives, maxima & minima.

THEORY OF COMPUTATION

Formal Languages and Automata Theory: Regular languages and finite automata, Context free languages and Push-down automata, Recursively enumerable sets and Turing machines, Un-decidability;

Analysis of Algorithms and Computational Complexity: Asymptotic analysis (best, worst, average case) of time and space, Upper and lower bounds on the complexity of specific problems, NP-completeness.

COMPUTER HARDWARE

Digital Logic: Logic functions, Minimization, Design and synthesis of Combinational and Sequential circuits; Number representation and Computer Arithmetic (fixed and floating point);

Computer Organization: Machine instructions and addressing modes, ALU and Data-path, hardwired and micro-programmed control, Memory interface, I/O interface (Interrupt and DMA mode), Serial communication interface, Instruction pipelining, Cache, main and secondary storage.

SOFTWARE SYSTEMS

Data structures: Notion of abstract data types, Stack, Queue, List, Set, String, Tree, Binary search tree, Heap, Graph;

Programming Methodology: C programming, Program control (iteration, recursion, Functions), Scope, Binding, Parameter passing, Elementary concepts of Object oriented, Functional and Logic Programming;

Algorithms for problem solving: Tree and graph traversals, Connected components, Spanning trees, Shortest paths; Hashing, Sorting, Searching; Design techniques (Greedy, Dynamic Programming, Divide-and-conquer);

Compiler Design: Lexical analysis, Parsing, Syntax directed translation, Runtime environment, Code generation, Linking (static and dynamic); Operating Systems: Classical concepts (concurrency, synchronization, deadlock), Processes, threads and Inter-process communication, CPU scheduling, Memory management, File systems, I/O systems, Protection and security.

Databases: Relational model (ER-model, relational algebra, tuple calculus), Database design (integrity constraints, normal forms), Query languages (SQL), File structures (sequential files, indexing, B+ trees), Transactions and concurrency control;

Computer Networks: ISO/OSI stack, sliding window protocol, LAN Technologies (Ethernet, Token ring), TCP/UDP, IP, Basic concepts of switches, gateways, and routers.

CH - CHEMISTRY

PHYSICAL CHEMISTRY

Structure: Quantum theory - principles and techniques; applications to particle in a box, harmonic oscillator, rigid rotor and hydrogen atom; valence bond and molecular orbital theories and Huckel approximation, approximate techniques: variation and perturbation; symmetry, point groups; rotational, vibrational, electronic, NMR and ESR spectroscopy.

Equilibrium: First law of thermodynamics, heat, energy and work; second law of thermodynamics and entropy; third law and absolute entropy; free energy; partial molar quantities; ideal and non-ideal solutions; phase transformation: phase rule and phase diagrams- one, two, and three component systems; activity, activity coefficient, fugacity and fugacity coefficient ; chemical equilibrium, response of chemical equilibrium to temperature and pressure; colligative properties; kinetic theory of gases; thermodynamics of electrochemical cells; standard electrode potentials: applications - corrosion and energy conversion; molecular partition function (translational, rotational, vibrational and electronic).

Kinetics: Rates of chemical reactions, theories of reaction rates, collision and transition state theory; temperature dependence of chemical reactions; elementary reactions, consecutive elementary reactions; steady state approximation, kinetics of photochemical reactions and free radical polymerization, homogenous and heterogeneous catalysis.

INORGANIC CHEMISTRY

Non-Transition Elements: General characteristics, structure and reactions of simple and industrially important compounds, boranes, carboranes, silicates, silicones, diamond and graphite; hydrides, oxides and oxoacids of N, P, S and halogens; boron nitride, borazines and phosphazenes; xenon compounds. Shapes of molecules, hard-soft acid base concept.

Transition Elements: General characteristics of d and f block elements; coordination chemistry: structure and isomerism, stability, theories of metal-ligand bonding (CFT and LFT), electronic spectra and magnetic properties of transition metal complexes and lanthanides; metal carbonyls, metal-metal bonds and metal atom clusters, metallocenes; transition metal complexes with bonds to hydrogen, alkyls, alkenes, and arenes; metal carbenes; use of organometallic compounds as catalysts in organic synthesis; mechanisms of substitution and electron transfer reactions of coordination complexes. Role of metals with special reference to Na, K, Mg, Ca, Fe, Co, Zn, and Mo in biological systems.

Solids: Crystal systems and lattices, Miller planes, crystal packing, crystal defects; Bragg's Law; ionic crystals, band theory, metals and semiconductors. Spinels.

Instrumental methods of analysis: atomic absorption, UV-visible spectrometry, chromatographic and electro-analytical methods.

ORGANIC CHEMISTRY

Synthesis, reactions and mechanisms involving the following: Alkenes, alkynes, arenes, alcohols, phenols, aldehydes, ketones, carboxylic acids and their derivatives; halides, nitro compounds and amines; stereochemical and conformational effects on reactivity and specificity; reactions with diborane and peracids. Michael reaction, Robinson annulation, reactivity umpolung, acyl anion equivalents; molecular rearrangements involving electron deficient atoms.

Photochemistry: Basic principles, photochemistry of olefins, carbonyl compounds, arenes, photo oxidation and reduction.

Pericyclic reactions: Cycloadditions, electrocyclic reactions, sigmatropic reactions; Woodward-Hoffmann rules.

Heterocycles: Structural properties and reactions of furan, pyrrole, thiophene, pyridine, indole.

Biomolecules: Structure, properties and reactions of mono- and di-saccharides, physico-chemical properties of amino acids, structural features of proteins and nucleic acids.

Spectroscopy: Principles and applications of IR, UV-visible, NMR and mass spectrometry in the determination of structures of organic compounds.

EC - ELECTRONICS AND COMMUNICATION ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix Algebra, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Mean value theorems, Theorems of integral calculus, Evaluation of definite and improper integrals, Partial Derivatives, Maxima and minima, Multiple integrals, Fourier series. Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equation (linear and nonlinear), Higher order linear differential equations with constant coefficients, Method of variation of parameters, Cauchy's and Euler's equations, Initial and boundary value problems, Partial Differential Equations and variable separable method.

Complex variables: Analytic functions, Cauchy's integral theorem and integral formula, Taylor's and Laurent' series, Residue theorem, solution integrals.

Probability and Statistics: Sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Discrete and continuous distributions, Poisson, Normal and Binomial distribution, Correlation and regression analysis.

Numerical Methods: Solutions of non-linear algebraic equations, single and multi-step methods for differential equations.

Transform Theory: Fourier transform, Laplace transform, Z-transform.

ELECTRONICS & COMMUNICATION ENGINEERING

Networks: Network graphs: matrices associated with graphs; incidence, fundamental cut set and fundamental circuit matrices. Solution methods: nodal and mesh analysis. Network theorems: superposition, Thevenin and Norton's maximum power transfer, Wye-Delta transformation. Steady state sinusoidal analysis using phasors. Linear constant coefficient differential equations; time domain analysis of simple RLC circuits, Solution of network equations using Laplace transform: frequency domain analysis of RLC circuits. 2-port network parameters: driving point and transfer functions. State equations for networks.

Electronic Devices: Energy bands in silicon, intrinsic and extrinsic silicon. Carrier transport in silicon: diffusion current, drift current, mobility, resistivity. Generation and recombination of carriers. p-n junction diode, Zener diode, tunnel diode, BJT, JFET, MOS capacitor, MOSFET, LED, p-I-n and avalanche photo diode, LASERs. Device technology: integrated circuits fabrication process, oxidation, diffusion, ion implantation, photolithography, n-tub, p-tub and twin-tub CMOS process.

Analog Circuits: Equivalent circuits (large and small-signal) of diodes, BJTs, JFETs, and MOSFETs. Simple diode circuits, clipping, clamping, rectifier. Biasing and bias stability of transistor and FET amplifiers. Amplifiers: single-and multi-stage, differential, operational, feedback and power. Analysis of amplifiers; frequency response of amplifiers. Simple op-amp circuits. Filters. Sinusoidal oscillators; criterion for oscillation; single-transistor and op-amp configurations. Function generators and wave-shaping circuits. Power supplies.

Digital circuits: Boolean algebra, minimization of Boolean functions; logic gates digital IC families (DTL, TTL, ECL, MOS, CMOS). Combinational circuits: arithmetic circuits, code converters, multiplexers and decoders. Sequential circuits: latches and flip-flops, counters and shift-registers. Sample and hold circuits, ADCs, DACs. Semiconductor memories. Microprocessor(8085): architecture, programming, memory and I/O interfacing.

Signals and Systems: Definitions and properties of Laplace transform, continuous-time and discrete-time Fourier series, continuous-time and discrete-time Fourier Transform, z-transform. Sampling theorems. Linear Time-Invariant (LTI) Systems: definitions and properties; casuality, stability, impulse response, convolution, poles and zeros frequency response, group delay, phase delay. Signal transmission through LTI systems. Random signals and noise: probability, random variables, probability density function, autocorrelation, power spectral density.

Controls Systems: Basic control system components; block diagrammatic description, reduction of block diagrams. Open loop and closed loop (feedback) systems and stability analysis of these systems. Signal flow graphs and their use in determining transfer functions of systems; transient and steady state analysis of LTI control systems and frequency response. Tools and techniques for LTI control system analysis: root loci, Routh-Hurwitz criterion, Bode and Nyquist plots. Control system compensators: elements of lead and lag compensation, elements of Proportional-Integral-Derivative(PID) control. State variable representation and solution of state equation of LTI control systems.

Communications: Analog communication systems: amplitude and angle modulation and demodulation systems, spectral analysis of these operations, superheterodyne receivers; elements of hardware, realizations of analog communication systems; signal-to-noise ratio (SNR) calculations for amplitude modulation (AM) and frequency modulation (FM) for low noise conditions. Digital communication systems: pulse code modulation (PCM), differential pulse code modulation (DPCM), delta modulation (DM); digital modulation schemes-amplitude, phase and frequency shift keying schemes (ASK, PSK, FSK), matched filter receivers, bandwith consideration and probability of error calculations for these schemes.

Electromagnetics: Elements of vector calculus: divergence and curl; Gauss' and Stokes' theorems, Maxwell's equations: differential and integral forms. Wave equation, Poynting vector. Plane waves: propagation through various media; reflection and refraction; phase and group velocity; skin depth. Transmission lines: characteristic impedance; impedance transformation; Smith chart; impedance matching; pulse excitation. Waveguides: modes in rectangular waveguides; boundary conditions; cut-off frequencies; dispersion relations. Antennas: Dipole antennas; antenna arrays; radiation pattern; reciprocity theorem, antenna gain.

EE - ELECTRICAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix Algebra, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Mean value theorems, Theorems of integral calculus, Evaluation of definite and improper integrals, Partial Derivatives, Maxima and minima, Multiple integrals, Fourier series. Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equation (linear and nonlinear), Higher order linear differential equations with constant coefficients, Method of variation of parameters, Cauchy's and Euler's equations, Initial and boundary value problems, Partial Differential Equations and variable separable method.

Complex variables: Analytic functions, Cauchy's integral theorem and integral formula, Taylor's and Laurent' series, Residue theorem, solution integrals.

Probability and Statistics: Sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Discrete and continuous distributions, Poisson, Normal and Binomial distribution, Correlation and regression analysis.

Numerical Methods: Solutions of non-linear algebraic equations, single and multi-step methods for differential equations.

Transform Theory: Fourier transform, Laplace transform, Z-transform.

ELECTRICAL ENGINEERING

Electrical Circuits and Fields: Network graph, KCL, KVL, node/ cut set, mesh/ tie set analysis, transient response of d.c. and a.c. networks; sinusoidal steady-state analysis; resonance in electrical circuits; concepts of ideal voltage and current sources, network theorems, driving point, immittance and transfer functions of two port networks, elementary concepts of filters; three phase circuits; Fourier series and its application; Gauss theorem, electric field intensity and potential due to point, line, plane and spherical charge distribution, dielectrics, capacitance calculations for simple configurations; Ampere's and Biot-Savart's law, inductance calculations for simple configurations.

Electrical Machines: Single phase transformer - equivalent circuit, phasor diagram, tests, regulation and efficiency; three phase transformers - connections, parallel operation; auto transformer and three-winding transformer; principles of energy conversion, windings of rotating machines: D. C. generators and motors - characteristics, starting and speed control, armature reaction and commutation; three phase induction motors-performance characteristics, starting and speed control; single-phase induction motors; synchronous generators-performance, regulation, parallel operation; synchronous motors - starting, characteristics, applications, synchronous condensers; fractional horse power motors; permanent magnet and stepper motors.

Power Systems: Electric power generation - thermal, hydro, nuclear; transmission line parameters; steady-state performance of overhead transmission lines and cables and surge propagation; distribution systems, insulators, bundle conductors, corona and radio interference effects; per-unit quantities; bus admittance and impedance matrices; load flow; voltage control and power factor correction; economic operation; symmetrical components, analysis of symmetrical and unsymmetrical faults; principles of over current, differential and distance protections; concept of solid state relays and digital protection; circuit breakers; concept of system stability-swing curves and equal area criterion; basic concepts of HVDC transmission.

Control Systems: Principles of feedback; transfer function; block diagrams: steady-state errors; stability-Routh and Nyquist criteria; Bode plots; compensation; root loci; elementary state variable formulation; state transition matrix and response for Linear Time Invariant systems.

Electrical and Electronic Measurements: Bridges and potentiometers, PMMC, moving iron, dynamometer and induction type instruments; measurement of voltage, current, power, energy and power factor; instrument transformers; digital voltmeters and multimeters; phase, time and frequency measurement; Q-meter, oscilloscopes, potentiometric recorders, error analysis.

Analog and Digital Electronics: Characteristics of diodes, BJT, FET, SCR; amplifiers-biasing, equivalent circuit and frequency response; oscillators and feedback amplifiers, operational amplifiers- characteristics and applications; simple active filters; VCOs and timers;

combinational and sequential logic circuits, multiplexer, Schmitt trigger, multivibrators, sample and hold circuits, A/D and D/A converters; microprocessors and their applications.

Power Electronics and Electric Drives: Semiconductor power devices-diodes, transistors, thyristors, triacs, GTOs, MOSFETs and IGBTs - static characteristics and principles of operation; triggering circuits; phase control rectifiers; bridge converters-fully controlled and half controlled; principles of choppers and inverters, basic concepts of adjustable speed dc and ac drives.

GG - GEOLOGY AND GEOPHYSICS

PART - I

Earth and planetary system; size, shape, internal structure and composition of the earth; atmosphere and greenhouse effect; isostasy; elements of seismology; continents and continental processes; physical oceanography; palaeomagnetism, continental drift plate tectonics, geothermal energy.

Weathering; soil formation; action of river, wind and glacier; oceans and oceanic features; earthquakes, volcanoes, orogeny and mountain building; elements of structural geology; crystallography; classification, composition and properties of minerals and rocks; engineering properties of rocks and soils, role of geology in the construction of engineering structures.

Processes of ore formation, occurrence and distribution of ores on land and on ocean floor; coal and petroleum resources in India; ground water geology including well hydraulics, geological time scale and geochronology; stratigraphic principles and stratigraphy of India; basics concepts of gravity, magnetic and electrical prospecting for ores and ground water.

PART - IIA: GEOLOGY

Crystal symmetry, forms, twinning; crystal chemistry; optical mineralogy, classification of minerals, diagnostic properties of rock minerals.

Mineralogy, structure, texture and classification of igneous, sedimentary and metamorphic rock, their origin and evolution; application of thermodynamics; structure and petrology of sedimentary rocks; sedimentary processes and environments, sedimentary facies, basin studies; basement cover relationship;

Primary and secondary structures; geometry and genesis of folds, faults, joints, unconformities, cleavage, schistosity and lineation; methods of projection. Tectonites and their significance; shear zone; superposed folding.

Morphology, classification and geological significance of important invertebrates, vertebrates, microfossils and palaeoflora; stratigraphic principles and Indian stratigraphy; geomorphic processes and agents; development and evolution of landforms; slope and drainage; processes on deep oceanic and near-shore regions; quantitative and applied geomorphology; air photo interpretation and remote sensing; chemical and optical properties of ore minerals; formation and localization of ore deposits; prospecting and exploration of economic minerals; coal and petroleum geology; origin and distribution of mineral and fuel deposits in India; ore dressing and mineral economics.

Cosmic abundance; meteorites; geochemical evolution of the earth; geochemical cycles; distribution of major, minor and trace elements; isotope geochemistry; geochemistry of waters including solution equilibria and water rock interaction.

Engineering properties of rocks and soils; rocks as construction material; geology of dams, tunnels and excavation sites; natural hazards; the fly ash problem; ground water geology and exploration; water quality; impact of human activity; Remote sensing techniques for the interpretation of landforms and resource management.

PART - II B: GEOPHYSICS

The earth as a planet; different motions of the earth; gravity filed of the earth and its shape; geochronology; isostasy, seismology and interior of the earth; variation of density, velocity, pressure, temperature, electrical and magnetic properties inside the earth; earthquakes-causes and measurements; zonation and seismic hazards; geomagnetic field, palaeomagnetism; oceanic and continental lithosphere; plate tectonics; heat flow; upper and lower atmospheric phenomena.

Theories of scalar and vector potential fields; Laplace, Maxwell and Helmholtz equations for solution of different types of boundary value problems for Cartesian, cylindrical and spherical polar coordinates; Green's theorem; Image theory; integral equations and conformal transformations in potential theory; Eikonal equation and ray theory.

'G' and 'g' units of measurement, density of rocks, gravimeters, preparation, analysis and interpretation of gravity maps; derivative maps, analytical continuation; gravity anomaly type curves; calculation of mass.

Earth's magnetic field, units of measurement, magnetic susceptibility of rocks, magnetometers, corrections, preparation of magnetic maps, magnetic anomaly type curve, analytical continuation, interpretation and application; magnetic well logging.

Conduction of electricity through rocks, electrical conductivities of metals, metallic, non-metallic and rock forming minerals, D.C. resistivity units and methods of measurement, electrode configuration for sounding and profiling, application of filter theory, interpretation of resistivity field data, application; self potential origin, classification, field measurement, interpretation of induced polarization time frequency, phase domain; IP units and methods of measurement, interpretation and application; ground-water exploration.

Origin of electromagnetic field elliptic polarization, methods of measurement for different source-receiver configuration components in EM measurements, interpretation and applications; earth's natural electromagnetic field, tellurics, magneto-tellurics; geomagnetic depth sounding principles, methods of measurement, processing of data and interpretation.

Seismic methods of prospecting: Reflection, refraction and CDP surveys; land and marine seismic sources, generation and propagation of elastic waves, velocity increasing with depth, geophones, hydrophones, recording instruments (DFS), digital formats, field layouts, seismic noises and noise profile analysis, optimum geophone grouping, noise cancellation by shot and geophone arrays, 2D and 3D seismic data acquisition and processing, CDP stacking charts, binning, filtering, dip-moveout, static and dynamic corrections, deconvolution, migration, signal processing, Fourier and Hilbert transforms, attribute analysis, bright and dim spots, seismic stratigraphy, high resolution seismics, VSP.

Principles and techniques of geophysical well-logging, SP, resistivity, induction, micro gamma ray, neutron, density, sonic, temperature, dip meter, caliper, nuclear magnetic, cement bond logging. Quantitative evaluation of formations from well logs; well hydraulics and application of geophysical methods for groundwater study; application of bore hole geophysics in ground water, mineral and oil exploration. Remote sensing techniques and application of remote sensing methods in geophysics.

IN - INSTRUMENTATION ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix Algebra, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Mean value theorems, Theorems of integral calculus, Evaluation of definite and improper integrals, Partial Derivatives, Maxima and minima, Multiple integrals, Fourier series.

Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equation (linear and nonlinear), Higher order linear differential equations with constant coefficients, Method of variation of parameters, Cauchy's and Euler's equations, Initial and boundary value problems, Partial Differential Equations and variable separable method.

Complex variables: Analytic functions, Cauchy's integral theorem and integral formula, Taylor's and Laurent' series, Residue theorem, solution integrals.

Probability and Statistics: Sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Discrete and continuous distributions, Poisson, Normal and Binomial distribution, Correlation and regression analysis.

Numerical Methods: Solutions of non-linear algebraic equations, single and multi-step methods for differential equations.

Transform Theory: Fourier transform, Laplace transform, Z-transform.

INSTRUMENTATION ENGINEERING

Measurement Basics and Metrology: Static and dynamic characteristics of measurement systems. Standards and calibration. Error and uncertainty analysis, statistical analysis of data, and curve fitting. Linear and angular measurements; Measurement of straightness, flatness, roundness and roughness.

Transducers, Mechanical Measurements and Industrial Instrumentation: Transducers - elastic, resistive, inductive, capacitive, thermo-electric, piezoelectric, photoelectric, electro-mechanical, electro-chemical, and ultrasonic. Measurement of displacement, velocity (linear and rotational), acceleration, shock, vibration, force, torque, power, strain, stress, pressure, flow, temperature, humidity, viscosity, and density. energy storing elements, suspension systems and dampers.

Analog Electronics: Characteristics of diodes, BJTs, JFETs and MOSFETs; Diode circuits; Amplifiers: single and multi-stage, feedback; Frequency response; Operational amplifiers - design, characteristic, linear and non-linear applications: difference amplifiers; instrumentation amplifiers; precision rectifiers, I-to-V converters, active filters, oscillators, comparators, signal generators, wave shaping circuits.

Digital Electronics: Combinational logic circuits, minimization of Boolean functions; IC families (TTL, MOS, CMOS), arithmetic circuits, multiplexer and decoders. Sequential circuits: flip-flops, counters, shift registers. Schmitt trigger, timers, and multivibrators. Analog switches, multiplexers, S/H circuits. Analog-to-digital and digital-to-analog converters. Basics of computer organization and architecture. 8-bit microprocessor (8085), applications, memory, I/O interfacing, and microcontrollers.

Signals and Systems: Vectors and matrices; Fourier series; Fourier transforms; Ordinary differential equations. Impulse and frequency responses of first and second order systems. Laplace transform and transfer function, convolution and correlation. Amplitude and frequency modulations and demodulations. Discrete time systems, difference equations, impulse and frequency responses; Z-transforms and transfer functions; IIR and FIR filters.

Electrical and Electronic Measurements: Measurement of R, L and C; bridges and potentiometers. Measurement of voltage, current, power, power factor, and energy; Instrument transformers; Q meter, waveform analyzers. Digital volt-meters and multi-meters. Time, phase and frequency measurements; Oscilloscope. Noise and interference in instrumentation.

Control Systems & Process Control: Principles of feedback; transfer function, signal flow graphs. Stability criteria, Bode plots, root-loci, Routh and Nyquist criteria. Compensation techniques; State space analysis. System components: mechanical, hydraulic, pneumatic, electrical and electronic; Servos and synchros; Stepper motors. On-off, cascade, P, PI, PID and feed-forward controls. Controller tuning and general frequency response.

Analytical, Optical and Biomedical Instrumentation: Principles of spectrometry, UV, visible, IR mass spectrometry, X-ray methods; nuclear radiation measurements, gas, solid and semi conductor lasers and their characteristics, interferometers, basics of fibre optics, transducers in biomedical applications, cardiovascular system measurements, instrumentation for clinical laboratory.

MA - MATHEMATICS

Linear Algebra: Finite dimensional vector spaces. Linear transformations and their matrix representations, rank; systems of linear equations, eigenvalues and eigenvectors, minimal polynomial, Cayley-Hamilton theorem, diagonalisation, Hermitian, Skew-Hermitian and unitary matrices. Finite dimensional inner product spaces, self-adjoint and Normal linear operators, spectral theorem, Quadratic forms.

Complex Analysis: Analytic functions, conformal mappings, bilinear transformations, complex integration: Cauchy's integral theorem and formula, Liouville's theorem, maximum modulus principle, Taylor and Laurent's series, residue theorem and applications for evaluating real integrals.

Real Analysis: Sequences and series of functions, uniform convergence, power series, Fourier series, functions of several variables, maxima, minima, multiple integrals, line, surface and volume integrals, theorems of Green, Stokes and Gauss; metric spaces, completeness, Weierstrass approximation theorem, compactness. Lebesgue measure, measurable functions; Lebesgue integral, Fatou's lemma, dominated convergence theorem.

Ordinary Differential Equations: First order ordinary differential equations, existence and uniqueness theorems, systems of linear first order ordinary differential equations, linear ordinary differential equations of higher order with constant coefficients; linear second order ordinary differential equations with variable coefficients, method of Laplace transforms for solving ordinary differential equations, series solutions; Legendre and Bessel functions and their orthogonality, Sturm Liouville system, Greeen's functions.

Algebra: Normal subgroups and homomorphisms theorems, automorphisms. Group actions, sylow's theorems and their applications groups of order less than or equal to 20, Finite p-groups. Euclidean domains, Principal ideal domains and unique factorizations domains. Prime ideals and maximal ideals in commutative rings.

Functional Analysis: Banach spaces, Hahn-Banach theorems, open mapping and closed graph theorems, principle of uniform boundedness; Hilbert spaces, orthonormal sets, Riesz representation theorem, self-adjoint, unitary and normal linear operators on Hilbert Spaces.

Numerical Analysis: Numerical solution of algebraic and transcendental equations; bisection, secant method, Newton-Raphson method, fixed point iteration, interpolation: existence and error of polynomial interpolation, Lagrange, Newton, Hermite(osculatory)interpolations; numerical differentiation and integration, Trapezoidal and Simpson rules; Gaussian quadrature; (Gauss-Legendre and Gauss-Chebyshev), method of undetermined parameters, least square and orthonormal polynomial approximation; numerical solution of systems of linear equations: direct and iterative methods, (Jacobi Gauss-Seidel and SOR) with convergence; matrix eigenvalue problems: Jacobi and Given's methods, numerical solution of ordinary differential equations: initial value problems, Taylor series method, Runge-Kutta methods, predictor-corrector methods; convergence and stability.

Partial Differential Equations: Linear and quasilinear first order partial differential equations, method of characteristics; second order linear equations in two variables and their classification; Cauchy, Dirichlet and Neumann problems, Green's functions; solutions of Laplace, wave and diffusion equations in two variables Fourier series and transform methods of solutions of the above equations and applications to physical problems.

Mechanics: Forces in three dimensions, Poinsot central axis, virtual work, Lagrange's equations for holonomic systems, theory of small oscillations, Hamiltonian equations;

Topology: Basic concepts of topology, product topology, connectedness, compactness, countability and separation axioms, Urysohn's Lemma, Tietze extension theorem, metrization theorems, Tychonoff theorem on compactness of product spaces.

Probability and Statistics: Probability space, conditional probability, Bayes' theorem, independence, Random variables, joint and conditional distributions, standard probability distributions and their properties, expectation, conditional expectation, moments. Weak and strong law of large numbers, central limit theorem. Sampling distributions, UMVU estimators, sufficiency and consistency, maximum likelihood estimators. Testing of hypotheses, Neyman-Pearson tests, monotone likelihood ratio, likelihood ratio tests, standard parametric tests based on normal, X2 ,t, F-distributions. Linear regression and test for linearity of regression. Interval estimation.

Linear Programming: Linear programming problem and its formulation, convex sets their properties, graphical method, basic feasible solution, simplex method, big-M and two phase methods, infeasible and unbounded LPP's, alternate optima. Dual problem and duality theorems, dual simplex method and its application in post optimality analysis, interpretation of dual variables. Balanced and unbalanced transportation problems, unimodular property and u-v method for solving transportation problems. Hungarian method for solving assignment problems.

Calculus of Variations and Integral Equations: Variational problems with fixed boundaries; sufficient conditions for extremum, Linear integral equations of Fredholm and Volterra type, their iterative solutions. Fredholm alternative.

ME - MECHANICAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

APPLIED MECHANICS AND DESIGN

Engineering Mechanics: Equivalent force systems, free-body concepts, equations of equilibrium, trusses and frames, virtual work and minimum potential energy. Kinematics and dynamics of particles and rigid bodies, impulse and momentum (linear and angular), energy methods, central force motion.

Strength of Materials: Stress and strain, stress-strain relationship and elastic constants, Mohr's circle for plane stress and plane strain, shear force and bending moment diagrams, bending and shear stresses, deflection of beams, torsion of circular shafts, thin and thick cylinders, Euler's theory of columns, strain energy methods, thermal stresses.

Theory of Machines: Displacement, velocity and acceleration, analysis of plane mechanisms, dynamic analysis of slider-crank mechanism, planar cams and followers, gear tooth profiles, kinematics of gears, governors and flywheels, balancing of reciprocating and rotating masses.

Vibrations: Free and forced vibration of single degree freedom systems, effect of damping, vibration isolation, resonance, critical speed of rotors.

Design of Machine Elements: Design for static and dynamic loading, failure theories, fatigue strength; design of bolted, riveted and welded joints; design of shafts and keys; design of spur gears, rolling and sliding contact bearings; brakes and clutches; belt, rope and chain drives.

FLUID MECHANICS AND THERMAL SCIENCES

Fluid Mechanics: Fluid properties, fluid statics, manometry, buoyancy; control-volume analysis of mass, momentum and energy; fluid acceleration; differential equations of continuity and momentum; Bernoulli's equation; viscous flow of incompressible fluids; boundary layer; elementary turbulent flow; flow through pipes, head losses in pipes, bends etc.

Heat-Transfer: Modes of heat transfer; one dimensional heat conduction, resistance concept, electrical analogy, unsteady heat conduction, fins; dimensionless parameters in free and forced convective heat transfer, various correlations for heat transfer in flow over flat plates and through pipes; thermal boundary layer; effect of turbulence; radiative heat transfer, black and grey surfaces, shape factors, network analysis; heat exchanger performance, LMTD and NTU methods.

Thermodynamics: Zeroth, First and Second laws of thermodynamics; thermodynamic system and processes; irreversibility and availability; behaviour of ideal and real gases, properties of pure substances, calculation of work and heat in ideal processes; analysis of thermodynamic cycles related to energy conversion; Carnot, Rankine, Otto, Diesel, Brayton and vapour compression cycles.

Power Plant Engineering: Steam generators; steam power cycles; steam turbines; impulse and reaction principles, velocity diagrams, pressure and velocity compounding; reheating and reheat factor; condensers and feed heaters.

I.C. Engines: Requirements and suitability of fuels in IC engines, fuel ratings, fuel-air mixture requirements; normal combustion in SI and CI engines; engine performance calculations.

Refrigeration and air-conditioning: Refrigerant compressors, expansion devices, condensers and evaporators; properties of moist air, psychrometric chart, basic psychometric processes.

Turbomachinery: Components of gas turbines; compression processes, centrifugal and axial flow compressors; axial flow turbines, elementary theory; hydraulic turbines; Euler-turbine equation; specific speed, Pelton-wheel, Francis and Kaplan turbines; centrifugal pumps.

MANUFACTURING AND INDUSTRIAL ENGINEERING

Engineering Materials: Structure and properties of engineering materials and their applications, heat treatment.

Metal Casting: Casting processes (expendable and non-expendable) -pattern, moulds and cores, heating and pouring, solidification and cooling, gating design, design considerations, defects.

Forming Processes: Stress-strain diagrams for ductile and brittle material, Plastic deformation and yield criteria, fundamentals of hot and cold working processes, Bulk metal forming processes (forging, rolling, extrusion, drawing), sheet metal working processes (punching, blanking, bending, deep drawing, coining, spinning, load estimation using homogeneous deformation methods, defects). processing of powder metals- atomization, compaction, sintering, secondary and finishing operations. forming and shaping of plastics- extrusion, injection moulding.

Joining Processes: Physics of welding, fusion and non-fusion welding processes, brazing and soldering, adhesive bonding, design considerations in welding, weld quality defects.

Machining and Machine Tool Operations: Mechanics of machining, single and multi-point cutting tools, tool geometry and materials, tool life and wear, cutting fluids, machinability, economics of machining, non-traditional machining processes.

Metrology and Inspection: Limits, fits and tolerances, linear and angular measurements, comparators, gauge design, interferometry, form and finish measurement, measurement of screw threads, alignment and testing methods.

Tool Engineering: Principles of work holding, design of jigs and fixtures.

Computer Integrated Manufacturing: Basic concepts of CAD, CAM and their integration tools.

Manufacturing Analysis: Part-print analysis, tolerance analysis in manufacturing and assembly, time and cost analysis.

Work-Study: Method study, work measurement, time study, work sampling, job evaluation, merit rating.

Production Planning and Control: Forecasting models, aggregate production planning, master scheduling, materials requirements planning.

Inventory Control: Deterministic and probabilistic models, safety stock inventory control systems.

Operations Research: Linear programming, simplex and duplex method, transportation, assignment, network flow models, simple queuing models, PERT and CPM

MN - MINING ENGINEERING

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes,

Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

MINING ENGINEERING

Mechanics: Equivalent force systems, equations of equilibrium, two dimensional frames and trusses, free body diagrams, friction forces, particle kinematics and dynamics.

Mine Development, Geomechanics and Strata Control: Drivages for underground mine development, drilling methods and machines, explosives, blasting devices and practices, shaft sinking. Physico-mechanical properties of rocks, rock mass classification, ground control instrumentation and stress measurement techniques, theories of rock failure, ground vibrations, stress distribution around mine openings, subsidence, design of supports in roadways and workings, stability of open pits, slopes.

Mining Methods and Machinery: Surface mining - layout, development, loading, transportation and mechanization, continuous surface mining systems. Underground coal mining - bord and pillar system, longwall mining, thick seam mining methods. Underground metal mining: different stoping methods, stope mechanization, ore handling systems, mine filling. Generation and transmission of mechanical, hydraulic, and pneumatic power. Materials handling - haulages, conveyors, ropeways, face and development machinery, hoisting systems, and pumps.

Ventilation, Underground Hazards and Surface Environment: Underground atmosphere, heat load sources and thermal environment, air cooling, mechanics of air flow distribution, natural and mechanical ventilation, mine fans and their usage, auxiliary ventilation. Subsurface hazards from fires, explosions, gases, dust, and inundation, rescue apparatus and practices, safety in mines, accident analysis, noise, mine lighting. Air and water pollution: causes, dispersion, quality standards, and control.

Surveying, Mine Planning and Systems Engineering: Fundamentals of engineering surveying, Levels and levelling, Theodolite, tacheometry, triangulation, contouring, errors and adjustments, correlation, underground surveying, curves, photogrammetry, field astronomy, GPS fundamentals. Principles of planning - Sampling methods and practices, reserve estimation techniques, basics of geostatistics, optimization of facility location, cash flow concepts and mine valuation, open pit design. Work study, concepts of reliability, reliability of series and parallel systems. Linear programming, transportation and assignment problems, queueing, network analysis, inventory control.

MT - METALLURGICAL ENGINEERING

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes,

Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

METALLURGICAL ENGINEERING

Thermodynamics and Rate Processes: Laws of thermodynamics, activity, equilibrium constant, applications to metallurgical systems, solutions, phase equilibria, basic kinetic laws, order of reactions, rate constants and rate limiting steps principles of electro chemistry, aqueous, corrosion and protection of metals, oxidation and high temperature corrosion - characterization and control; momentum transfer - concepts of viscosity, shell balances, Bernoulli's equation; heat transfer - conduction, convection and heat transfer coefficient relations, radiation, mass transfer - diffusion and Fick's laws.

Extractive Metallurgy: Flotation, gravity and other methods of mineral processing; agglomeration, pyro-hydro-and electro-metallurgical processes; material and energy balances; principles and processes for the extraction of non-ferrous metals - aluminium, copper, zinc, lead, magnesium, nickel, titanium and other rare metals; iron and steel making - principles, blast furnace, direct reduction processes, primary and secondary steel making, deoxidation and inclusion in steel; ingot and continuous casting; stainless steel making, design of furnaces; fuels and refractories.

Physical Metallurgy: Crystal structure and bonding characteristics of metals, alloys, ceramics and polymers; solid solutions; solidification; phase transformation and binary phase diagrams; principles of heat treatment of steels, aluminum alloys and cast irons; recovery, recrystallization and grain growth; industrially important ferrous and non-ferrous alloys; elements of X-ray and electron diffraction; principles of scanning and transmission electron microscopy; elements of ceramics, composites and electronic materials; electronic basis of thermal, optical, electrical and magnetic properties of materials.

Mechanical Metallurgy: Elements of elasticity and plasticity; defects in crystals; elements of dislocation theory - types of dislocations, slip and twinning, stress fields of dislocations, dislocation interactions and reactions, methods of seeing dislocations; strengthening mechanisms; tensile, fatigue and creep behaviour; superplasticity; fracture - Griffith theory, ductile to brittle transition, fracture toughness; failure analysis; mechanical testing - tension, compression, torsion, hardness, impact, creep, fatigue, fracture toughness and formability tests.

Manufacturing Processes: Metal casting - patterns, moulds, melting, gating, feeding and casting processes, defects and castings, hot and cold working of metals; Metal forming - fundamentals of metal forming, rolling wire drawing, extrusion, forming, sheet metal forming processes, defects in forming; Metal joining - soldering, brazing and welding, common welding processes, welding metallurgy, problems associated with welding of steels and aluminium alloys, defects in welding, powder metallurgy; NDT methods - ultrasonic, radiography, eddy current, acoustic emission and magnetic.

PH - PHYSICS

Mathematical Physics: Linear vector space, matrices; vector calculus; linear differential equations; elements of complex analysis; Laplace transforms, Fourier analysis, elementary ideas about tensors.

Classical Mechanics: Conservation laws; central forces; collisions and scattering in laboratory and centre of mass reference frames; mechanics of system of particles; rigid body dynamics; moment of inertia tensor; noninertial frames and pseudo forces; variational principle; Lagrange's and Hamilton's formalisms; equation of motion, cyclic coordinates, Poisson bracket; periodic motion, small oscillations, normal modes; wave equation and wave propagation; special theory of relativity - Lorentz transformations, relativistic kinematics, mass-energy equivalence.

Electromagnetic Theory: Laplace and Poisson equations; conductors and dielectrics; boundary value problems; Ampere's and Biot-Savart's laws; Faraday's law; Maxwell's equations; scalar and vector potentials; Coulomb and Lorentz gauges; boundary conditions at interfaces; electromagnetic waves; interference, diffraction and polarization; radiation from moving charges.

Quantum Mechanics: Physical basis of quantum mechanics; uncertainty principle; Schrodinger equation; one and three dimensional potential problems; Particle in a box, harmonic oscillator, hydrogen atom; linear vectors and operators in Hilbert space; angular momentum and spin; addition of angular momentum; time independent perturbation theory; elementary scattering theory.

Atomic and Molecular Physics: Spectra of one-and many-electron atoms; LS and jj coupling; hyperfine structure; Zeeman and Stark effects; electric dipole transitions and selection rules; X-ray spectra; rotational and vibrational spectra of diatomic molecules; electronic transition in diatomic molecules, Franck-Condon principle; Raman effect; NMR and ESR; lasers.

Thermodynamics and Statistical Physics: Laws of thermodynamics; macrostates, phase space; probability ensembles; partition function, free energy, calculation of thermodynamic quantities; classical and quantum statistics; degenerate Fermi gas; black body radiation and Planck's distribution law; Bose-Einstein condensation; first and second order phase transitions, critical point.

Solid State Physics: Elements of crystallography; diffraction methods for structure determination; bonding in solids; elastic properties of solids; defects in crystals; lattice vibrations and thermal properties of solids; free electron theory; band theory of solids; metals, semiconductors and insulators; transport properties; optical, dielectric and magnetic properties of solids; elements of superconductivity.

Nuclear and Particle Physics: Rutheford scattering; basic properties of nuclei; radioactive decay; nuclear forces; two nucleon problem; nuclear reactions; conservation laws; fission and fusion; nuclear models; particle accelerators, detectors; elementary particles; photons, baryons, mesons and leptons; Quark model.

Electronics: Network analysis; semiconductor devices; bipolar transistors; FETs; power supplies, amplifier, oscillators; operational amplifiers; elements of digital electronics; logic circuits.

PI - PRODUCTION AND INDUSTRIAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear

differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

GENERAL ENGINEERING:

Engineering Materials: Structure and properties of engineering materials and their applications; effect of strain, strain rate and temperature on mechanical properties of metals and alloys; heat treatment of metals and alloys.

Applied Mechanics: Engineering mechanics - equivalent force systems, free body concepts, equations of equilibrium, virtual work and minimum potential energy; strength of materials-stress, strain and their relationship, Mohr's circle, deflection of beams, bending and shear stress, Euler's theory of columns.

Theory of Machines and Design: Analysis of planar mechanisms, plane cams and followers; governers and fly wheels; design of elements-failure theories; design of bolted, riveted and welded joints; design of shafts, keys, belt drives, brakes and clutches.

Thermal Engineering: Fluid machines - fluid statics, Bernoulli's equation, flow through pipes, equations of continuity and momentum; Thermodynamics - zeroth, First and Second laws of thermodynamics, thermodynamic system and processes, calculation of work and heat for systems and control volumes; Heat transfer - fundamentals of conduction, convection and radiation.

PRODUCTION ENGINEERING

Metal Casting: Casting processes; patterns-materials; allowances; moulds and cores - materials, making and testing; melting and founding of cast iron, steels and nonferrous metals and alloys; solidification; design of casting, gating and risering; casting defects and inspection.

Metal working: Stress-strain in elastic and plastic deformation; deformation mechanisms; hot and cold working-forging, rolling, extrusion, wire and tube drawing; sheet metal working; analysis of rolling, forging, extrusion and wire /rod drawing; metal working defects, high energy rate forming processes-explosive, magnetic, electro and electrohydraulic.

Metal Joining Processes: Welding processes - gas shielded metal arc, TIG, MIG, submerged arc, electroslag, thermit, resistance, pressure and forge welding; thermal cutting; other joining processes - soldering, brazing, braze welding; welding codes, welding symbols, design of welded joints, defects and inspection; introduction to modern welding processes - friction, ultrasonic, explosive, electron beam, laser and plasma.

Machining and Machine Tool Operations: Machining processes-turning, drilling, boring, milling, shaping, planing, sawing, gear cutting, thread production, broaching, grinding, lapping, honing super finishing; mechanics of cutting- Merchant's analysis, geometry of cutting tools, cutting forces, power requirements; selection of process parameters; tool materials, tool wear and tool life, cutting fluids, machinability; nontraditional machining processes and hybrid processes- EDM, CHM, ECM, USM, LBM, EBM, AJM, PAM AND WJM; economics of machining.

Metrology and Inspection: Limits and fits, linear and angular measurements by mechanical and optical methods, comparators; design of limit gauges; interferometry; measurement of straightness, flatness, roundness, squareness and symmetry; surface finish measurement; inspection of screw threads and gears; alignment testing.

Powder Metallurgy and Processing of Plastics: Production of powders, compaction, sintering; Polymers and composites; injection, compression and blow molding, extrusion, calendaring and thermoforming; molding of composites.

Tool Engineering: Work-holding-location and clamping; principles and methods; design of jigs and fixtures; design of press working tools, forging dies.

Manufacturing Analysis: Sources of errors in manufacturing; process capability; part-print analysis; tolerance analysis in manufacturing and assembly; process planning; parameter selection and comparison of production alternatives; time and cost analysis; Issues in choosing manufacturing technologies and strategies.

Computer Integrated Manufacturing: Basic concepts of CAD, CAM, CAPP, group technology, NC, CNC, DNC, FMS, Robotics and CIM.

INDUSTRIAL ENGINEERING

Product Design and Development: Principles of good product design, component and tolerance design; efficiency, quality and cost considerations; product life cycle; standardization, simplification, diversification, value analysis, concurrent engineering.

Engineering Economy and Costing: Financial statements; elementary cost accounting, methods of depreciation; break-even analysis, techniques for evaluation of capital investments.

Work System Design: Taylor's scientific management, Gilbreths's contributions; productivity concepts and measurements; method study, micro-motion study, principles of motion economy; human factors engineering, ergonomics; work measurement - time study, PMTS, work sampling; job evaluation, merit rating, wage administration, incentive systems; business process reengineering.

Logistics and Facility Design: Facility location factors, evaluation of alternatives, types of plant layout, evaluation; computer aided layout; assembly line balancing; material handling systems; supply chain management.

Production Planning and Inventory Control: Inventory Function costs, classifications - deterministic and probabilistic models; quantity discount; safety stock; inventory control system; Forecasting techniques - causal and time series models, moving average, exponential smoothing; trend and seasonality; aggregate production planning; master scheduling; bill of materials and material requirement planning; order control and flow control, routing, scheduling and priority dispatching; JIT; Kanban PULL systems; bottleneck scheduling and theory of constraints.

Operation Research: Linear programming - problem formulation, simplex method, duality and sensitivity analysis; transportation; assignment; network flow models, constrained optimization and Lagrange multipliers; simple queuing models; dynamic programming; simulation; PERT and CPM, time-cost trade-off, resource leveling.

Quality Control: Taguchi method; design of experiments; quality costs, statistical quality assurance, process control charts, acceptance sampling, zero defects; quality circles, total quality management.

Reliability and Maintenance: Reliability, availability and maintainability; probabilistic failure and repair times; system reliability; preventive maintenance and replacement, TPM.

Management Information System: Value of information; information storage and retrieval system - database and data structures; interactive systems; knowledge based systems.

Intellectual Property System: Definition of intellectual property, importance of IPR; TRIPS, and its implications, WIPO and Global IP structure, and IPS in India; patent, copyright, industrial design and trademark; meanings, rules and procedures, terms, infringements and remedies.

PY - PHARMACEUTICAL SCIENCES

Natural Products: Pharmacognosy & Phytochemistry - Chemistry, tests, isolation, characterization and estimation of phytopharmaceuticals belonging to the group of Alkaloids, Glycosides, Terpenoids, Steroids, Bioflavanoids, Purines, Guggul lipids. Pharmacognosy of crude drugs which contain the above constituents. Standardisation of raw materials and herbal products. WHO guide lines. Quantitative microscopy including modern techniques used for evaluation. Biotechnological principles and techniques for plant development Tissue culture.

Pharmacology: General pharmacological principles including Toxicology. Drug interaction. Pharmacology of drugs acting on Central nervous system, Cardiovascular system, Autonomic nervous system, Gastro intestinal system and Respiratory system. Pharmacology of Autocoids, Hormones, Chemotherapeutic agents including anticancer drugs. Bioassays. Immuno Pharmacology.

Medicinal Chemistry: Structure, nomenclature, classification, synthesis, SAR and metabolism of the following category of drugs which are official in Indian Pharmacopoeia and British Pharmacopoeia Hypnotics and Sedatives, Analgesics, NSAIDS, Neuroleptics, Antidepressants, Anxiolytics, Anticonvulsants, Antihistaminics, Local anaesthetics, Cardio Vascular drugs - Antianginal agents Vasodilators, Adrenergic & cholinergic drugs, Cardiotonic agents, Diuretics, Antihypertensive drugs, Hypoglycemic agents, Antilipedmic agents, Coagulants, Anticoagulants, Antiplatelet agents. Chemotherapeutic agents - Antibiotics, Antibacterials, Sulphadrugs. Antiproliozoal drugs, Antiviral, Antitubercular, Antimalarial, Anticancer, Antiamoebic drugs. Diagnostic agents. Preparation and storage and uses of official Radiopharmaceuticals. Vitamins and Hormones.

Pharmaceutics: Development, manufacturing standards, labeling, packing as per the pharmacopoeal requirements, Storage of different dosage forms and new drug delivery systems. Biopharmaceutics and Pharmacokinetics and their importance in formulation. Formulation and preparation of cosmetics - lipstick, shampoo, creams, nail preparations and dentifrices. Pharmaceutical calculations.

Pharmaceutical Jurisprudence: Legal aspects of manufacture, storage, sale of drugs. D and C act and rules. Pharmacy act.

Pharmaceutical Analysis: Principles, instrumentation and applications of the following. Absorption spectroscopy (UV, visible & IR), Fluorimetry, Flame photometry, Potentiometry, Conductometry and Plarography. Pharmacopoeial assays. Principles of NMR, ESR, Mass spectroscopy, X-ray diffraction analysis and different chromatographic methods.

Biochemistry and Clinical Pharmacy: Biochemical role of hormones, Vitamins, Enzymes, Nucleic acids. Bioenergetics. General principles of immunology. Immunological techniques. Adverse drug interaction.

Microbiology: Principles and methods of microbiological assays of the Pharmacopoeia. Methods of preparation of official sera and vaccines. Serological and diagnostic tests. Applications of microorganisms in Bio Conversions and in Pharmaceutical industry.

TF - TEXTILE ENGINEERING AND FIBRE SCIENCE

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

TEXTILE ENGINEERING & FIBRE SCIENCE

Textile Fibres: Classification of textile fibres according to their nature and origin; general characteristics of textile fibres-their chemical and physical structures and their properties; essential characteristics of fibre forming polymers; uses of natural and man-made fibres; physical and chemical methods of fibre and blend identification and blend analysis.

Melt Spinning processes with special reference to polyamide and polyester fibres; wet and dry spinning of viscose and acrylic fibres; post spinning operations-drawing, heat setting, texturing- false twist and air-jet, tow-to-top conversion. Methods of investigating fibre structure e.g. X-ray diffraction, birefringence, optical and electron microscopy, I.R. absorption, thermal methods; structure and morphology and principal natural and man-made fibres, mechanical properties of fibres, moisture sorption in fibres; fibre structure and property correlation.

Textile Testing: Sampling techniques, sample size and sampling errors; measurement of fibre length, fineness, crimp, strength and reflectance; measurement of cotton fibre maturity ad trash content; HVI and AFIS for fibre testing. Measurement of yarn count, twist and hairiness; tensile testing of fibres, yarn and fabrics; evenness testing of slivers, rovings and yarns; testing equipment for measurement test methods of fabric properties like thickness, compressibility, air permeability, drape, crease recovery, tear strength bursting strength and abrasion resistance. Correlation analysis, significance tests and analysis of variance; frequency distributions and control charts.

Yarn Manufacture and Yarn Structure: Modern methods of opening, cleaning and blending of fibrous materials; the technology of carding with particular reference to modern developments; causes of irregularity introduced by drafting, the development of modern drafting systems; principles and techniques of preparing material for combing; recent development in combers; functions and synchronization of various mechanisms concerned with roving production; forces acting on yarn and traveller, ring and traveller designs; causes of end breakages; properties of doubles yarns; new methods of yarn production such as rotor spinning, air jet spinning and friction spinning.

Yarn diameter; specific volume, packing coefficient; twist-strength relationship; fibre orientation in yarn; fibre migration.

Fabric Manufacture and Fabric Structure: Principles of cheese and cone winding processes and machines; random and precision winding; package faults and their remedies; yarn clearers and tensioners; different systems of yarn splicing; features of modern cone winding machines;

different types of warping creels; features of modern beam and sectional warping machines; different sizing systems, sizing of spun and filament yarns, modern sizing machines; principles of pirn winding processes and machines; primary and secondary motions of loom, effect of their settings and timings on fabric formation, fabric appearance and weaving performance; dobby and jacquard shedding; mechanics of weft insertion with shuttle; warp and weft stop motions, warp protection, weft replenishment; functional principles of weft insertion systems of shuttleless weaving machines, principles of multiphase and circular looms. Principles of weft and warp knitting; basic weft and warp knitted structures; classification, production and areas of application of nonwoven fabrics.

Basic woven fabric constructions and their derivatives; crepe, cord, terry, gauze, lino and double cloth constructions.

Peirce's equations for fabric geometry; thickness, cover and maximum sett of woven fabrics

Textile Chemical Processing: Preparatory processes for natural-and and their blends; mercerization of cotton; machines for yarn and fabric mercerization.

Dyeing and printing of natural- and synthetic- fibre fabrics and their blends with different dye classes; dyeing and printing machines; styles of printing; fastness properties of dyed and printed textile materials.

Finishing of textile materials, wash and wear, durable press, soil release, water repellent, flame retardant and antistatic finishes; shrink-resistance finish for wool; heat setting of synthetic-fibre fabrics, finishing machines; energy efficient processes; pollution control.

XE - ENGINERING SCIENCES

The syllabi of the sections of this paper are as follows:

SECTION A. ENGINEERING MATHEMATICS (Compulsory)

Linear Algebra : Determinates, algebra of matrices, rank, inverse, system of linear equations, symmetric, skew-symmetric and orthogonal matrices. Hermitian, skew-hermitian and unitary matrices. eigenvalues and eigenvectors, diagonalisation of matrices, Cayley-Hamiltonian, quadratic forms.

Calculus : Functions of single variables, limit, continuity and differentiability, Mean value theorems, Intermediate forms and L'Hospital rule, Maxima and minima, Taylor's series, Fundamental and mean value-theorems of integral calculus. Evaluation of definite and improper integrals, Beta and Gamma functions, Functions of two variables, limit, continuity, partial derivatives, Euler's theorem for homogeneous functions, total derivatives, maxima and minima, Lagrange method of multipliers, double and triple integrals and their applications, sequence and series, tests for convergence, power series, Fourier Series, Fourier integrals.

Complex variable: Analytic functions, Cauchy's integral theorem and integral formula without proof. Taylor's and Laurent' series, Residue theorem (without proof) with application to the evaluation of real integarls.

Vector Calculus: Gradient, divergence and curl, vector identities, directional derivatives, line, surface and volume integrals, Stokes, Gauss and Green's theorems (without proofs) with applications.

Ordinary Differential Equations: First order equation (linear and nonlinear), higher order linear differential equations with constant coefficients, method of variation of paramaters, Cauchy's and Euler's equations, initial and boundary value problems, power series solutions, Legendre polynomials and Bessel's functions of the first kind.

Partial Differential Equations: Variables separable method, solutions of one dimensional heat, wave and Laplace equations.

Probability and Statistics: Definitions of probability and simple theorems, conditional probability, mean, mode and standard deviation, random variables, discrete and continuous distributions, Poisson, normal and Binomial distribution, correlation and regression

Numerical Methods: L-U decomposition for systems of linear equations,Newton-Raphson method, numerical integration(trapezoidal and Simpson's rule), numerical methods for first order differential equation (Euler method)

SECTION B. COMPUTATIONAL SCIENCE

Numerical Methods: Truncation errors, round off errors and their propagation; Interpolation; Lagrange, Newton's forward, backward and divided difference formulas, least square curve fitting, solution of non-linear equations of one variables using bisection, false position, secant and Newton Raphson methods; Rate of convergence of these methods, general iterative methods. Simple and multiple roots of polynomials. Solutions of system of linear algebraic equations using Gauss elimination methods, Jacobi and Gauss-Seidel iterative methods and their rate of convergence; ill conditioned and well conditioned system. eigen values and eigen vectors using power methods. Numerical integration using trapezoidal, Simpson's rule and other quadrature formulas. Numerical Differentiation. Solution of boundary value problems. Solution of initial value problems of ordinary differential equations using Euler's method, predictor corrector and Runge Kutta method.

Programming : Elementary concepts and terminology of a computer system and system software, Fortran77 and C programming.

Fortran : Program organization, arithmetic statements, transfer of control, Do loops, subscripted variables, functions and subroutines.

C language : Basic data types and declarations, flow of control- iterative statement, conditional statement, unconditional branching, arrays, functions and procedures.

SECTION C. ELECTRICAL SCIENCES

Electric Circuits: Ideal voltage and current sources; RLC circuits, steady state and transient analysis of DC circuits, network theorems; alternating currents and voltages, single-phase AC circuits, resonance; three-phase circuits.

Magnetic circuits: Mmf and flux, and their relationship with voltage and current; transformer, equivalent circuit of a practical transformer, three-phase transformer connections.

Electrical machines: Principle of operation, characteristics, efficiency and regulation of DC and synchronous machines; equivalent circuit and performance of three-phase and single-phase induction motors.

Electronic Circuits: Characteristics of p-n junction diodes, zener diodes, bipolar junction transistors (BJT) and junction field effect transistors (JFET); MOSFET's structure, characteristics, and operations; rectifiers, filters, and regulated power supplies; biasing circuits, different configurations of transistor amplifiers, class A, B and C of power amplifiers; linear applications of operational amplifiers; oscillators; tuned and phase shift types.

Digital circuits: Number systems, Boolean algebra; logic gates, combinational circuits, flip-flops (RS, JK, D and T) counters.

Measuring instruments: Moving coil, moving iron, and dynamometer type instruments; shunts, instrument transformers, cathode ray oscilloscopes; D/A and A/D converters.

SECTION D. FLUID MECHANICS

Fluid Properties: Relation between stress and strain rate for Newtonian fluids

Hydrostatics, buoyancy, manometry

Concept of local and convective accelerations; control volume analysis for mass, momentum and energy conservation.

Differential equations of continuity and momentum (Euler's equation of motion); concept of fluid rotation, stream function, potential function; Bernoulli's equation and its applications.

Qualitative ideas of boundary layers and its separation; streamlined and bluff bodies; drag and lift forces.

Fully-developed pipe flow; laminar and turbulent flows; friction factor; Darcy Weisbach relation; Moody's friction chart; losses in pipe fittings; flow measurements using venturimeter and orifice plates.

Dimensional analysis; similitude and concept of dynamic similarity; importance of dimensionless numbers in model studies.

SECTION E. MATERIALS SCIENCE

Atomic structure and bonding in materials: metals, ceramics and polymers.

Structure of materials: Crystal systems, unit cells and space lattice; determination of structures of simple crystals by X-ray diffraction; Miller indices for planes and directions. Packing geometry in metallic, ionic and covalent solids.

Concept of amorphous, single and polycrystalline structures and their effects on properties of materials.

Imperfections in crystalline solids and their role in influencing various properties.

Fick´s laws of diffusion and applications of diffusion in sintering, doping of semiconductors and surface hardening of metals.

Alloys: solid solution and solubility limit. Binary phase diagram, intermediate phases and intermetallic compounds; iron-iron carbide phase diagram. Phase transformation in steels. Cold and hot working of metals, recovery, recrystallization and grain growth.

Properties and applications of ferrous and nonferrous alloys.

Structure, properties, processing and applications of traditional and advanced ceramics.

Polymers: classification, polymerization, structure and properties, additives for polymer products, processing and application.

Composites: properties and application of various composites.

Corrosion and environmental degradation of materials (metals, ceramics and polymers).

Mechanical properties of materials: Stress-strain diagrams of metallic, ceramic and polymeric materials, modulus of elasticity, yield strength, plastic deformation and toughness, tensile strength and elongation at break; viscoelasticity, hardness, impact strength. ductile and brittle fracture. creep and fatigue properties of materials.

Heat capacity, thermal conductivity, thermal expansion of materials.

Concept of energy band diagram for materials; conductors, semiconductors and insulators in terms of energy bands. Electrical conductivity, effect of temperature on conductivity in materials, intrinsic and extrinsic semiconductors, dielectric properties of materials.

Refraction, reflection, absorption and transmission of electromagnetic radiation in solids.

Origin of magnetism in metallic and ceramic materials, paramagnetism, diamagnetism, antiferromagnetism, ferromagnetism, ferrimagnetism in materials and magnetic hysteresis.

Advanced materials: Smart materials exhibiting ferroelectric, piezoelectric, optoelectronic, semiconducting behaviour; lasers and optical fibers; photoconductivity and superconductivity in materials.

SECTION F. SOLID MECHANICS

Equivalent force systems; free-body diagrams; equilibrium equations; analysis of determinate and indeterminate trusses and frames; friction.

Simple relative motion of particles; force as function of position, time and speed; force acting on a body in motion; laws of motion; law of conservation of energy; law of conservation of momentum

Stresses and strains; principal stresses and strains; Mohr's circle; generalized Hooke's Law; equilibrium equations; compatibility conditions; yield criteria.

Axial, shear and bending moment diagrams; axial, shear and bending stresses; deflection (for symmetric bending); torsion in circular shafts; thin cylinders; energy methods (Castigliano's Theorems); Euler buckling.

SECTION G. THERMODYNAMICS

Basic Concepts: Continuum, macroscopic approach, thermodynamic system (closed and open or control volume); thermodynamic properties and equilibrium; state of a system, state diagram, path and process; different modes of work; Zeroth law of thermodynamics; concept of temperature; heat.

First Law of Thermodynamics: Energy, enthalpy, specific heats, first law applied to systems and control volumes, steady and unsteady flow analysis.

Second Law of Thermodynamics: Kelvin-Planck and Clausius statements, reversible and irreversible processes, Carnot theorems, thermodynamic temperature scale, Clausius inequality and concept of entropy, principle of increase of entropy; availability and irreversibility.

Properties of Pure Substances: Thermodynamic properties of pure substances in solid, liquid and vapour phases, P-V-T behaviour of simple compressible substances, phase rule, thermodynamic property tables and charts, ideal and real gases, equations of state, compressibility chart.

Thermodynamic Relations: T-ds relations, Maxwell equations, Joule-Thomson coefficient, coefficient of volume expansion, adiabatic and isothermal compressibilities, Clapeyron equation.

Ideal Gas Mixtures: Dalton's and Amagat's laws, calculations of properties, air-water vapour mixtures.

XL - LIFE SCIENCES

The syllabi of the Sections of this paper are as follows:

SECTION H. CHEMISTRY (Compulsory)

Atomic structure and periodicity: Quantum chemistry; Planck's quantum theory, wave particle duality, uncertainty principle, quantum mechanical model of hydrogen atom; electronic configuration of atoms; periodic table and periodic properties; ionization energy, election affinity, electronegativity, atomic size.

Structure and bonding: Ionic and covalent bonding M.O. and V.B. approaches for diatomic molecules, VSEPR theory and shape of molecules, hybridisation, resonance, dipole moment, structure parameters such as bond length, bond angle and bond energy, hydrogen bonding, van der Waals interactions. Ionic solids; ionic radii, lattice energy (Born-Haber Cycle).

s.p. and d Block Elements: Oxides, halides and hydrides of alkali and alkaline earth metals, B, Al, S, N, P and S, silicones, general characteristics of 3d elements, coordination complexes: valence bond and crystal field theory, color, geometry and magnetic properties.

Chemical Equilibria: Colligative properties of solutions, ionic equilibria in solution, solubility product, common ion effect, hydrolysis of salts, pH, buffer and their applications in chemical analysis.

Electrochemistry: Conductance, Kohlrausch law, Half Cell potentials, emf, Nernst equation, galvanic cells, thermodynamic aspects and their applications.

Reaction Kinetics: Rate constant, order of reaction, molecularity, activation energy, zero, first and second order kinetics, equilibrium constants (Kc, Kp and Kx) for homogeneous reactions, catalysis and elementary enzyme reactions.

Thermodynamics: First law, reversible and irreversible processes, internal energy, enthalpy, Kirchoff's equation, heat of reaction, Hess law, heat of formation, Second law, entropy, free energy, and work function. Gibbs-Helmholtz equation, Clausius-Clapeyron equation, free energy change and equilibrium constant, Troutons rule, Third law of thermodynamics.

Mechanistic Basis of Organic Reactions: Elementary treatment of SN1, SN2, E1 and E2 reactions, Hoffmann and Saytzeff rules, Addition reactions, Markonikoff rule and Kharash effect, Diels-Alder reaction, aromatic electrophilic substitution, orientation effect as exemplified by various functional groups.

Structure-Reactivity Correlations: Acids and bases, electronic and steric effects, optical and geometrical isomerism, tautomerism, concept of aromaticity

SECTION I. BIOCHEMISTRY

Organization of life. Importance of water. Cell structure and organelles. Structure and function of biomolecules: Carbohydrates, Lipids, Proteins and Nucleic acids. Biochemical separation techniques. Spectroscopic methods; UV-visible and fluorescence. Protein structure, folding and function: Myoglobin, Hemoglobin, Lysozyme, ribonuclease A, Carboxypeptidase and Chymotrypsin. Enzyme kinetics and regulation, Coenzymes.

Metabolism and bioenergitics. Generation and utilization of ATP. Photosynthesis. Major metabolic pathways and their regulation. Biological membranes. Transport across membranes. Signal transduction; hormones and neurotransmitters.

DNA replication, transcription and translation. Biochemical regulation of gene expression. Recombinant DNA technology and applications. Genomics and Proteomics.

The immune system. Active and passive immunity. Complement system. Antobody structure, function and diversity. Cells of the immune system: T, B and macrophages. T and B cell activation. Major histocompatibilty complex. T cell receptor. Immunological techniques:

Immunodiffusion, immunoelectrophoresis, RIA and ELISA.

SECTION J. BIOTECHNOLOGY

Recombinant DNA technology for the production of therapeutic proteins. Micro array technology. Heterologous protein expression systems in bacteria, yeast etc.

Architecture of plant genome; plant tissue culture techniques; methods of gene transfer into plant cells; manipulation of phenotypic traits in plants; plant cell fermentations and production of secondary metabolites using suspension/ immobilized cell culture; methods for plant micro propagation; crop improvement and development of transgenic plants. Expression of animal proteins in plants.

Animal cell metabolism and regulation; cell cycle; primary cell culture; nutritional requirements for animal cell culture; techniques for the mass culture of animal cell lines; production of vaccines; growth hormones and interferons using animal cell culture; cytokines-production and therapeutic uses; hybridoma technology; vectors for gene transfer and expression in animal cells. Transgenic animals and molecular pharming.

Microbial production of industrial enzymes; methods for immobilization of enzymes; kinetics of soluble and immobilized enzymes; application of soluble and immobilized enzymes; enzyme-based sensors.

Microbial growth kinetics; batch, fed batch and continuous culture of microbial cells; media for industrial fermentations; sterilization of air and media; design features and operation of stirred tank, air-lift and fluidized bed reactors; aeration and agitation in aerobic fermentations; recovery and purification of fermentation products- filtration, centrifugation, cell disintegration, solvent extraction and chromatographic separations; industrial fermentations for the production of ethanol, citric acid, lysine, penicillin and other biomolecules; simple calculations based on material and energy balance of fermentation processes; application of microbes in the management of domestic and industrial wastes.

SECTION K. BOTANY

Anatomy: Roots, stem and leaves of land plants, meristems, vascular system, their ontogeny, structure and functions. Plant cell structure, organisation, organelles, cytoskeleton, cell wall and membranes.

Development: Cell cycle, cell division, senescence, hormonal regulation of growth; life cycle of an angiosperm, pollination, fertilization, embryogenesis, seed formation, seed storage proteins, seed dormancy and germination. Concept of cellular totipotency, organogenesis and somatic embryogenesis, somaclonal variation, embryo culture, in vitro fertilization.

Physiology and Biochemistry: Plant water relations, transport of minerals and solutes, N2 metabolism, proteins and nucleic acid, respiration, photophysiology, photosynthesis, photorespiration; biosynthesis, mechanism of action and physiological effects of plant growth regulators.

Genetics: Principles of Mendelian inheritance, linkage, recombination and genetic mapping; extrachromosomal inheritance; eukaryotic genome organization (chromatin structure) and regulation of gene expression, gene mutation, chromosome aberrations (numerical and structural), transposons.

Plant Breeding: Principles, methods - selection, hybridization, heterosis; male sterility, self and inter-specific incompatibility; haploidy; somatic cell hybridization; molecular marker-assisted selection; gene transfer methods viz. direct and vector-mediated, transgenic plants and their applications in agriculture.

Economic Botany: Economically important plants - cereals, pulses, plants yielding fiber, timber, sugar, beverages, oils, rubber, dyes, gums, drugs and narcotics - a general account.

Systematics: Systems of classification (non-phylogenetic vs. phylogenetic - outline), plant groups, molecular systematics.

Plant Pathology: Nature and classification of plant diseases, diseases of important crops caused by fungi, bacteria and viruses, and their control measures, mechanism(s) of pathogenesis and resistance, molecular detection of pathogens; plant-microbe beneficial interactions.

Ecology and Plant Geography: Ecosystems - types, dynamics, degradation, ecological succession; food chains; vegetation types of the world; pollution and global warming; speciation and extinction, conservation strategies, cryopreservation.

SECTION L. MICROBIOLOGY

Historical perspective - Discovery of the microbial world; Controversy over spontaneous generation; Role of microorganisms in transformation of organic matter and in the causation of diseases.

Methods in microbiology - Pure culture techniques; Theory and practice of sterilization; Principles of microbial nutrition; Construction of culture media; Enrichment culture techniques for isolation of chemoautotrophs, chemoheterotrophs and photosynthetic microorganisms.

Microbial evolution, systematics and taxonomy - Evolution of earth and earliest life forms; Primitive organisms and their metabolic strategies; New approaches to bacterial taxonomic classification including ribotyping; Nomenclature.

Microbial diversity - Bacteria, archea and their broad classification; Eukaryotic microbes, yeast, fungi, slime mold and protozoa; Viruses and their classification.

Microbial growth -The definition of growth, mathematical expression of growth, growth curve, measurement of growth and growth yields; Synchronous growth; Continuous culture.

Nutrition and metabolism - Overview of metabolism; Microbial nutrition; Energy classes of microorganisms; Culture media; Energetics, modes of ATP generation; ATP generation by heterotrophs; Fermentation; Glycolysis; Respiration; The citric acid cycle; Electron transport systems; Alternate modes of energy generation; Pathways (anabolism) in the biosynthesis of amino acids, purines, pyrimidines and fatty acids.

Metabolic diversity among microorganisms - Photosynthesis in microorganisms; Role of chlorophylls, carotenoids and phycobilins; Calvin cycle; Chemolithotrophy; Hydrogen- iron- nitrite-oxidizing bacteria; Nitrate and sulfate reduction; Methanogenesis and acetogenesis.

Prokaryotic cells: structure-function - Cells walls of eubacteria (peptidoglycan) and related molecules; Outer-membrane of gram-negative bacteria; Cell wall and cell membrane synthesis; Flagella and motility; Cell inclusions like endospores, gas vesicles.

Microbial diseases and host parasite relationships - Normal microflora of skin; Oral cavity; Gastrointestinal tract; Entry of pathogens into the host; Infectious disease transmission; Respiratory infections caused by bacteria and viruses; Tuberculosis; Sexually transmitted diseases including AIDS; Diseases transmitted by animals (Rabies, plague), insects and ticks (rikettsias, Lyme disease, malaria); Food and water borne diseases; Public health and water quality; Pahtogenic fungi; Emerging and resurgent infectious diseases.

Chemotherapy/Antibiotics - Antimicrobial agents; Sulfa drugs; Antibiotics; Pencillins and cephalosporins; Broad-spectrum antibiotics; Antibiotics from prokaryotes; Antifungal antibiotics; Mode of action; Resistance to antibiotics.

Microbial genetics - Genes, mutation and mutagenesis - UV and chemical mutagnes; Types of mutations; Ames test for mutagenesis; Methods of genetic analysis. Bacterial genetic system - Transformation; Conjugation; Transduction; Recombination; Plasmids and Transposons; Bacterial genetic map with reference to E. coli. Viruses and their genetic system - Phage ? and its life cycle; RNA phages; RNA viruses; Retroviruses; Genetic systems of yeast and Neurospora; Extrachromosomal inheritance and mitochondrial genetics; Basic concept of genomics.

SECTION M. ZOOLOGY

Animal world: Animal diversity, distribution, systematic and classification of animals, the phylogenetic relationship.

Evolution: Origin of life, history of life on earth, evolutionary theories, natural selection, adaptation, speciation.

Genetics: Principles of inheritance, molecular basis of heredity, the genetic material, transmission of genetic material, mutations, cytoplasmic inheritance.

Biochemistry and Molecular Biology: Nucleic acids, proteins and other biological macromolecules. Replication, transcription and translation, regulation of gene expression, organization of genome, Kreb's cycle, glycolysis, enzyme catalysis, hormones and their action.

Cell Biology: Structure of cell, cellular organelles and their structure and function, cell cycle, cell division, cellular differentiation, chromosome and chromatin structure. Eukaryotic gene organisation and expression.

Animal Anatomy and Physiology: Comparative physiology, the respiratory system, circulatory system, digestive system, the nervous system, the excretory system, the endocrine system, the reproductive system, the skeletal system, osmoregulation.

Parasitology and Immunology: Nature of parasite, host-parasite relation, protozoan and helminthic parasites, the immune response, cellular and humoral immune response, evolution of the immune system.

Development Biology: Embryonic development, cellular differentiation, organogenesis, metamorphosis, genetic basis of development.

Ecology: The ecosystem, habitats the food chain, population dynamics, species diversity, zoogeography, biogeochemical cycles, conservation biology.

Animal Behaviour: Types of behaviours, courtship, mating and territoriality, instinct, learning and memory, social behaviour across the animal taxa, communication, pheromones, evolution of animal behaviour.

IT - INFORMATION TECHNOLOGY

ENGINEERING MATHEMATICS

Mathematical Logic: Propositional Logic; First Order Logic.

Probability: Conditional Probability; Mean, Median, Mode and Standard Deviation; Random Variables; Distributions; uniform, normal, exponential, Poisson, Binomial.

Set Theory & Algebra: Sets; Relations; Functions; Groups; Partial Orders; Lattice; Boolean Algebra.

Combinatorics: Permutations; Combinations; Counting; Summation; generating functions; recurrence relations; asymptotics.

Graph Theory: Connectivity; spanning trees; Cut vertices & edges; covering; matching; independent sets; Colouring; Planarity; Isomorphism.

Linear Algebra: Algebra of matrices, determinants, systems of linear equations, Eigen values and Eigen vectors.

Numerical Methods: LU decomposition for systems of linear equations; numerical solutions of non linear algebraic equations by Secant, Bisection and Newton-Raphson Methods; Numerical integration by trapezoidal and Simpson's rules.

Calculus: Limit, Continuity & differentiability, Mean value Theorems, Theorems of integral calculus, evaluation of definite & improper integrals, Partial derivatives, Total derivatives, maxima & minima.

FORMAL LANGUAGES AND AUTOMATA

Regular Languages: finite automata, regular expressions, regular grammar.

Context free languages: push down automata, context free grammars

COMPUTER HARDWARE

Digital Logic: Logic functions, minimization, design and synthesis of combinatorial and sequential circuits, number representation and computer arithmetic (fixed and floating point)

Computer organization: Machine instructions and addressing modes, ALU and data path, hardwired and microprogrammed control, memory interface, I/O interface (interrupt and DMA mode), serial communication interface, instruction pipelining, cache, main and secondary storage

SOFTWARE SYSTEMS

Data structures and Algorithms: the notion of abstract data types, stack, queue, list, set, string, tree, binary search tree, heap, graph, tree and graph traversals, connected components, spanning trees, shortest paths, hashing, sorting, searching, design techniques (greedy, dynamic, divide and conquer), asymptotic analysis (best, worst, average cases) of time and space, upper and lower bounds, intractability

Programming Methodology: C programming, program control (iteration, recursion, functions), scope, binding, parameter passing, elementary concepts of object oriented programming

Operating Systems (in the context of Unix): classical concepts (concurrency, synchronization, deadlock), processes, threads and interprocess communication, CPU scheduling, memory management, file systems, I/O systems, protection and security

Information Systems and Software Engineering: information gathering, requirement and feasibility analysis, data flow diagrams, process specifications, input/output design, process life cycle, planning and managing the project, design, coding, testing, implementation, maintenance.

Databases: relational model, database design, integrity constraints, normal forms, query languages (SQL), file structures (sequential, indexed), b-trees, transaction and concurrency control

Data Communication: data encoding and transmission, data link control, multiplexing, packet switching, LAN architecture, LAN systems (Ethernet, token ring), Network devices: switches, gateways, routers

Networks: ISO/OSI stack, sliding window protocols, routing protocols, TCP/UDP, application layer protocols & systems (http, smtp, dns, ftp), network security

Web technologies: three tier web based architecture; JSP, ASP, J2EE, .NET systems; html, XML

AG - AGRICULTURAL ENGINEERING

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

FARM MACHINERY AND POWER:

Sources of power on the farm-human, animal, mechanical, electrical, wind, solar and biomass; design and selection of machine elements - gears, pulleys, chains and sprockets and belts; overload safety devices used in farm machinery; measurement of force, torque, speed, displacement and acceleration on machine elements.

Soil tillage; forces acting on a tillage tool; hitch systems and hitching of tillage implements; functional requirements, principles of working, construction and operation of manual, animal and power operated equipment for tillage. sowing, planting, fertilizer application, inter-cultivation, spraying, mowing, chaff cutting, harvesting, threshing and transport; testing of agricultural machinery and equipment; calculation of performance parameters -field capacity, efficiency, application rate and losses; cost analysis of implements and tractors.

Thermodynamic principles of I.C. engines; I.C. engine cycles; engine components; fuels and combustion; lubricants and their properties; I.C. engine systems - fuel, cooling, lubrication, ignition, electrical, intake and exhaust; selection, operation, maintenance and repair of I.C. engines; power efficiencies and measurement; calculation of power, torque, fuel consumption, heat load and power losses.

Tractors and power tillers - type, selection, maintenance and repair; tractor clutches and brakes; power transmission systems - gear trains, differential, final drives and power take-off; mechanics of tractor chassis; traction theory; three point hitches- free link and restrained link operations; mechanical steering and hydraulic control systems used in tractors; human engineering and safety in tractor design; tractor tests and performance.

SOIL AND WATER CONSERVATION ENGINEERING:

Ideal and real fluids, properties of fluids; hydrostatic pressure and its measurement; hydrostatic forces on plane and curved surface; continuity equation; Bernoulli's theorem; laminar and turbulent flow in pipes, Darcy-Weisbach and Hazen-Williams equations, Moody's diagram; flow through orifices and notches; flow in open channels.

Engineering properties of soils, fundamental definitions and relationships; index properties of soils; permeability and seepage analysis; shear strength, Mohr's circle of stresses; active and passive earth pressures; stability of slopes.

Hydrological cycle; precipitation measurement, analysis of precipitation data; abstraction from precipitation; runoff; hydrograph analysis, unit hydrograph theory and application; stream flow measurement; flood routing, hydrological reservoir and channel routing.

Mechanics of soil erosion, factors affecting erosion; soil loss estimation; biological and engineering measures to control erosion, terraces and bunds; vegetative waterways; gully control structures, drop, drop inlet and chute spillways; farm ponds; earthen dams; principles of watershed management.

Water requirement of crops; consumptive use and evapo-transpiration; irrigation scheduling; irrigation efficiencies; design of prismatic and silt loaded channels; methods of irrigation water application; design and evaluation of irrigation methods; drainage coefficient; surface and subsurface drainage systems; leaching requirement and salinity control; irrigation and drainage water quality; classification of pumps; pump characteristics; pump selection; types of aquifer; evaluation of aquifer properties; well hydraulics; ground water recharge.

AGRICULTURAL PROCESSING AND FOOD ENGINEERING:

Steady state heat transfer in conduction, convection and radiation; transient heat transfer in simple geometry; condensation and boiling heat transfer; working principles of heat exchangers; diffusive and convective mass transfer; simultaneous heat and mass transfer in agricultural processing operations.

Material and energy balances in food processing systems; water activity, sorption and desorption isotherms; centrifugal separation of solids, liquids and gases; kinetics of microbial death - pasteurisation and sterilization of liquid foods; preservation of food by cooling and freezing; psychrometry - properties of air-vapour mixture; concentration and dehydration of liquid foods - evaporators, tray, drum and spray dryers.

Mechanics and energy requirement in size reduction of granular solids; particle size analysis for comminuted solids; size separation by screening; fluidisation of granular solids; cleaning and grading efficiency and effectiveness of grain cleaners; conditioning and hydrothermal treatments for grains; dehydration of food grains; processes and machines for processing of cereals, pulses and oilseeds; design considerations for grain silos.

AR - ARCHITECTURE AND PLANNING

City planning: Historical development of cities; principles of city planning; new towns; survey methods, site planning, planning regulations and building bye-laws.

Housing: Concept of shelter; housing policies and design; community planning; role of government agencies; finance and management.

Landscape Design: Principles of landscape design and site planning; history and landscape styles; landscape elements and materials; planting design.

Computer Aided Design: Application of computers in architecture and planning; understanding elements of hardware and software; computer graphics; programming languages - C and Visual Basic and usage of packages such as AutoCAD.

Environmental and Building Science: Elements of environmental science; ecological principles concerning environment; role of micro-climate in design; climatic control through design elements; thermal comfort; elements of solar architecture; principles of lighting and illumination; basic principles of architectural acoustics; air pollution, noise pollution and their control.

Visual and Urban Design: Principles of visual composition; proportion, scale, rhythm, symmetry, harmony, balance, form and colour; sense of place and space, division of space; focal point, vista, imageability, visual survey.

History of Architecture: Indian - Indus valley, Vedic, Buddhist, Indo-Aryan, Dravidian and Mughal periods; European - Egyptian, Greek, Roman, medieval and renaissance periods.

Development of Contemporary Architecture: Architectural developments and impacts on society since industrial revolution; influence of modern art on architecture; works of national and international architects; post modernism in architecture.

Building Services: Water supply, Sewerage and Drainage systems; Sanitary fittings and fixtures; principles of electrification of buildings; elevators, their standards and uses; air-conditioning systems; fire fighting systems.

Building Construction and Management: Building construction techniques, methods and details; building systems and prefabrication of building elements; principles of modular coordination; estimation, specification, valuation, professional practice; project management, PERT, CPM.

Materials and Structural Systems: Behavioural characteristics of all types of building materials e.g. mud, timber, bamboo, brick, concrete, steel, glass, FRP; principles of strength of materials; design of structural elements in wood, steel and RCC; elastic and limit state design; complex structural systems; principles of pre-stressing.

Planning Theory: Planning process; multilevel planning; comprehensive planning; central place theory; settlement pattern; land use and land utilization.

Techniques of Planning: Planning surveys; Preparation of urban and regional structure plans, development plans, action plans; site planning principles and design; statistical methods; application of remote sensing techniques in urban and regional planning.

Traffic and Transportation Planning: Principles of traffic engineering and transportation planning; methods of conducting surveys; design of roads, intersections and parking areas; hierarchy of roads and levels of services; traffic and transport management in urban areas; traffic safety and traffic laws; public transportation planning; modes of transportation.

Services and Amenities: Principles and design of water supply systems, sewerage systems, solid waste disposal systems, power supply and communication systems; Health, education, recreation and demography related standards at various levels of the settlements.

Development Administration and Management: Planning laws; development control and zoning regulations; laws relating to land acquisition; development enforcements, land ceiling; regional and urban plan preparations; planning and municipal administration; taxation, revenue resources and fiscal management; public participation and role of NGO.

CE - CIVIL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative,

Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

STRUCTURAL ENGINEERING

Mechanics: Bending moments and shear forces in statically determinate beams; simple stress and strain: relationship; stress and strain in two dimensions, principal stresses, stress transformation, Mohr's circle; simple bending theory; flexural shear stress; thin-walled pressure vessels; uniform torsion.

Structural Analysis: Analysis of statically determinate trusses, arches and frames; displacements in statically determinate structures and analysis of statically indeterminate structures by force/energy methods; analysis by displacement methods (slope-deflection and moment-distribution methods); influence lines for determinate and indeterminate structures; basic concepts of matrix methods of structural analysis.

Concrete Structures: Basic working stress and limit states design concepts; analysis of ultimate load capacity and design of members subject to flexure, shear, compression and torsion (beams, columns and isolated footings); basic elements of prestressed concrete: analysis of beam sections at transfer and service loads.

Steel Structures: Analysis and design of tension and compression members, beams and beam-columns, column bases; connections - simple and eccentric, beam-column connections, plate girders and trusses; plastic analysis of beams and frames.

GEOTECHNICAL ENGINEERING

Soil Mechanics: Origin of soils; soil classification; three-phase system, fundamental definitions, relationship and inter-relationships; permeability and seepage; effective stress principle: consolidation, compaction; shear strength.

Foundation Engineering: Sub-surface investigation - scope, drilling bore holes, sampling, penetrometer tests, plate load test; earth pressure theories, effect of water table, layered soils; stability of slopes - infinite slopes, finite slopes; foundation types - foundation design requirements; shallow foundations; bearing capacity, effect of shape, water table and other factors, stress distribution, settlement analysis in sands and clays; deep foundations - pile types, dynamic and static formulae, load capacity of piles in sands and clays.

WATER RESOURCES ENGINEERING

Fluid Mechanics and Hydraulics: Hydrostatics, applications of Bernoulli equation, laminar and turbulent flow in pipes, pipe networks; concept of boundary layer and its growth; uniform flow, critical flow and gradually varied flow in channels, specific energy concept, hydraulic jump; forces on immersed bodies; flow measurement in channels; tanks and pipes;

dimensional analysis and hydraulic modeling. Applications of momentum equation, potential flow, kinematics of flow; velocity triangles and specific speed of pumps and turbines.

Hydrology: Hydrologic cycle; rainfall; evaporation infiltration, unit hydrographs, flood estimation, reservoir design, reservoir and channel routing, well hydraulics.

Irrigation: Duty, delta, estimation of evapo-transpiration; crop water requirements; design of lined and unlined canals; waterways; head works, gravity dams and Ogee spillways. Designs of weirs on permeable foundation, irrigation methods.

ENVIRONMENTAL ENGINEERING

Water requirements; quality and standards, basic unit processes and operations for water treatment, distribution of water. Sewage and sewerage treatment: quantity and characteristic of waste water sewerage; primary and secondary treatment of waste water; sludge disposal; effluent discharge standards.

TRANSPORTATION ENGINEERING

Highway planning; geometric design of highways; testing and specifications of paving materials; design of flexible and rigid pavements.

CH - CHEMICAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

CHEMICAL ENGINEERING

Process Calculations and Thermodynamics: Laws of conservation of mass and energy; use of tie components; recycle, bypass and purge calculations; degree of freedom analysis.

First and Second laws of thermodynamics and their applications; equations of state and thermodynamic properties of real systems; phase equilibria; fugacity, excess properties and correlations of activity coefficients; chemical reaction equilibria.

Fluid Mechanics and Mechanical Operations: Fluid statics, Newtonian and non-Newtonian fluids, Bernoulli equation, Macroscopic friction factors, energy balance, dimensional analysis, shell balances, flow through pipeline systems, flow meters, pumps and compressors, packed and fluidized beds, elementary boundary layer theory, size reduction and size separation; free and hindered settling; centrifuge and cyclones; thickening and classification, filtration, mixing and agitation; conveying of solids.

Heat Transfer: Conduction, convection and radiation, heat transfer coefficients, steady and unsteady heat conduction, boiling, condensation and evaporation; types of heat exchangers and evaporators and their design.

Mass Transfer: Fick's law, molecular diffusion in fluids, mass transfer coefficients, film, penetration and surface renewal theories; momentum, heat and mass transfer analogies; stagewise and continuous contacting and stage efficiencies; HTU & NTU concepts design and operation of equipment for distillation, absorption, leaching, liquid-liquid extraction, crystallization, drying, humidification, dehumidification and adsorption.

Chemical Reaction Engineering: Theories of reaction rates; kinetics of homogeneous reactions, interpretation of kinetic data, single and multiple reactions in ideal reactors, non-ideal reactors; residence time; non-isothermal reactors; kinetics of heterogeneous catalytic reactions; diffusion effects in catalysis.

Instrumentation and Process Control: Measurement of process variables; sensors, transducers and their dynamics, dynamics of simple systems, dynamics such as CSTRs, transfer functions and responses of simple systems, process reaction curve, controller modes (P, PI, and PID); control valves; analysis of closed loop systems including stability, frequency response (including Bode plots) and controller tuning, cascade, feed forward control.

Plant Design and Economics: Design and sizing of chemical engineering equipment such as compressors, heat exchangers, multistage contactors; principles of process economics and cost estimation including total annualized cost, cost indexes, rate of return, payback period, discounted cash flow, optimization in Design.

Chemical Technology: Inorganic chemical industries; sulfuric acid, NaOH, fertilizers (Ammonia, Urea, SSP and TSP); natural products industries (Pulp and Paper, Sugar, Oil, and Fats); petroleum refining and petrochemicals; polymerization industries; polyethylene, polypropylene, PVC and polyester synthetic fibers.

CS - COMPUTER SCIENCE AND ENGINEERING

ENGINEERING MATHEMATICS

Mathematical Logic: Propositional Logic; First Order Logic.

Probability: Conditional Probability; Mean, Median, Mode and Standard Deviation; Random Variables; Distributions; uniform, normal, exponential, Poisson, Binomial.

Set Theory & Algebra: Sets; Relations; Functions; Groups; Partial Orders; Lattice; Boolean Algebra.

Combinatorics: Permutations; Combinations; Counting; Summation; generating functions; recurrence relations; asymptotics.

Graph Theory: Connectivity; spanning trees; Cut vertices & edges; covering; matching; independent sets; Colouring; Planarity; Isomorphism.

Linear Algebra: Algebra of matrices, determinants, systems of linear equations, Eigen values and Eigen vectors.

Numerical Methods: LU decomposition for systems of linear equations; numerical solutions of non linear algebraic equations by Secant, Bisection and Newton-Raphson Methods; Numerical integration by trapezoidal and Simpson's rules.

Calculus: Limit, Continuity & differentiability, Mean value Theorems, Theorems of integral calculus, evaluation of definite & improper integrals, Partial derivatives, Total derivatives, maxima & minima.

THEORY OF COMPUTATION

Formal Languages and Automata Theory: Regular languages and finite automata, Context free languages and Push-down automata, Recursively enumerable sets and Turing machines, Un-decidability;

Analysis of Algorithms and Computational Complexity: Asymptotic analysis (best, worst, average case) of time and space, Upper and lower bounds on the complexity of specific problems, NP-completeness.

COMPUTER HARDWARE

Digital Logic: Logic functions, Minimization, Design and synthesis of Combinational and Sequential circuits; Number representation and Computer Arithmetic (fixed and floating point);

Computer Organization: Machine instructions and addressing modes, ALU and Data-path, hardwired and micro-programmed control, Memory interface, I/O interface (Interrupt and DMA mode), Serial communication interface, Instruction pipelining, Cache, main and secondary storage.

SOFTWARE SYSTEMS

Data structures: Notion of abstract data types, Stack, Queue, List, Set, String, Tree, Binary search tree, Heap, Graph;

Programming Methodology: C programming, Program control (iteration, recursion, Functions), Scope, Binding, Parameter passing, Elementary concepts of Object oriented, Functional and Logic Programming;

Algorithms for problem solving: Tree and graph traversals, Connected components, Spanning trees, Shortest paths; Hashing, Sorting, Searching; Design techniques (Greedy, Dynamic Programming, Divide-and-conquer);

Compiler Design: Lexical analysis, Parsing, Syntax directed translation, Runtime environment, Code generation, Linking (static and dynamic); Operating Systems: Classical concepts (concurrency, synchronization, deadlock), Processes, threads and Inter-process communication, CPU scheduling, Memory management, File systems, I/O systems, Protection and security.

Databases: Relational model (ER-model, relational algebra, tuple calculus), Database design (integrity constraints, normal forms), Query languages (SQL), File structures (sequential files, indexing, B+ trees), Transactions and concurrency control;

Computer Networks: ISO/OSI stack, sliding window protocol, LAN Technologies (Ethernet, Token ring), TCP/UDP, IP, Basic concepts of switches, gateways, and routers.

CH - CHEMISTRY

PHYSICAL CHEMISTRY

Structure: Quantum theory - principles and techniques; applications to particle in a box, harmonic oscillator, rigid rotor and hydrogen atom; valence bond and molecular orbital theories and Huckel approximation, approximate techniques: variation and perturbation; symmetry, point groups; rotational, vibrational, electronic, NMR and ESR spectroscopy.

Equilibrium: First law of thermodynamics, heat, energy and work; second law of thermodynamics and entropy; third law and absolute entropy; free energy; partial molar quantities; ideal and non-ideal solutions; phase transformation: phase rule and phase diagrams- one, two, and three component systems; activity, activity coefficient, fugacity and fugacity coefficient ; chemical equilibrium, response of chemical equilibrium to temperature and pressure; colligative properties; kinetic theory of gases; thermodynamics of electrochemical cells; standard electrode potentials: applications - corrosion and energy conversion; molecular partition function (translational, rotational, vibrational and electronic).

Kinetics: Rates of chemical reactions, theories of reaction rates, collision and transition state theory; temperature dependence of chemical reactions; elementary reactions, consecutive elementary reactions; steady state approximation, kinetics of photochemical reactions and free radical polymerization, homogenous and heterogeneous catalysis.

INORGANIC CHEMISTRY

Non-Transition Elements: General characteristics, structure and reactions of simple and industrially important compounds, boranes, carboranes, silicates, silicones, diamond and graphite; hydrides, oxides and oxoacids of N, P, S and halogens; boron nitride, borazines and phosphazenes; xenon compounds. Shapes of molecules, hard-soft acid base concept.

Transition Elements: General characteristics of d and f block elements; coordination chemistry: structure and isomerism, stability, theories of metal-ligand bonding (CFT and LFT), electronic spectra and magnetic properties of transition metal complexes and lanthanides; metal carbonyls, metal-metal bonds and metal atom clusters, metallocenes; transition metal complexes with bonds to hydrogen, alkyls, alkenes, and arenes; metal carbenes; use of organometallic compounds as catalysts in organic synthesis; mechanisms of substitution and electron transfer reactions of coordination complexes. Role of metals with special reference to Na, K, Mg, Ca, Fe, Co, Zn, and Mo in biological systems.

Solids: Crystal systems and lattices, Miller planes, crystal packing, crystal defects; Bragg's Law; ionic crystals, band theory, metals and semiconductors. Spinels.

Instrumental methods of analysis: atomic absorption, UV-visible spectrometry, chromatographic and electro-analytical methods.

ORGANIC CHEMISTRY

Synthesis, reactions and mechanisms involving the following: Alkenes, alkynes, arenes, alcohols, phenols, aldehydes, ketones, carboxylic acids and their derivatives; halides, nitro compounds and amines; stereochemical and conformational effects on reactivity and specificity; reactions with diborane and peracids. Michael reaction, Robinson annulation, reactivity umpolung, acyl anion equivalents; molecular rearrangements involving electron deficient atoms.

Photochemistry: Basic principles, photochemistry of olefins, carbonyl compounds, arenes, photo oxidation and reduction.

Pericyclic reactions: Cycloadditions, electrocyclic reactions, sigmatropic reactions; Woodward-Hoffmann rules.

Heterocycles: Structural properties and reactions of furan, pyrrole, thiophene, pyridine, indole.

Biomolecules: Structure, properties and reactions of mono- and di-saccharides, physico-chemical properties of amino acids, structural features of proteins and nucleic acids.

Spectroscopy: Principles and applications of IR, UV-visible, NMR and mass spectrometry in the determination of structures of organic compounds.

EC - ELECTRONICS AND COMMUNICATION ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix Algebra, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Mean value theorems, Theorems of integral calculus, Evaluation of definite and improper integrals, Partial Derivatives, Maxima and minima, Multiple integrals, Fourier series. Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equation (linear and nonlinear), Higher order linear differential equations with constant coefficients, Method of variation of parameters, Cauchy's and Euler's equations, Initial and boundary value problems, Partial Differential Equations and variable separable method.

Complex variables: Analytic functions, Cauchy's integral theorem and integral formula, Taylor's and Laurent' series, Residue theorem, solution integrals.

Probability and Statistics: Sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Discrete and continuous distributions, Poisson, Normal and Binomial distribution, Correlation and regression analysis.

Numerical Methods: Solutions of non-linear algebraic equations, single and multi-step methods for differential equations.

Transform Theory: Fourier transform, Laplace transform, Z-transform.

ELECTRONICS & COMMUNICATION ENGINEERING

Networks: Network graphs: matrices associated with graphs; incidence, fundamental cut set and fundamental circuit matrices. Solution methods: nodal and mesh analysis. Network theorems: superposition, Thevenin and Norton's maximum power transfer, Wye-Delta transformation. Steady state sinusoidal analysis using phasors. Linear constant coefficient differential equations; time domain analysis of simple RLC circuits, Solution of network equations using Laplace transform: frequency domain analysis of RLC circuits. 2-port network parameters: driving point and transfer functions. State equations for networks.

Electronic Devices: Energy bands in silicon, intrinsic and extrinsic silicon. Carrier transport in silicon: diffusion current, drift current, mobility, resistivity. Generation and recombination of carriers. p-n junction diode, Zener diode, tunnel diode, BJT, JFET, MOS capacitor, MOSFET, LED, p-I-n and avalanche photo diode, LASERs. Device technology: integrated circuits fabrication process, oxidation, diffusion, ion implantation, photolithography, n-tub, p-tub and twin-tub CMOS process.

Analog Circuits: Equivalent circuits (large and small-signal) of diodes, BJTs, JFETs, and MOSFETs. Simple diode circuits, clipping, clamping, rectifier. Biasing and bias stability of transistor and FET amplifiers. Amplifiers: single-and multi-stage, differential, operational, feedback and power. Analysis of amplifiers; frequency response of amplifiers. Simple op-amp circuits. Filters. Sinusoidal oscillators; criterion for oscillation; single-transistor and op-amp configurations. Function generators and wave-shaping circuits. Power supplies.

Digital circuits: Boolean algebra, minimization of Boolean functions; logic gates digital IC families (DTL, TTL, ECL, MOS, CMOS). Combinational circuits: arithmetic circuits, code converters, multiplexers and decoders. Sequential circuits: latches and flip-flops, counters and shift-registers. Sample and hold circuits, ADCs, DACs. Semiconductor memories. Microprocessor(8085): architecture, programming, memory and I/O interfacing.

Signals and Systems: Definitions and properties of Laplace transform, continuous-time and discrete-time Fourier series, continuous-time and discrete-time Fourier Transform, z-transform. Sampling theorems. Linear Time-Invariant (LTI) Systems: definitions and properties; casuality, stability, impulse response, convolution, poles and zeros frequency response, group delay, phase delay. Signal transmission through LTI systems. Random signals and noise: probability, random variables, probability density function, autocorrelation, power spectral density.

Controls Systems: Basic control system components; block diagrammatic description, reduction of block diagrams. Open loop and closed loop (feedback) systems and stability analysis of these systems. Signal flow graphs and their use in determining transfer functions of systems; transient and steady state analysis of LTI control systems and frequency response. Tools and techniques for LTI control system analysis: root loci, Routh-Hurwitz criterion, Bode and Nyquist plots. Control system compensators: elements of lead and lag compensation, elements of Proportional-Integral-Derivative(PID) control. State variable representation and solution of state equation of LTI control systems.

Communications: Analog communication systems: amplitude and angle modulation and demodulation systems, spectral analysis of these operations, superheterodyne receivers; elements of hardware, realizations of analog communication systems; signal-to-noise ratio (SNR) calculations for amplitude modulation (AM) and frequency modulation (FM) for low noise conditions. Digital communication systems: pulse code modulation (PCM), differential pulse code modulation (DPCM), delta modulation (DM); digital modulation schemes-amplitude, phase and frequency shift keying schemes (ASK, PSK, FSK), matched filter receivers, bandwith consideration and probability of error calculations for these schemes.

Electromagnetics: Elements of vector calculus: divergence and curl; Gauss' and Stokes' theorems, Maxwell's equations: differential and integral forms. Wave equation, Poynting vector. Plane waves: propagation through various media; reflection and refraction; phase and group velocity; skin depth. Transmission lines: characteristic impedance; impedance transformation; Smith chart; impedance matching; pulse excitation. Waveguides: modes in rectangular waveguides; boundary conditions; cut-off frequencies; dispersion relations. Antennas: Dipole antennas; antenna arrays; radiation pattern; reciprocity theorem, antenna gain.

EE - ELECTRICAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix Algebra, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Mean value theorems, Theorems of integral calculus, Evaluation of definite and improper integrals, Partial Derivatives, Maxima and minima, Multiple integrals, Fourier series. Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equation (linear and nonlinear), Higher order linear differential equations with constant coefficients, Method of variation of parameters, Cauchy's and Euler's equations, Initial and boundary value problems, Partial Differential Equations and variable separable method.

Complex variables: Analytic functions, Cauchy's integral theorem and integral formula, Taylor's and Laurent' series, Residue theorem, solution integrals.

Probability and Statistics: Sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Discrete and continuous distributions, Poisson, Normal and Binomial distribution, Correlation and regression analysis.

Numerical Methods: Solutions of non-linear algebraic equations, single and multi-step methods for differential equations.

Transform Theory: Fourier transform, Laplace transform, Z-transform.

ELECTRICAL ENGINEERING

Electrical Circuits and Fields: Network graph, KCL, KVL, node/ cut set, mesh/ tie set analysis, transient response of d.c. and a.c. networks; sinusoidal steady-state analysis; resonance in electrical circuits; concepts of ideal voltage and current sources, network theorems, driving point, immittance and transfer functions of two port networks, elementary concepts of filters; three phase circuits; Fourier series and its application; Gauss theorem, electric field intensity and potential due to point, line, plane and spherical charge distribution, dielectrics, capacitance calculations for simple configurations; Ampere's and Biot-Savart's law, inductance calculations for simple configurations.

Electrical Machines: Single phase transformer - equivalent circuit, phasor diagram, tests, regulation and efficiency; three phase transformers - connections, parallel operation; auto transformer and three-winding transformer; principles of energy conversion, windings of rotating machines: D. C. generators and motors - characteristics, starting and speed control, armature reaction and commutation; three phase induction motors-performance characteristics, starting and speed control; single-phase induction motors; synchronous generators-performance, regulation, parallel operation; synchronous motors - starting, characteristics, applications, synchronous condensers; fractional horse power motors; permanent magnet and stepper motors.

Power Systems: Electric power generation - thermal, hydro, nuclear; transmission line parameters; steady-state performance of overhead transmission lines and cables and surge propagation; distribution systems, insulators, bundle conductors, corona and radio interference effects; per-unit quantities; bus admittance and impedance matrices; load flow; voltage control and power factor correction; economic operation; symmetrical components, analysis of symmetrical and unsymmetrical faults; principles of over current, differential and distance protections; concept of solid state relays and digital protection; circuit breakers; concept of system stability-swing curves and equal area criterion; basic concepts of HVDC transmission.

Control Systems: Principles of feedback; transfer function; block diagrams: steady-state errors; stability-Routh and Nyquist criteria; Bode plots; compensation; root loci; elementary state variable formulation; state transition matrix and response for Linear Time Invariant systems.

Electrical and Electronic Measurements: Bridges and potentiometers, PMMC, moving iron, dynamometer and induction type instruments; measurement of voltage, current, power, energy and power factor; instrument transformers; digital voltmeters and multimeters; phase, time and frequency measurement; Q-meter, oscilloscopes, potentiometric recorders, error analysis.

Analog and Digital Electronics: Characteristics of diodes, BJT, FET, SCR; amplifiers-biasing, equivalent circuit and frequency response; oscillators and feedback amplifiers, operational amplifiers- characteristics and applications; simple active filters; VCOs and timers; combinational and sequential logic circuits, multiplexer, Schmitt trigger, multivibrators, sample and hold circuits, A/D and D/A converters; microprocessors and their applications.

Power Electronics and Electric Drives: Semiconductor power devices-diodes, transistors, thyristors, triacs, GTOs, MOSFETs and IGBTs - static characteristics and principles of operation; triggering circuits; phase control rectifiers; bridge converters-fully controlled and half controlled; principles of choppers and inverters, basic concepts of adjustable speed dc and ac drives.

GG - GEOLOGY AND GEOPHYSICS

PART - I

Earth and planetary system; size, shape, internal structure and composition of the earth; atmosphere and greenhouse effect; isostasy; elements of seismology; continents and continental processes; physical oceanography; palaeomagnetism, continental drift plate tectonics, geothermal energy.

Weathering; soil formation; action of river, wind and glacier; oceans and oceanic features; earthquakes, volcanoes, orogeny and mountain building; elements of structural geology; crystallography; classification, composition and properties of minerals and rocks; engineering properties of rocks and soils, role of geology in the construction of engineering structures.

Processes of ore formation, occurrence and distribution of ores on land and on ocean floor; coal and petroleum resources in India; ground water geology including well hydraulics, geological time scale and geochronology; stratigraphic principles and stratigraphy of India; basics concepts of gravity, magnetic and electrical prospecting for ores and ground water.

PART - IIA: GEOLOGY

Crystal symmetry, forms, twinning; crystal chemistry; optical mineralogy, classification of minerals, diagnostic properties of rock minerals.

Mineralogy, structure, texture and classification of igneous, sedimentary and metamorphic rock, their origin and evolution; application of thermodynamics; structure and petrology of sedimentary rocks; sedimentary processes and environments, sedimentary facies, basin studies; basement cover relationship;

Primary and secondary structures; geometry and genesis of folds, faults, joints, unconformities, cleavage, schistosity and lineation; methods of projection. Tectonites and their significance; shear zone; superposed folding.

Morphology, classification and geological significance of important invertebrates, vertebrates, microfossils and palaeoflora; stratigraphic principles and Indian stratigraphy; geomorphic processes and agents; development and evolution of landforms; slope and drainage; processes on deep oceanic and near-shore regions; quantitative and applied geomorphology; air photo interpretation and remote sensing; chemical and optical properties of ore minerals; formation and localization of ore deposits; prospecting and exploration of economic minerals; coal and petroleum geology; origin and distribution of mineral and fuel deposits in India; ore dressing and mineral economics.

Cosmic abundance; meteorites; geochemical evolution of the earth; geochemical cycles; distribution of major, minor and trace elements; isotope geochemistry; geochemistry of waters including solution equilibria and water rock interaction.

Engineering properties of rocks and soils; rocks as construction material; geology of dams, tunnels and excavation sites; natural hazards; the fly ash problem; ground water geology and exploration; water quality; impact of human activity; Remote sensing techniques for the interpretation of landforms and resource management.

PART - II B: GEOPHYSICS

The earth as a planet; different motions of the earth; gravity filed of the earth and its shape; geochronology; isostasy, seismology and interior of the earth; variation of density, velocity, pressure, temperature, electrical and magnetic properties inside the earth; earthquakes-causes and measurements; zonation and seismic hazards; geomagnetic field, palaeomagnetism; oceanic and continental lithosphere; plate tectonics; heat flow; upper and lower atmospheric phenomena.

Theories of scalar and vector potential fields; Laplace, Maxwell and Helmholtz equations for solution of different types of boundary value problems for Cartesian, cylindrical and spherical polar coordinates; Green's theorem; Image theory; integral equations and conformal transformations in potential theory; Eikonal equation and ray theory.

'G' and 'g' units of measurement, density of rocks, gravimeters, preparation, analysis and interpretation of gravity maps; derivative maps, analytical continuation; gravity anomaly type curves; calculation of mass.

Earth's magnetic field, units of measurement, magnetic susceptibility of rocks, magnetometers, corrections, preparation of magnetic maps, magnetic anomaly type curve, analytical continuation, interpretation and application; magnetic well logging.

Conduction of electricity through rocks, electrical conductivities of metals, metallic, non-metallic and rock forming minerals, D.C. resistivity units and methods of measurement, electrode configuration for sounding and profiling, application of filter theory, interpretation of resistivity field data, application; self potential origin, classification, field measurement, interpretation of induced polarization time frequency, phase domain; IP units and methods of measurement, interpretation and application; ground-water exploration.

Origin of electromagnetic field elliptic polarization, methods of measurement for different source-receiver configuration components in EM measurements, interpretation and applications; earth's natural electromagnetic field, tellurics, magneto-tellurics; geomagnetic depth sounding principles, methods of measurement, processing of data and interpretation.

Seismic methods of prospecting: Reflection, refraction and CDP surveys; land and marine seismic sources, generation and propagation of elastic waves, velocity increasing with depth, geophones, hydrophones, recording instruments (DFS), digital formats, field layouts, seismic noises and noise profile analysis, optimum geophone grouping, noise cancellation by shot and geophone arrays, 2D and 3D seismic data acquisition and processing, CDP stacking charts, binning, filtering, dip-moveout, static and dynamic corrections, deconvolution, migration, signal processing, Fourier and Hilbert transforms, attribute analysis, bright and dim spots, seismic stratigraphy, high resolution seismics, VSP.

Principles and techniques of geophysical well-logging, SP, resistivity, induction, micro gamma ray, neutron, density, sonic, temperature, dip meter, caliper, nuclear magnetic, cement bond logging. Quantitative evaluation of formations from well logs; well hydraulics and application of geophysical methods for groundwater study; application of bore hole geophysics in ground water, mineral and oil exploration. Remote sensing techniques and application of remote sensing methods in geophysics.

IN - INSTRUMENTATION ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix Algebra, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Mean value theorems, Theorems of integral calculus, Evaluation of definite and improper integrals, Partial Derivatives, Maxima and minima, Multiple integrals, Fourier series. Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equation (linear and nonlinear), Higher order linear differential equations with constant coefficients, Method of variation of parameters, Cauchy's and Euler's equations, Initial and boundary value problems, Partial Differential Equations and variable separable method.

Complex variables: Analytic functions, Cauchy's integral theorem and integral formula, Taylor's and Laurent' series, Residue theorem, solution integrals.

Probability and Statistics: Sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Discrete and continuous distributions, Poisson, Normal and Binomial distribution, Correlation and regression analysis.

Numerical Methods: Solutions of non-linear algebraic equations, single and multi-step methods for differential equations.

Transform Theory: Fourier transform, Laplace transform, Z-transform.

INSTRUMENTATION ENGINEERING

Measurement Basics and Metrology: Static and dynamic characteristics of measurement systems. Standards and calibration. Error and uncertainty analysis, statistical analysis of data, and curve fitting. Linear and angular measurements; Measurement of straightness, flatness, roundness and roughness.

Transducers, Mechanical Measurements and Industrial Instrumentation: Transducers - elastic, resistive, inductive, capacitive, thermo-electric, piezoelectric, photoelectric, electro-mechanical, electro-chemical, and ultrasonic. Measurement of displacement, velocity (linear and rotational), acceleration, shock, vibration, force, torque, power, strain, stress, pressure, flow, temperature, humidity, viscosity, and density. energy storing elements, suspension systems and dampers.

Analog Electronics: Characteristics of diodes, BJTs, JFETs and MOSFETs; Diode circuits; Amplifiers: single and multi-stage, feedback; Frequency response; Operational amplifiers - design, characteristic, linear and non-linear applications: difference amplifiers; instrumentation amplifiers; precision rectifiers, I-to-V converters, active filters, oscillators, comparators, signal generators, wave shaping circuits.

Digital Electronics: Combinational logic circuits, minimization of Boolean functions; IC families (TTL, MOS, CMOS), arithmetic circuits, multiplexer and decoders. Sequential circuits: flip-flops, counters, shift registers. Schmitt trigger, timers, and multivibrators. Analog switches, multiplexers, S/H circuits. Analog-to-digital and digital-to-analog converters. Basics of computer organization and architecture. 8-bit microprocessor (8085), applications, memory, I/O interfacing, and microcontrollers.

Signals and Systems: Vectors and matrices; Fourier series; Fourier transforms; Ordinary differential equations. Impulse and frequency responses of first and second order systems. Laplace transform and transfer function, convolution and correlation. Amplitude and frequency modulations and demodulations. Discrete time systems, difference equations, impulse and frequency responses; Z-transforms and transfer functions; IIR and FIR filters.

Electrical and Electronic Measurements: Measurement of R, L and C; bridges and potentiometers. Measurement of voltage, current, power, power factor, and energy; Instrument transformers; Q meter, waveform analyzers. Digital volt-meters and multi-meters. Time, phase and frequency measurements; Oscilloscope. Noise and interference in instrumentation.

Control Systems & Process Control: Principles of feedback; transfer function, signal flow graphs. Stability criteria, Bode plots, root-loci, Routh and Nyquist criteria. Compensation techniques; State space analysis. System components: mechanical, hydraulic, pneumatic, electrical and electronic; Servos and synchros; Stepper motors. On-off, cascade, P, PI, PID and feed-forward controls. Controller tuning and general frequency response.

Analytical, Optical and Biomedical Instrumentation: Principles of spectrometry, UV, visible, IR mass spectrometry, X-ray methods; nuclear radiation measurements, gas, solid and semi conductor lasers and their characteristics, interferometers, basics of fibre optics, transducers in biomedical applications, cardiovascular system measurements, instrumentation for clinical laboratory.

MA - MATHEMATICS

Linear Algebra: Finite dimensional vector spaces. Linear transformations and their matrix representations, rank; systems of linear equations, eigenvalues and eigenvectors, minimal polynomial, Cayley-Hamilton theorem, diagonalisation, Hermitian, Skew-Hermitian and unitary matrices. Finite dimensional inner product spaces, self-adjoint and Normal linear operators, spectral theorem, Quadratic forms.

Complex Analysis: Analytic functions, conformal mappings, bilinear transformations, complex integration: Cauchy's integral theorem and formula, Liouville's theorem, maximum modulus principle, Taylor and Laurent's series, residue theorem and applications for evaluating real integrals.

Real Analysis: Sequences and series of functions, uniform convergence, power series, Fourier series, functions of several variables, maxima, minima, multiple integrals, line, surface and volume integrals, theorems of Green, Stokes and Gauss; metric spaces, completeness, Weierstrass approximation theorem, compactness. Lebesgue measure, measurable functions; Lebesgue integral, Fatou's lemma, dominated convergence theorem.

Ordinary Differential Equations: First order ordinary differential equations, existence and uniqueness theorems, systems of linear first order ordinary differential equations, linear ordinary differential equations of higher order with constant coefficients; linear second order ordinary differential equations with variable coefficients, method of Laplace transforms for solving ordinary differential equations, series solutions; Legendre and Bessel functions and their orthogonality, Sturm Liouville system, Greeen's functions.

Algebra: Normal subgroups and homomorphisms theorems, automorphisms. Group actions, sylow's theorems and their applications groups of order less than or equal to 20, Finite p-groups. Euclidean domains, Principal ideal domains and unique factorizations domains. Prime ideals and maximal ideals in commutative rings.

Functional Analysis: Banach spaces, Hahn-Banach theorems, open mapping and closed graph theorems, principle of uniform boundedness; Hilbert spaces, orthonormal sets, Riesz representation theorem, self-adjoint, unitary and normal linear operators on Hilbert Spaces.

Numerical Analysis: Numerical solution of algebraic and transcendental equations; bisection, secant method, Newton-Raphson method, fixed point iteration, interpolation: existence and error of polynomial interpolation, Lagrange, Newton, Hermite(osculatory)interpolations; numerical differentiation and integration, Trapezoidal and Simpson rules; Gaussian quadrature; (Gauss-Legendre and Gauss-Chebyshev), method of undetermined parameters, least square and orthonormal polynomial approximation; numerical solution of systems of linear equations: direct and iterative methods, (Jacobi Gauss-Seidel and SOR) with convergence; matrix eigenvalue problems: Jacobi and Given's methods, numerical solution of ordinary differential equations: initial value problems, Taylor series method, Runge-Kutta methods, predictor-corrector methods; convergence and stability.

Partial Differential Equations: Linear and quasilinear first order partial differential equations, method of characteristics; second order linear equations in two variables and their classification; Cauchy, Dirichlet and Neumann problems, Green's functions; solutions of Laplace, wave and diffusion equations in two variables Fourier series and transform methods of solutions of the above equations and applications to physical problems.

Mechanics: Forces in three dimensions, Poinsot central axis, virtual work, Lagrange's equations for holonomic systems, theory of small oscillations, Hamiltonian equations;

Topology: Basic concepts of topology, product topology, connectedness, compactness, countability and separation axioms, Urysohn's Lemma, Tietze extension theorem, metrization theorems, Tychonoff theorem on compactness of product spaces.

Probability and Statistics: Probability space, conditional probability, Bayes' theorem, independence, Random variables, joint and conditional distributions, standard probability distributions and their properties, expectation, conditional expectation, moments. Weak and strong law of large numbers, central limit theorem. Sampling distributions, UMVU estimators, sufficiency and consistency, maximum likelihood estimators. Testing of hypotheses, Neyman-Pearson tests, monotone likelihood ratio, likelihood ratio tests, standard parametric tests based on normal, X2 ,t, F-distributions. Linear regression and test for linearity of regression. Interval estimation.

Linear Programming: Linear programming problem and its formulation, convex sets their properties, graphical method, basic feasible solution, simplex method, big-M and two phase methods, infeasible and unbounded LPP's, alternate optima. Dual problem and duality theorems, dual simplex method and its application in post optimality analysis, interpretation of dual variables. Balanced and unbalanced transportation problems, unimodular property and u-v method for solving transportation problems. Hungarian method for solving assignment problems.

Calculus of Variations and Integral Equations: Variational problems with fixed boundaries; sufficient conditions for extremum, Linear integral equations of Fredholm and Volterra type, their iterative solutions. Fredholm alternative.

ME - MECHANICAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

APPLIED MECHANICS AND DESIGN

Engineering Mechanics: Equivalent force systems, free-body concepts, equations of equilibrium, trusses and frames, virtual work and minimum potential energy. Kinematics and dynamics of particles and rigid bodies, impulse and momentum (linear and angular), energy methods, central force motion.

Strength of Materials: Stress and strain, stress-strain relationship and elastic constants, Mohr's circle for plane stress and plane strain, shear force and bending moment diagrams, bending and shear stresses, deflection of beams, torsion of circular shafts, thin and thick cylinders, Euler's theory of columns, strain energy methods, thermal stresses.

Theory of Machines: Displacement, velocity and acceleration, analysis of plane mechanisms, dynamic analysis of slider-crank mechanism, planar cams and followers, gear tooth profiles, kinematics of gears, governors and flywheels, balancing of reciprocating and rotating masses.

Vibrations: Free and forced vibration of single degree freedom systems, effect of damping, vibration isolation, resonance, critical speed of rotors.

Design of Machine Elements: Design for static and dynamic loading, failure theories, fatigue strength; design of bolted, riveted and welded joints; design of shafts and keys; design of spur gears, rolling and sliding contact bearings; brakes and clutches; belt, rope and chain drives.

FLUID MECHANICS AND THERMAL SCIENCES

Fluid Mechanics: Fluid properties, fluid statics, manometry, buoyancy; control-volume analysis of mass, momentum and energy; fluid acceleration; differential equations of continuity and momentum; Bernoulli's equation; viscous flow of incompressible fluids; boundary layer; elementary turbulent flow; flow through pipes, head losses in pipes, bends etc.

Heat-Transfer: Modes of heat transfer; one dimensional heat conduction, resistance concept, electrical analogy, unsteady heat conduction, fins; dimensionless parameters in free and forced convective heat transfer, various correlations for heat transfer in flow over flat plates and through pipes; thermal boundary layer; effect of turbulence; radiative heat transfer, black and grey surfaces, shape factors, network analysis; heat exchanger performance, LMTD and NTU methods.

Thermodynamics: Zeroth, First and Second laws of thermodynamics; thermodynamic system and processes; irreversibility and availability; behaviour of ideal and real gases, properties of pure substances, calculation of work and heat in ideal processes; analysis of thermodynamic cycles related to energy conversion; Carnot, Rankine, Otto, Diesel, Brayton and vapour compression cycles.

Power Plant Engineering: Steam generators; steam power cycles; steam turbines; impulse and reaction principles, velocity diagrams, pressure and velocity compounding; reheating and reheat factor; condensers and feed heaters.

I.C. Engines: Requirements and suitability of fuels in IC engines, fuel ratings, fuel-air mixture requirements; normal combustion in SI and CI engines; engine performance calculations.

Refrigeration and air-conditioning: Refrigerant compressors, expansion devices, condensers and evaporators; properties of moist air, psychrometric chart, basic psychometric processes.

Turbomachinery: Components of gas turbines; compression processes, centrifugal and axial flow compressors; axial flow turbines, elementary theory; hydraulic turbines; Euler-turbine equation; specific speed, Pelton-wheel, Francis and Kaplan turbines; centrifugal pumps.

MANUFACTURING AND INDUSTRIAL ENGINEERING

Engineering Materials: Structure and properties of engineering materials and their applications, heat treatment.

Metal Casting: Casting processes (expendable and non-expendable) -pattern, moulds and cores, heating and pouring, solidification and cooling, gating design, design considerations, defects.

Forming Processes: Stress-strain diagrams for ductile and brittle material, Plastic deformation and yield criteria, fundamentals of hot and cold working processes, Bulk metal forming processes (forging, rolling, extrusion, drawing), sheet metal working processes (punching, blanking, bending, deep drawing, coining, spinning, load estimation using homogeneous deformation methods, defects). processing of powder metals- atomization, compaction, sintering, secondary and finishing operations. forming and shaping of plastics- extrusion, injection moulding.

Joining Processes: Physics of welding, fusion and non-fusion welding processes, brazing and soldering, adhesive bonding, design considerations in welding, weld quality defects.

Machining and Machine Tool Operations: Mechanics of machining, single and multi-point cutting tools, tool geometry and materials, tool life and wear, cutting fluids, machinability, economics of machining, non-traditional machining processes.

Metrology and Inspection: Limits, fits and tolerances, linear and angular measurements, comparators, gauge design, interferometry, form and finish measurement, measurement of screw threads, alignment and testing methods.

Tool Engineering: Principles of work holding, design of jigs and fixtures.

Computer Integrated Manufacturing: Basic concepts of CAD, CAM and their integration tools.

Manufacturing Analysis: Part-print analysis, tolerance analysis in manufacturing and assembly, time and cost analysis.

Work-Study: Method study, work measurement, time study, work sampling, job evaluation, merit rating.

Production Planning and Control: Forecasting models, aggregate production planning, master scheduling, materials requirements planning.

Inventory Control: Deterministic and probabilistic models, safety stock inventory control systems.

Operations Research: Linear programming, simplex and duplex method, transportation, assignment, network flow models, simple queuing models, PERT and CPM

MN - MINING ENGINEERING

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables;

Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

MINING ENGINEERING

Mechanics: Equivalent force systems, equations of equilibrium, two dimensional frames and trusses, free body diagrams, friction forces, particle kinematics and dynamics.

Mine Development, Geomechanics and Strata Control: Drivages for underground mine development, drilling methods and machines, explosives, blasting devices and practices, shaft sinking. Physico-mechanical properties of rocks, rock mass classification, ground control instrumentation and stress measurement techniques, theories of rock failure, ground vibrations, stress distribution around mine openings, subsidence, design of supports in roadways and workings, stability of open pits, slopes.

Mining Methods and Machinery: Surface mining - layout, development, loading, transportation and mechanization, continuous surface mining systems. Underground coal mining - bord and pillar system, longwall mining, thick seam mining methods. Underground metal mining: different stoping methods, stope mechanization, ore handling systems, mine filling. Generation and transmission of mechanical, hydraulic, and pneumatic power. Materials handling - haulages, conveyors, ropeways, face and development machinery, hoisting systems, and pumps.

Ventilation, Underground Hazards and Surface Environment: Underground atmosphere, heat load sources and thermal environment, air cooling, mechanics of air flow distribution, natural and mechanical ventilation, mine fans and their usage, auxiliary ventilation. Subsurface hazards from fires, explosions, gases, dust, and inundation, rescue apparatus and practices, safety in mines, accident analysis, noise, mine lighting. Air and water pollution: causes, dispersion, quality standards, and control.

Surveying, Mine Planning and Systems Engineering: Fundamentals of engineering surveying, Levels and levelling, Theodolite, tacheometry, triangulation, contouring, errors and adjustments, correlation, underground surveying, curves, photogrammetry, field astronomy, GPS fundamentals. Principles of planning - Sampling methods and practices, reserve estimation techniques, basics of geostatistics, optimization of facility location, cash flow concepts and mine valuation, open pit design. Work study, concepts of reliability, reliability of series and parallel systems. Linear programming, transportation and assignment problems, queueing, network analysis, inventory control.

MT - METALLURGICAL ENGINEERING

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables;

Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

METALLURGICAL ENGINEERING

Thermodynamics and Rate Processes: Laws of thermodynamics, activity, equilibrium constant, applications to metallurgical systems, solutions, phase equilibria, basic kinetic laws, order of reactions, rate constants and rate limiting steps principles of electro chemistry, aqueous, corrosion and protection of metals, oxidation and high temperature corrosion - characterization and control; momentum transfer - concepts of viscosity, shell balances, Bernoulli's equation; heat transfer - conduction, convection and heat transfer coefficient relations, radiation, mass transfer - diffusion and Fick's laws.

Extractive Metallurgy: Flotation, gravity and other methods of mineral processing; agglomeration, pyro-hydro-and electro-metallurgical processes; material and energy balances; principles and processes for the extraction of non-ferrous metals - aluminium, copper, zinc, lead, magnesium, nickel, titanium and other rare metals; iron and steel making - principles, blast furnace, direct reduction processes, primary and secondary steel making, deoxidation and inclusion in steel; ingot and continuous casting; stainless steel making, design of furnaces; fuels and refractories.

Physical Metallurgy: Crystal structure and bonding characteristics of metals, alloys, ceramics and polymers; solid solutions; solidification; phase transformation and binary phase diagrams; principles of heat treatment of steels, aluminum alloys and cast irons; recovery, recrystallization and grain growth; industrially important ferrous and non-ferrous alloys; elements of X-ray and electron diffraction; principles of scanning and transmission electron microscopy; elements of ceramics, composites and electronic materials; electronic basis of thermal, optical, electrical and magnetic properties of materials.

Mechanical Metallurgy: Elements of elasticity and plasticity; defects in crystals; elements of dislocation theory - types of dislocations, slip and twinning, stress fields of dislocations, dislocation interactions and reactions, methods of seeing dislocations; strengthening mechanisms; tensile, fatigue and creep behaviour; superplasticity; fracture - Griffith theory, ductile to brittle transition, fracture toughness; failure analysis; mechanical testing - tension, compression, torsion, hardness, impact, creep, fatigue, fracture toughness and formability tests.

Manufacturing Processes: Metal casting - patterns, moulds, melting, gating, feeding and casting processes, defects and castings, hot and cold working of metals; Metal forming - fundamentals of metal forming, rolling wire drawing, extrusion, forming, sheet metal forming processes, defects in forming; Metal joining - soldering, brazing and welding, common welding processes, welding metallurgy, problems associated with welding of steels and aluminium alloys, defects in welding, powder metallurgy; NDT methods - ultrasonic, radiography, eddy current, acoustic emission and magnetic.

PH - PHYSICS

Mathematical Physics: Linear vector space, matrices; vector calculus; linear differential equations; elements of complex analysis; Laplace transforms, Fourier analysis, elementary ideas about tensors.

Classical Mechanics: Conservation laws; central forces; collisions and scattering in laboratory and centre of mass reference frames; mechanics of system of particles; rigid body dynamics; moment of inertia tensor; noninertial frames and pseudo forces; variational principle; Lagrange's and Hamilton's formalisms; equation of motion, cyclic coordinates, Poisson bracket; periodic motion, small oscillations, normal modes; wave equation and wave propagation; special theory of relativity - Lorentz transformations, relativistic kinematics, mass-energy equivalence.

Electromagnetic Theory: Laplace and Poisson equations; conductors and dielectrics; boundary value problems; Ampere's and Biot-Savart's laws; Faraday's law; Maxwell's equations; scalar and vector potentials; Coulomb and Lorentz gauges; boundary conditions at interfaces; electromagnetic waves; interference, diffraction and polarization; radiation from moving charges.

Quantum Mechanics: Physical basis of quantum mechanics; uncertainty principle; Schrodinger equation; one and three dimensional potential problems; Particle in a box, harmonic oscillator, hydrogen atom; linear vectors and operators in Hilbert space; angular momentum and spin; addition of angular momentum; time independent perturbation theory; elementary scattering theory.

Atomic and Molecular Physics: Spectra of one-and many-electron atoms; LS and jj coupling; hyperfine structure; Zeeman and Stark effects; electric dipole transitions and selection rules; X-ray spectra; rotational and vibrational spectra of diatomic molecules; electronic transition in diatomic molecules, Franck-Condon principle; Raman effect; NMR and ESR; lasers.

Thermodynamics and Statistical Physics: Laws of thermodynamics; macrostates, phase space; probability ensembles; partition function, free energy, calculation of thermodynamic quantities; classical and quantum statistics; degenerate Fermi gas; black body radiation and Planck's distribution law; Bose-Einstein condensation; first and second order phase transitions, critical point.

Solid State Physics: Elements of crystallography; diffraction methods for structure determination; bonding in solids; elastic properties of solids; defects in crystals; lattice vibrations and thermal properties of solids; free electron theory; band theory of solids; metals, semiconductors and insulators; transport properties; optical, dielectric and magnetic properties of solids; elements of superconductivity.

Nuclear and Particle Physics: Rutheford scattering; basic properties of nuclei; radioactive decay; nuclear forces; two nucleon problem; nuclear reactions; conservation laws; fission and fusion; nuclear models; particle accelerators, detectors; elementary particles; photons, baryons, mesons and leptons; Quark model.

Electronics: Network analysis; semiconductor devices; bipolar transistors; FETs; power supplies, amplifier, oscillators; operational amplifiers; elements of digital electronics; logic circuits.

PI - PRODUCTION AND INDUSTRIAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional

probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

GENERAL ENGINEERING:

Engineering Materials: Structure and properties of engineering materials and their applications; effect of strain, strain rate and temperature on mechanical properties of metals and alloys; heat treatment of metals and alloys.

Applied Mechanics: Engineering mechanics - equivalent force systems, free body concepts, equations of equilibrium, virtual work and minimum potential energy; strength of materials-stress, strain and their relationship, Mohr's circle, deflection of beams, bending and shear stress, Euler's theory of columns.

Theory of Machines and Design: Analysis of planar mechanisms, plane cams and followers; governers and fly wheels; design of elements-failure theories; design of bolted, riveted and welded joints; design of shafts, keys, belt drives, brakes and clutches.

Thermal Engineering: Fluid machines - fluid statics, Bernoulli's equation, flow through pipes, equations of continuity and momentum; Thermodynamics - zeroth, First and Second laws of thermodynamics, thermodynamic system and processes, calculation of work and heat for systems and control volumes; Heat transfer - fundamentals of conduction, convection and radiation.

PRODUCTION ENGINEERING

Metal Casting: Casting processes; patterns-materials; allowances; moulds and cores - materials, making and testing; melting and founding of cast iron, steels and nonferrous metals and alloys; solidification; design of casting, gating and risering; casting defects and inspection.

Metal working: Stress-strain in elastic and plastic deformation; deformation mechanisms; hot and cold working-forging, rolling, extrusion, wire and tube drawing; sheet metal working; analysis of rolling, forging, extrusion and wire /rod drawing; metal working defects, high energy rate forming processes-explosive, magnetic, electro and electrohydraulic.

Metal Joining Processes: Welding processes - gas shielded metal arc, TIG, MIG, submerged arc, electroslag, thermit, resistance, pressure and forge welding; thermal cutting; other joining processes - soldering, brazing, braze welding; welding codes, welding symbols, design of welded joints, defects and inspection; introduction to modern welding processes - friction, ultrasonic, explosive, electron beam, laser and plasma.

Machining and Machine Tool Operations: Machining processes-turning, drilling, boring, milling, shaping, planing, sawing, gear cutting, thread production, broaching, grinding, lapping, honing super finishing; mechanics of cutting- Merchant's analysis, geometry of cutting tools, cutting forces, power requirements; selection of process parameters; tool materials, tool wear and tool life, cutting fluids, machinability; nontraditional machining processes and hybrid processes- EDM, CHM, ECM, USM, LBM, EBM, AJM, PAM AND WJM; economics of machining.

Metrology and Inspection: Limits and fits, linear and angular measurements by mechanical and optical methods, comparators; design of limit gauges; interferometry; measurement of straightness, flatness, roundness, squareness and symmetry; surface finish measurement; inspection of screw threads and gears; alignment testing.

Powder Metallurgy and Processing of Plastics: Production of powders, compaction, sintering; Polymers and composites; injection, compression and blow molding, extrusion, calendaring and thermoforming; molding of composites.

Tool Engineering: Work-holding-location and clamping; principles and methods; design of jigs and fixtures; design of press working tools, forging dies.

Manufacturing Analysis: Sources of errors in manufacturing; process capability; part-print analysis; tolerance analysis in manufacturing and assembly; process planning; parameter selection and comparison of production alternatives; time and cost analysis; Issues in choosing manufacturing technologies and strategies.

Computer Integrated Manufacturing: Basic concepts of CAD, CAM, CAPP, group technology, NC, CNC, DNC, FMS, Robotics and CIM.

INDUSTRIAL ENGINEERING

Product Design and Development: Principles of good product design, component and tolerance design; efficiency, quality and cost considerations; product life cycle; standardization, simplification, diversification, value analysis, concurrent engineering.

Engineering Economy and Costing: Financial statements; elementary cost accounting, methods of depreciation; break-even analysis, techniques for evaluation of capital investments.

Work System Design: Taylor's scientific management, Gilbreths's contributions; productivity concepts and measurements; method study, micro-motion study, principles of motion economy; human factors engineering, ergonomics; work measurement - time study, PMTS, work sampling; job evaluation, merit rating, wage administration, incentive systems; business process reengineering.

Logistics and Facility Design: Facility location factors, evaluation of alternatives, types of plant layout, evaluation; computer aided layout; assembly line balancing; material handling systems; supply chain management.

Production Planning and Inventory Control: Inventory Function costs, classifications - deterministic and probabilistic models; quantity discount; safety stock; inventory control system; Forecasting techniques - causal and time series models, moving average, exponential smoothing; trend and seasonality; aggregate production planning; master scheduling; bill of materials and material requirement planning; order control and flow control, routing, scheduling and priority dispatching; JIT; Kanban PULL systems; bottleneck scheduling and theory of constraints.

Operation Research: Linear programming - problem formulation, simplex method, duality and sensitivity analysis; transportation; assignment; network flow models, constrained optimization and Lagrange multipliers; simple queuing models; dynamic programming; simulation; PERT and CPM, time-cost trade-off, resource leveling.

Quality Control: Taguchi method; design of experiments; quality costs, statistical quality assurance, process control charts, acceptance sampling, zero defects; quality circles, total quality management.

Reliability and Maintenance: Reliability, availability and maintainability; probabilistic failure and repair times; system reliability; preventive maintenance and replacement, TPM.

Management Information System: Value of information; information storage and retrieval system - database and data structures; interactive systems; knowledge based systems.

Intellectual Property System: Definition of intellectual property, importance of IPR; TRIPS, and its implications, WIPO and Global IP structure, and IPS in India; patent, copyright, industrial design and trademark; meanings, rules and procedures, terms, infringements and remedies.

PY - PHARMACEUTICAL SCIENCES

Natural Products: Pharmacognosy & Phytochemistry - Chemistry, tests, isolation, characterization and estimation of phytopharmaceuticals belonging to the group of Alkaloids, Glycosides, Terpenoids, Steroids, Bioflavanoids, Purines, Guggul lipids. Pharmacognosy of crude drugs which contain the above constituents. Standardisation of raw materials and herbal products. WHO guide lines. Quantitative microscopy including modern techniques used for evaluation. Biotechnological principles and techniques for plant development Tissue culture.

Pharmacology: General pharmacological principles including Toxicology. Drug interaction. Pharmacology of drugs acting on Central nervous system, Cardiovascular system, Autonomic nervous system, Gastro intestinal system and Respiratory system. Pharmacology of Autocoids, Hormones, Chemotherapeutic agents including anticancer drugs. Bioassays. Immuno Pharmacology.

Medicinal Chemistry: Structure, nomenclature, classification, synthesis, SAR and metabolism of the following category of drugs which are official in Indian Pharmacopoeia and British Pharmacopoeia Hypnotics and Sedatives, Analgesics, NSAIDS, Neuroleptics, Antidepressants, Anxiolytics, Anticonvulsants, Antihistaminics, Local anaesthetics, Cardio Vascular drugs - Antianginal agents Vasodilators, Adrenergic & cholinergic drugs, Cardiotonic agents, Diuretics, Antihypertensive drugs, Hypoglycemic agents, Antilipedmic agents, Coagulants, Anticoagulants, Antiplatelet agents. Chemotherapeutic agents - Antibiotics, Antibacterials, Sulphadrugs. Antiproliozoal drugs, Antiviral, Antitubercular, Antimalarial, Anticancer, Antiamoebic drugs. Diagnostic agents. Preparation and storage and uses of official Radiopharmaceuticals. Vitamins and Hormones.

Pharmaceutics: Development, manufacturing standards, labeling, packing as per the pharmacopoeal requirements, Storage of different dosage forms and new drug delivery systems. Biopharmaceutics and Pharmacokinetics and their importance in formulation. Formulation and preparation of cosmetics - lipstick, shampoo, creams, nail preparations and dentifrices. Pharmaceutical calculations.

Pharmaceutical Jurisprudence: Legal aspects of manufacture, storage, sale of drugs. D and C act and rules. Pharmacy act.

Pharmaceutical Analysis: Principles, instrumentation and applications of the following. Absorption spectroscopy (UV, visible & IR), Fluorimetry, Flame photometry, Potentiometry, Conductometry and Plarography. Pharmacopoeial assays. Principles of NMR, ESR, Mass spectroscopy, X-ray diffraction analysis and different chromatographic methods.

Biochemistry and Clinical Pharmacy: Biochemical role of hormones, Vitamins, Enzymes, Nucleic acids. Bioenergetics. General principles of immunology. Immunological techniques. Adverse drug interaction.

Microbiology: Principles and methods of microbiological assays of the Pharmacopoeia. Methods of preparation of official sera and vaccines. Serological and diagnostic tests. Applications of microorganisms in Bio Conversions and in Pharmaceutical industry.

TF - TEXTILE ENGINEERING AND FIBRE SCIENCE

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

TEXTILE ENGINEERING & FIBRE SCIENCE

Textile Fibres: Classification of textile fibres according to their nature and origin; general characteristics of textile fibres-their chemical and physical structures and their properties; essential characteristics of fibre forming polymers; uses of natural and man-made fibres; physical and chemical methods of fibre and blend identification and blend analysis.

Melt Spinning processes with special reference to polyamide and polyester fibres; wet and dry spinning of viscose and acrylic fibres; post spinning operations-drawing, heat setting, texturing- false twist and air-jet, tow-to-top conversion. Methods of investigating fibre structure e.g. X-ray diffraction, birefringence, optical and electron microscopy, I.R. absorption, thermal methods; structure and morphology and principal natural and man-made fibres, mechanical properties of fibres, moisture sorption in fibres; fibre structure and property correlation.

Textile Testing: Sampling techniques, sample size and sampling errors; measurement of fibre length, fineness, crimp, strength and reflectance; measurement of cotton fibre maturity ad trash content; HVI and AFIS for fibre testing. Measurement of yarn count, twist and hairiness; tensile testing of fibres, yarn and fabrics; evenness testing of slivers, rovings and yarns; testing equipment for measurement test methods of fabric properties like thickness, compressibility, air permeability, drape, crease recovery, tear strength bursting strength and abrasion resistance. Correlation analysis, significance tests and analysis of variance; frequency distributions and control charts.

Yarn Manufacture and Yarn Structure: Modern methods of opening, cleaning and blending of fibrous materials; the technology of carding with particular reference to modern developments; causes of irregularity introduced by drafting, the development of modern drafting systems; principles and techniques of preparing material for combing; recent development in combers; functions and synchronization of various mechanisms concerned with roving production; forces acting on yarn and traveller, ring and traveller designs; causes of end breakages; properties of doubles yarns; new methods of yarn production such as rotor spinning, air jet spinning and friction spinning.

Yarn diameter; specific volume, packing coefficient; twist-strength relationship; fibre orientation in yarn; fibre migration.

Fabric Manufacture and Fabric Structure: Principles of cheese and cone winding processes and machines; random and precision winding; package faults and their remedies; yarn clearers and tensioners; different systems of yarn splicing; features of modern cone winding machines; different types of warping creels; features of modern beam and sectional warping machines; different sizing systems, sizing of spun and filament yarns, modern sizing machines; principles of pirn winding processes and machines; primary and secondary motions of loom, effect of their settings and timings on fabric formation, fabric appearance and weaving performance; dobby and jacquard shedding; mechanics of weft insertion with shuttle; warp and weft stop motions, warp protection, weft replenishment; functional principles of weft insertion systems of shuttleless weaving machines, principles of multiphase and circular looms. Principles of weft and warp knitting; basic weft and warp knitted structures; classification, production and areas of application of nonwoven fabrics.

Basic woven fabric constructions and their derivatives; crepe, cord, terry, gauze, lino and double cloth constructions.

Peirce's equations for fabric geometry; thickness, cover and maximum sett of woven fabrics

Textile Chemical Processing: Preparatory processes for natural-and and their blends; mercerization of cotton; machines for yarn and fabric mercerization.

Dyeing and printing of natural- and synthetic- fibre fabrics and their blends with different dye classes; dyeing and printing machines; styles of printing; fastness properties of dyed and printed textile materials.

Finishing of textile materials, wash and wear, durable press, soil release, water repellent, flame retardant and antistatic finishes; shrink-resistance finish for wool; heat setting of synthetic-fibre fabrics, finishing machines; energy efficient processes; pollution control.

XE - ENGINERING SCIENCES

The syllabi of the sections of this paper are as follows:

SECTION A. ENGINEERING MATHEMATICS (Compulsory)

Linear Algebra : Determinates, algebra of matrices, rank, inverse, system of linear equations, symmetric, skew-symmetric and orthogonal matrices. Hermitian, skew-hermitian and unitary matrices. eigenvalues and eigenvectors, diagonalisation of matrices, Cayley-Hamiltonian, quadratic forms.

Calculus : Functions of single variables, limit, continuity and differentiability, Mean value theorems, Intermediate forms and L'Hospital rule, Maxima and minima, Taylor's series, Fundamental and mean value-theorems of integral calculus. Evaluation of definite and improper integrals, Beta and Gamma functions, Functions of two variables, limit, continuity, partial derivatives, Euler's theorem for homogeneous functions, total derivatives, maxima and minima, Lagrange method of multipliers, double and triple integrals and their applications, sequence and series, tests for convergence, power series, Fourier Series, Fourier integrals.

Complex variable: Analytic functions, Cauchy's integral theorem and integral formula without proof. Taylor's and Laurent' series, Residue theorem (without proof) with application to the evaluation of real integarls.

Vector Calculus: Gradient, divergence and curl, vector identities, directional derivatives, line, surface and volume integrals, Stokes, Gauss and Green's theorems (without proofs) with applications.

Ordinary Differential Equations: First order equation (linear and nonlinear), higher order linear differential equations with constant coefficients, method of variation of paramaters, Cauchy's and Euler's equations, initial and boundary value problems, power series solutions, Legendre polynomials and Bessel's functions of the first kind.

Partial Differential Equations: Variables separable method, solutions of one dimensional heat, wave and Laplace equations.

Probability and Statistics: Definitions of probability and simple theorems, conditional probability, mean, mode and standard deviation, random variables, discrete and continuous distributions, Poisson, normal and Binomial distribution, correlation and regression

Numerical Methods: L-U decomposition for systems of linear equations,Newton-Raphson method, numerical integration(trapezoidal and Simpson's rule), numerical methods for first order differential equation (Euler method)

SECTION B. COMPUTATIONAL SCIENCE

Numerical Methods: Truncation errors, round off errors and their propagation; Interpolation; Lagrange, Newton's forward, backward and divided difference formulas, least square curve fitting, solution of non-linear equations of one variables using bisection, false position, secant and Newton Raphson methods; Rate of convergence of these methods, general iterative methods. Simple and multiple roots of polynomials. Solutions of system of linear algebraic equations using Gauss elimination methods, Jacobi and Gauss-Seidel iterative methods and their rate of convergence; ill conditioned and well conditioned system. eigen values and eigen vectors using power methods. Numerical integration using trapezoidal, Simpson's rule and other quadrature formulas. Numerical Differentiation. Solution of boundary value problems. Solution of initial value problems of ordinary differential equations using Euler's method, predictor corrector and Runge Kutta method.

Programming : Elementary concepts and terminology of a computer system and system software, Fortran77 and C programming.

Fortran : Program organization, arithmetic statements, transfer of control, Do loops, subscripted variables, functions and subroutines.

C language : Basic data types and declarations, flow of control- iterative statement, conditional statement, unconditional branching, arrays, functions and procedures.

SECTION C. ELECTRICAL SCIENCES

Electric Circuits: Ideal voltage and current sources; RLC circuits, steady state and transient analysis of DC circuits, network theorems; alternating currents and voltages, single-phase AC circuits, resonance; three-phase circuits.

Magnetic circuits: Mmf and flux, and their relationship with voltage and current; transformer, equivalent circuit of a practical transformer, three-phase transformer connections.

Electrical machines: Principle of operation, characteristics, efficiency and regulation of DC and synchronous machines; equivalent circuit and performance of three-phase and single-phase induction motors.

Electronic Circuits: Characteristics of p-n junction diodes, zener diodes, bipolar junction transistors (BJT) and junction field effect transistors (JFET); MOSFET's structure, characteristics, and operations; rectifiers, filters, and regulated power supplies; biasing circuits, different configurations of transistor amplifiers, class A, B and C of power amplifiers; linear applications of operational amplifiers; oscillators; tuned and phase shift types.

Digital circuits: Number systems, Boolean algebra; logic gates, combinational circuits, flip-flops (RS, JK, D and T) counters.

Measuring instruments: Moving coil, moving iron, and dynamometer type instruments; shunts, instrument transformers, cathode ray oscilloscopes; D/A and A/D converters.

SECTION D. FLUID MECHANICS

Fluid Properties: Relation between stress and strain rate for Newtonian fluids

Hydrostatics, buoyancy, manometry

Concept of local and convective accelerations; control volume analysis for mass, momentum and energy conservation.

Differential equations of continuity and momentum (Euler's equation of motion); concept of fluid rotation, stream function, potential function; Bernoulli's equation and its applications.

Qualitative ideas of boundary layers and its separation; streamlined and bluff bodies; drag and lift forces.

Fully-developed pipe flow; laminar and turbulent flows; friction factor; Darcy Weisbach relation; Moody's friction chart; losses in pipe fittings; flow measurements using venturimeter and orifice plates.

Dimensional analysis; similitude and concept of dynamic similarity; importance of dimensionless numbers in model studies.

SECTION E. MATERIALS SCIENCE

Atomic structure and bonding in materials: metals, ceramics and polymers.

Structure of materials: Crystal systems, unit cells and space lattice; determination of structures of simple crystals by X-ray diffraction; Miller indices for planes and directions. Packing geometry in metallic, ionic and covalent solids.

Concept of amorphous, single and polycrystalline structures and their effects on properties of materials.

Imperfections in crystalline solids and their role in influencing various properties.

Fick´s laws of diffusion and applications of diffusion in sintering, doping of semiconductors and surface hardening of metals.

Alloys: solid solution and solubility limit. Binary phase diagram, intermediate phases and intermetallic compounds; iron-iron carbide phase diagram. Phase transformation in steels. Cold and hot working of metals, recovery, recrystallization and grain growth.

Properties and applications of ferrous and nonferrous alloys.

Structure, properties, processing and applications of traditional and advanced ceramics.

Polymers: classification, polymerization, structure and properties, additives for polymer products, processing and application.

Composites: properties and application of various composites.

Corrosion and environmental degradation of materials (metals, ceramics and polymers).

Mechanical properties of materials: Stress-strain diagrams of metallic, ceramic and polymeric materials, modulus of elasticity, yield strength, plastic deformation and toughness, tensile strength and elongation at break; viscoelasticity, hardness, impact strength. ductile and brittle fracture. creep and fatigue properties of materials.

Heat capacity, thermal conductivity, thermal expansion of materials.

Concept of energy band diagram for materials; conductors, semiconductors and insulators in terms of energy bands. Electrical conductivity, effect of temperature on conductivity in materials, intrinsic and extrinsic semiconductors, dielectric properties of materials.

Refraction, reflection, absorption and transmission of electromagnetic radiation in solids.

Origin of magnetism in metallic and ceramic materials, paramagnetism, diamagnetism, antiferromagnetism, ferromagnetism, ferrimagnetism in materials and magnetic hysteresis.

Advanced materials: Smart materials exhibiting ferroelectric, piezoelectric, optoelectronic, semiconducting behaviour; lasers and optical fibers; photoconductivity and superconductivity in materials.

SECTION F. SOLID MECHANICS

Equivalent force systems; free-body diagrams; equilibrium equations; analysis of determinate and indeterminate trusses and frames; friction.

Simple relative motion of particles; force as function of position, time and speed; force acting on a body in motion; laws of motion; law of conservation of energy; law of conservation of momentum

Stresses and strains; principal stresses and strains; Mohr's circle; generalized Hooke's Law; equilibrium equations; compatibility conditions; yield criteria.

Axial, shear and bending moment diagrams; axial, shear and bending stresses; deflection (for symmetric bending); torsion in circular shafts; thin cylinders; energy methods (Castigliano's Theorems); Euler buckling.

SECTION G. THERMODYNAMICS

Basic Concepts: Continuum, macroscopic approach, thermodynamic system (closed and open or control volume); thermodynamic properties and equilibrium; state of a system, state diagram, path and process; different modes of work; Zeroth law of thermodynamics; concept of temperature; heat.

First Law of Thermodynamics: Energy, enthalpy, specific heats, first law applied to systems and control volumes, steady and unsteady flow analysis.

Second Law of Thermodynamics: Kelvin-Planck and Clausius statements, reversible and irreversible processes, Carnot theorems, thermodynamic temperature scale, Clausius inequality and concept of entropy, principle of increase of entropy; availability and irreversibility.

Properties of Pure Substances: Thermodynamic properties of pure substances in solid, liquid and vapour phases, P-V-T behaviour of simple compressible substances, phase rule, thermodynamic property tables and charts, ideal and real gases, equations of state, compressibility chart.

Thermodynamic Relations: T-ds relations, Maxwell equations, Joule-Thomson coefficient, coefficient of volume expansion, adiabatic and isothermal compressibilities, Clapeyron equation.

Ideal Gas Mixtures: Dalton's and Amagat's laws, calculations of properties, air-water vapour mixtures.

XL - LIFE SCIENCES

The syllabi of the Sections of this paper are as follows:

SECTION H. CHEMISTRY (Compulsory)

Atomic structure and periodicity: Quantum chemistry; Planck's quantum theory, wave particle duality, uncertainty principle, quantum mechanical model of hydrogen atom; electronic configuration of atoms; periodic table and periodic properties; ionization energy, election affinity, electronegativity, atomic size.

Structure and bonding: Ionic and covalent bonding M.O. and V.B. approaches for diatomic molecules, VSEPR theory and shape of molecules, hybridisation, resonance, dipole moment, structure parameters such as bond length, bond angle and bond energy, hydrogen bonding, van der Waals interactions. Ionic solids; ionic radii, lattice energy (Born-Haber Cycle).

s.p. and d Block Elements: Oxides, halides and hydrides of alkali and alkaline earth metals, B, Al, S, N, P and S, silicones, general characteristics of 3d elements, coordination complexes: valence bond and crystal field theory, color, geometry and magnetic properties.

Chemical Equilibria: Colligative properties of solutions, ionic equilibria in solution, solubility product, common ion effect, hydrolysis of salts, pH, buffer and their applications in chemical analysis.

Electrochemistry: Conductance, Kohlrausch law, Half Cell potentials, emf, Nernst equation, galvanic cells, thermodynamic aspects and their applications.

Reaction Kinetics: Rate constant, order of reaction, molecularity, activation energy, zero, first and second order kinetics, equilibrium constants (Kc, Kp and Kx) for homogeneous reactions, catalysis and elementary enzyme reactions.

Thermodynamics: First law, reversible and irreversible processes, internal energy, enthalpy, Kirchoff's equation, heat of reaction, Hess law, heat of formation, Second law, entropy, free energy, and work function. Gibbs-Helmholtz equation, Clausius-Clapeyron equation, free energy change and equilibrium constant, Troutons rule, Third law of thermodynamics.

Mechanistic Basis of Organic Reactions: Elementary treatment of SN1, SN2, E1 and E2 reactions, Hoffmann and Saytzeff rules, Addition reactions, Markonikoff rule and Kharash effect, Diels-Alder reaction, aromatic electrophilic substitution, orientation effect as exemplified by various functional groups.

Structure-Reactivity Correlations: Acids and bases, electronic and steric effects, optical and geometrical isomerism, tautomerism, concept of aromaticity

SECTION I. BIOCHEMISTRY

Organization of life. Importance of water. Cell structure and organelles. Structure and function of biomolecules: Carbohydrates, Lipids, Proteins and Nucleic acids. Biochemical separation techniques. Spectroscopic methods; UV-visible and fluorescence. Protein structure, folding and function: Myoglobin, Hemoglobin, Lysozyme, ribonuclease A, Carboxypeptidase and Chymotrypsin. Enzyme kinetics and regulation, Coenzymes.

Metabolism and bioenergitics. Generation and utilization of ATP. Photosynthesis. Major metabolic pathways and their regulation. Biological membranes. Transport across membranes. Signal transduction; hormones and neurotransmitters.

DNA replication, transcription and translation. Biochemical regulation of gene expression. Recombinant DNA technology and applications. Genomics and Proteomics.

The immune system. Active and passive immunity. Complement system. Antobody structure, function and diversity. Cells of the immune system: T, B and macrophages. T and B cell activation. Major histocompatibilty complex. T cell receptor. Immunological techniques: Immunodiffusion, immunoelectrophoresis, RIA and ELISA.

SECTION J. BIOTECHNOLOGY

Recombinant DNA technology for the production of therapeutic proteins. Micro array technology. Heterologous protein expression systems in bacteria, yeast etc.

Architecture of plant genome; plant tissue culture techniques; methods of gene transfer into plant cells; manipulation of phenotypic traits in plants; plant cell fermentations and production of secondary metabolites using suspension/ immobilized cell culture; methods for plant micro propagation; crop improvement and development of transgenic plants. Expression of animal proteins in plants.

Animal cell metabolism and regulation; cell cycle; primary cell culture; nutritional requirements for animal cell culture; techniques for the mass culture of animal cell lines; production of vaccines; growth hormones and interferons using animal cell culture; cytokines-production and therapeutic uses; hybridoma technology; vectors for gene transfer and expression in animal cells. Transgenic animals and molecular pharming.

Microbial production of industrial enzymes; methods for immobilization of enzymes; kinetics of soluble and immobilized enzymes; application of soluble and immobilized enzymes; enzyme-based sensors.

Microbial growth kinetics; batch, fed batch and continuous culture of microbial cells; media for industrial fermentations; sterilization of air and media; design features and operation of stirred tank, air-lift and fluidized bed reactors; aeration and agitation in aerobic fermentations; recovery and purification of fermentation products- filtration, centrifugation, cell disintegration, solvent extraction and chromatographic separations; industrial fermentations for the production of ethanol, citric acid, lysine, penicillin and other biomolecules; simple calculations based on material and energy balance of fermentation processes; application of microbes in the management of domestic and industrial wastes.

SECTION K. BOTANY

Anatomy: Roots, stem and leaves of land plants, meristems, vascular system, their ontogeny, structure and functions. Plant cell structure, organisation, organelles, cytoskeleton, cell wall and membranes.

Development: Cell cycle, cell division, senescence, hormonal regulation of growth; life cycle of an angiosperm, pollination, fertilization, embryogenesis, seed formation, seed storage proteins, seed dormancy and germination. Concept of cellular totipotency, organogenesis and somatic embryogenesis, somaclonal variation, embryo culture, in vitro fertilization.

Physiology and Biochemistry: Plant water relations, transport of minerals and solutes, N2 metabolism, proteins and nucleic acid, respiration, photophysiology, photosynthesis, photorespiration; biosynthesis, mechanism of action and physiological effects of plant growth regulators.

Genetics: Principles of Mendelian inheritance, linkage, recombination and genetic mapping; extrachromosomal inheritance; eukaryotic genome organization (chromatin structure) and regulation of gene expression, gene mutation, chromosome aberrations (numerical and structural), transposons.

Plant Breeding: Principles, methods - selection, hybridization, heterosis; male sterility, self and inter-specific incompatibility; haploidy; somatic cell hybridization; molecular marker-assisted selection; gene transfer methods viz. direct and vector-mediated, transgenic plants and their applications in agriculture.

Economic Botany: Economically important plants - cereals, pulses, plants yielding fiber, timber, sugar, beverages, oils, rubber, dyes, gums, drugs and narcotics - a general account.

Systematics: Systems of classification (non-phylogenetic vs. phylogenetic - outline), plant groups, molecular systematics.

Plant Pathology: Nature and classification of plant diseases, diseases of important crops caused by fungi, bacteria and viruses, and their control measures, mechanism(s) of pathogenesis and resistance, molecular detection of pathogens; plant-microbe beneficial interactions.

Ecology and Plant Geography: Ecosystems - types, dynamics, degradation, ecological succession; food chains; vegetation types of the world; pollution and global warming; speciation and extinction, conservation strategies, cryopreservation.

SECTION L. MICROBIOLOGY

Historical perspective - Discovery of the microbial world; Controversy over spontaneous generation; Role of microorganisms in transformation of organic matter and in the causation of diseases.

Methods in microbiology - Pure culture techniques; Theory and practice of sterilization; Principles of microbial nutrition; Construction of culture media; Enrichment culture techniques for isolation of chemoautotrophs, chemoheterotrophs and photosynthetic microorganisms.

Microbial evolution, systematics and taxonomy - Evolution of earth and earliest life forms; Primitive organisms and their metabolic strategies; New approaches to bacterial taxonomic classification including ribotyping; Nomenclature.

Microbial diversity - Bacteria, archea and their broad classification; Eukaryotic microbes, yeast, fungi, slime mold and protozoa; Viruses and their classification.

Microbial growth -The definition of growth, mathematical expression of growth, growth curve, measurement of growth and growth yields; Synchronous growth; Continuous culture.

Nutrition and metabolism - Overview of metabolism; Microbial nutrition; Energy classes of microorganisms; Culture media; Energetics, modes of ATP generation; ATP generation by heterotrophs; Fermentation; Glycolysis; Respiration; The citric acid cycle; Electron transport systems; Alternate modes of energy generation; Pathways (anabolism) in the biosynthesis of amino acids, purines, pyrimidines and fatty acids.

Metabolic diversity among microorganisms - Photosynthesis in microorganisms; Role of chlorophylls, carotenoids and phycobilins; Calvin cycle; Chemolithotrophy; Hydrogen- iron- nitrite-oxidizing bacteria; Nitrate and sulfate reduction; Methanogenesis and acetogenesis.

Prokaryotic cells: structure-function - Cells walls of eubacteria (peptidoglycan) and related molecules; Outer-membrane of gram-negative bacteria; Cell wall and cell membrane synthesis; Flagella and motility; Cell inclusions like endospores, gas vesicles.

Microbial diseases and host parasite relationships - Normal microflora of skin; Oral cavity; Gastrointestinal tract; Entry of pathogens into the host; Infectious disease transmission; Respiratory infections caused by bacteria and viruses; Tuberculosis; Sexually transmitted diseases including AIDS; Diseases transmitted by animals (Rabies, plague), insects and ticks (rikettsias, Lyme disease, malaria); Food and water borne diseases; Public health and water quality; Pahtogenic fungi; Emerging and resurgent infectious diseases.

Chemotherapy/Antibiotics - Antimicrobial agents; Sulfa drugs; Antibiotics; Pencillins and cephalosporins; Broad-spectrum antibiotics; Antibiotics from prokaryotes; Antifungal antibiotics; Mode of action; Resistance to antibiotics.

Microbial genetics - Genes, mutation and mutagenesis - UV and chemical mutagnes; Types of mutations; Ames test for mutagenesis; Methods of genetic analysis. Bacterial genetic system - Transformation; Conjugation; Transduction; Recombination; Plasmids and Transposons; Bacterial genetic map with reference to E. coli. Viruses and their genetic system - Phage ? and its life cycle; RNA phages; RNA viruses; Retroviruses; Genetic systems of yeast and Neurospora; Extrachromosomal inheritance and mitochondrial genetics; Basic concept of genomics.

SECTION M. ZOOLOGY

Animal world: Animal diversity, distribution, systematic and classification of animals, the phylogenetic relationship.

Evolution: Origin of life, history of life on earth, evolutionary theories, natural selection, adaptation, speciation.

Genetics: Principles of inheritance, molecular basis of heredity, the genetic material, transmission of genetic material, mutations, cytoplasmic inheritance.

Biochemistry and Molecular Biology: Nucleic acids, proteins and other biological macromolecules. Replication, transcription and translation, regulation of gene expression, organization of genome, Kreb's cycle, glycolysis, enzyme catalysis, hormones and their action.

Cell Biology: Structure of cell, cellular organelles and their structure and function, cell cycle, cell division, cellular differentiation, chromosome and chromatin structure. Eukaryotic gene organisation and expression.

Animal Anatomy and Physiology: Comparative physiology, the respiratory system, circulatory system, digestive system, the nervous system, the excretory system, the endocrine system, the reproductive system, the skeletal system, osmoregulation.

Parasitology and Immunology: Nature of parasite, host-parasite relation, protozoan and helminthic parasites, the immune response, cellular and humoral immune response, evolution of the immune system.

Development Biology: Embryonic development, cellular differentiation, organogenesis, metamorphosis, genetic basis of development.

Ecology: The ecosystem, habitats the food chain, population dynamics, species diversity, zoogeography, biogeochemical cycles, conservation biology.

Animal Behaviour: Types of behaviours, courtship, mating and territoriality, instinct, learning and memory, social behaviour across the animal taxa, communication, pheromones, evolution of animal behaviour.

IT - INFORMATION TECHNOLOGY

ENGINEERING MATHEMATICS

Mathematical Logic: Propositional Logic; First Order Logic.

Probability: Conditional Probability; Mean, Median, Mode and Standard Deviation; Random Variables; Distributions; uniform, normal, exponential, Poisson, Binomial.

Set Theory & Algebra: Sets; Relations; Functions; Groups; Partial Orders; Lattice; Boolean Algebra.

Combinatorics: Permutations; Combinations; Counting; Summation; generating functions; recurrence relations; asymptotics.

Graph Theory: Connectivity; spanning trees; Cut vertices & edges; covering; matching; independent sets; Colouring; Planarity; Isomorphism.

Linear Algebra: Algebra of matrices, determinants, systems of linear equations, Eigen values and Eigen vectors.

Numerical Methods: LU decomposition for systems of linear equations; numerical solutions of non linear algebraic equations by Secant, Bisection and Newton-Raphson Methods; Numerical integration by trapezoidal and Simpson's rules.

Calculus: Limit, Continuity & differentiability, Mean value Theorems, Theorems of integral calculus, evaluation of definite & improper integrals, Partial derivatives, Total derivatives, maxima & minima.

FORMAL LANGUAGES AND AUTOMATA

Regular Languages: finite automata, regular expressions, regular grammar.

Context free languages: push down automata, context free grammars

COMPUTER HARDWARE

Digital Logic: Logic functions, minimization, design and synthesis of combinatorial and sequential circuits, number representation and computer arithmetic (fixed and floating point)

Computer organization: Machine instructions and addressing modes, ALU and data path, hardwired and microprogrammed control, memory interface, I/O interface (interrupt and DMA mode), serial communication interface, instruction pipelining, cache, main and secondary storage

SOFTWARE SYSTEMS

Data structures and Algorithms: the notion of abstract data types, stack, queue, list, set, string, tree, binary search tree, heap, graph, tree and graph traversals, connected components, spanning trees, shortest paths, hashing, sorting, searching, design techniques (greedy, dynamic, divide and conquer), asymptotic analysis (best, worst, average cases) of time and space, upper and lower bounds, intractability

Programming Methodology: C programming, program control (iteration, recursion, functions), scope, binding, parameter passing, elementary concepts of object oriented programming

Operating Systems (in the context of Unix): classical concepts (concurrency, synchronization, deadlock), processes, threads and interprocess communication, CPU scheduling, memory management, file systems, I/O systems, protection and security

Information Systems and Software Engineering: information gathering, requirement and feasibility analysis, data flow diagrams, process specifications, input/output design, process life cycle, planning and managing the project, design, coding, testing, implementation, maintenance.

Databases: relational model, database design, integrity constraints, normal forms, query languages (SQL), file structures (sequential, indexed), b-trees, transaction and concurrency control

Data Communication: data encoding and transmission, data link control, multiplexing, packet switching, LAN architecture, LAN systems (Ethernet, token ring), Network devices: switches, gateways, routers

Networks: ISO/OSI stack, sliding window protocols, routing protocols, TCP/UDP, application layer protocols & systems (http, smtp, dns, ftp), network security

Web technologies: three tier web based architecture; JSP, ASP, J2EE, .NET systems; html, XML

AG - AGRICULTURAL ENGINEERING

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

FARM MACHINERY AND POWER:

Sources of power on the farm-human, animal, mechanical, electrical, wind, solar and biomass; design and selection of machine elements - gears, pulleys, chains and sprockets and belts; overload safety devices used in farm machinery; measurement of force, torque, speed, displacement and acceleration on machine elements.

Soil tillage; forces acting on a tillage tool; hitch systems and hitching of tillage implements; functional requirements, principles of working, construction and operation of manual, animal and power operated equipment for tillage. sowing, planting, fertilizer application, inter-cultivation, spraying, mowing, chaff cutting, harvesting, threshing and transport; testing of agricultural machinery and equipment; calculation of performance parameters -field capacity, efficiency, application rate and losses; cost analysis of implements and tractors.

Thermodynamic principles of I.C. engines; I.C. engine cycles; engine components; fuels and combustion; lubricants and their properties; I.C. engine systems - fuel, cooling, lubrication, ignition, electrical, intake and exhaust; selection, operation, maintenance and repair of I.C. engines; power efficiencies and measurement; calculation of power, torque, fuel consumption, heat load and power losses.

Tractors and power tillers - type, selection, maintenance and repair; tractor clutches and brakes; power transmission systems - gear trains, differential, final drives and power take-off; mechanics of tractor chassis; traction theory; three point hitches- free link and restrained link operations; mechanical steering and hydraulic control systems used in tractors; human engineering and safety in tractor design; tractor tests and performance.

SOIL AND WATER CONSERVATION ENGINEERING:

Ideal and real fluids, properties of fluids; hydrostatic pressure and its measurement; hydrostatic forces on plane and curved surface; continuity equation; Bernoulli's theorem; laminar and turbulent flow in pipes, Darcy-Weisbach and Hazen-Williams equations, Moody's diagram; flow through orifices and notches; flow in open channels.

Engineering properties of soils, fundamental definitions and relationships; index properties of soils; permeability and seepage analysis; shear strength, Mohr's circle of stresses; active and passive earth pressures; stability of slopes.

Hydrological cycle; precipitation measurement, analysis of precipitation data; abstraction from precipitation; runoff; hydrograph analysis, unit hydrograph theory and application; stream flow measurement; flood routing, hydrological reservoir and channel routing.

Mechanics of soil erosion, factors affecting erosion; soil loss estimation; biological and engineering measures to control erosion, terraces and bunds; vegetative waterways; gully control structures, drop, drop inlet and chute spillways; farm ponds; earthen dams; principles of watershed management.

Water requirement of crops; consumptive use and evapo-transpiration; irrigation scheduling; irrigation efficiencies; design of prismatic and silt loaded channels; methods of irrigation water application; design and evaluation of irrigation methods; drainage coefficient; surface and subsurface drainage systems; leaching requirement and salinity control; irrigation and drainage water quality; classification of pumps; pump characteristics; pump selection; types of aquifer; evaluation of aquifer properties; well hydraulics; ground water recharge.

AGRICULTURAL PROCESSING AND FOOD ENGINEERING:

Steady state heat transfer in conduction, convection and radiation; transient heat transfer in simple geometry; condensation and boiling heat transfer; working principles of heat exchangers; diffusive and convective mass transfer; simultaneous heat and mass transfer in agricultural processing operations.

Material and energy balances in food processing systems; water activity, sorption and desorption isotherms; centrifugal separation of solids, liquids and gases; kinetics of microbial death - pasteurisation and sterilization of liquid foods; preservation of food by cooling and freezing; psychrometry - properties of air-vapour mixture; concentration and dehydration of liquid foods - evaporators, tray, drum and spray dryers.

Mechanics and energy requirement in size reduction of granular solids; particle size analysis for comminuted solids; size separation by screening; fluidisation of granular solids; cleaning and grading efficiency and effectiveness of grain cleaners; conditioning and hydrothermal treatments for grains; dehydration of food grains; processes and machines for processing of cereals, pulses and oilseeds; design considerations for grain silos.

AR - ARCHITECTURE AND PLANNING

City planning: Historical development of cities; principles of city planning; new towns; survey methods, site planning, planning regulations and building bye-laws.

Housing: Concept of shelter; housing policies and design; community planning; role of government agencies; finance and management.

Landscape Design: Principles of landscape design and site planning; history and landscape styles; landscape elements and materials; planting design.

Computer Aided Design: Application of computers in architecture and planning; understanding elements of hardware and software; computer graphics; programming languages - C and Visual Basic and usage of packages such as AutoCAD.

Environmental and Building Science: Elements of environmental science; ecological principles concerning environment; role of micro-climate in design; climatic control through design elements; thermal comfort; elements of solar architecture; principles of lighting and illumination; basic principles of architectural acoustics; air pollution, noise pollution and their control.

Visual and Urban Design: Principles of visual composition; proportion, scale, rhythm, symmetry, harmony, balance, form and colour; sense of place and space, division of space; focal point, vista, imageability, visual survey.

History of Architecture: Indian - Indus valley, Vedic, Buddhist, Indo-Aryan, Dravidian and Mughal periods; European - Egyptian, Greek, Roman, medieval and renaissance periods.

Development of Contemporary Architecture: Architectural developments and impacts on society since industrial revolution; influence of modern art on architecture; works of national and international architects; post modernism in architecture.

Building Services: Water supply, Sewerage and Drainage systems; Sanitary fittings and fixtures; principles of electrification of buildings; elevators, their standards and uses; air-conditioning systems; fire fighting systems.

Building Construction and Management: Building construction techniques, methods and details; building systems and prefabrication of building elements; principles of modular coordination; estimation, specification, valuation, professional practice; project management, PERT, CPM.

Materials and Structural Systems: Behavioural characteristics of all types of building materials e.g. mud, timber, bamboo, brick, concrete, steel, glass, FRP; principles of strength of materials; design of structural elements in wood, steel and RCC; elastic and limit state design; complex structural systems; principles of pre-stressing.

Planning Theory: Planning process; multilevel planning; comprehensive planning; central place theory; settlement pattern; land use and land utilization.

Techniques of Planning: Planning surveys; Preparation of urban and regional structure plans, development plans, action plans; site planning principles and design; statistical methods; application of remote sensing techniques in urban and regional planning.

Traffic and Transportation Planning: Principles of traffic engineering and transportation planning; methods of conducting surveys; design of roads, intersections and parking areas; hierarchy of roads and levels of services; traffic and transport management in urban areas; traffic safety and traffic laws; public transportation planning; modes of transportation.

Services and Amenities: Principles and design of water supply systems, sewerage systems, solid waste disposal systems, power supply and communication systems; Health, education, recreation and demography related standards at various levels of the settlements.

Development Administration and Management: Planning laws; development control and zoning regulations; laws relating to land acquisition; development enforcements, land ceiling; regional and urban plan preparations; planning and municipal administration; taxation, revenue resources and fiscal management; public participation and role of NGO.

CE - CIVIL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

STRUCTURAL ENGINEERING

Mechanics: Bending moments and shear forces in statically determinate beams; simple stress and strain: relationship; stress and strain in two dimensions, principal stresses, stress transformation, Mohr's circle; simple bending theory; flexural shear stress; thin-walled pressure vessels; uniform torsion.

Structural Analysis: Analysis of statically determinate trusses, arches and frames; displacements in statically determinate structures and analysis of statically indeterminate structures by force/energy methods; analysis by displacement methods (slope-deflection and moment-distribution methods); influence lines for determinate and indeterminate structures; basic concepts of matrix methods of structural analysis.

Concrete Structures: Basic working stress and limit states design concepts; analysis of ultimate load capacity and design of members subject to flexure, shear, compression and torsion (beams, columns and isolated footings); basic elements of prestressed concrete: analysis of beam sections at transfer and service loads.

Steel Structures: Analysis and design of tension and compression members, beams and beam-columns, column bases; connections - simple and eccentric, beam-column connections, plate girders and trusses; plastic analysis of beams and frames.

GEOTECHNICAL ENGINEERING

Soil Mechanics: Origin of soils; soil classification; three-phase system, fundamental definitions, relationship and inter-relationships; permeability and seepage; effective stress principle: consolidation, compaction; shear strength.

Foundation Engineering: Sub-surface investigation - scope, drilling bore holes, sampling, penetrometer tests, plate load test; earth pressure theories, effect of water table, layered soils; stability of slopes - infinite slopes, finite slopes; foundation types - foundation design requirements; shallow foundations; bearing capacity, effect of shape, water table and other factors, stress distribution, settlement analysis in sands and clays; deep foundations - pile types, dynamic and static formulae, load capacity of piles in sands and clays.

WATER RESOURCES ENGINEERING

Fluid Mechanics and Hydraulics: Hydrostatics, applications of Bernoulli equation, laminar and turbulent flow in pipes, pipe networks; concept of boundary layer and its growth; uniform flow, critical flow and gradually varied flow in channels, specific energy concept, hydraulic jump; forces on immersed bodies; flow measurement in channels; tanks and pipes; dimensional analysis and hydraulic modeling. Applications of momentum equation, potential flow, kinematics of flow; velocity triangles and specific speed of pumps and turbines.

Hydrology: Hydrologic cycle; rainfall; evaporation infiltration, unit hydrographs, flood estimation, reservoir design, reservoir and channel routing, well hydraulics.

Irrigation: Duty, delta, estimation of evapo-transpiration; crop water requirements; design of lined and unlined canals; waterways; head works, gravity dams and Ogee spillways. Designs of weirs on permeable foundation, irrigation methods.

ENVIRONMENTAL ENGINEERING

Water requirements; quality and standards, basic unit processes and operations for water treatment, distribution of water. Sewage and sewerage treatment: quantity and characteristic of waste water sewerage; primary and secondary treatment of waste water; sludge disposal; effluent discharge standards.

TRANSPORTATION ENGINEERING

Highway planning; geometric design of highways; testing and specifications of paving materials; design of flexible and rigid pavements.

CH - CHEMICAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

CHEMICAL ENGINEERING

Process Calculations and Thermodynamics: Laws of conservation of mass and energy; use of tie components; recycle, bypass and purge calculations; degree of freedom analysis.

First and Second laws of thermodynamics and their applications; equations of state and thermodynamic properties of real systems; phase equilibria; fugacity, excess properties and correlations of activity coefficients; chemical reaction equilibria.

Fluid Mechanics and Mechanical Operations: Fluid statics, Newtonian and non-Newtonian fluids, Bernoulli equation, Macroscopic friction factors, energy balance, dimensional analysis, shell balances, flow through pipeline systems, flow meters, pumps and compressors, packed and fluidized beds, elementary boundary layer theory, size reduction and size separation; free and hindered settling; centrifuge and cyclones; thickening and classification, filtration, mixing and agitation; conveying of solids.

Heat Transfer: Conduction, convection and radiation, heat transfer coefficients, steady and unsteady heat conduction, boiling, condensation and evaporation; types of heat exchangers and evaporators and their design.

Mass Transfer: Fick's law, molecular diffusion in fluids, mass transfer coefficients, film, penetration and surface renewal theories; momentum, heat and mass transfer analogies; stagewise and continuous contacting and stage efficiencies; HTU & NTU concepts design and operation of equipment for distillation, absorption, leaching, liquid-liquid extraction, crystallization, drying, humidification, dehumidification and adsorption.

Chemical Reaction Engineering: Theories of reaction rates; kinetics of homogeneous reactions, interpretation of kinetic data, single and multiple reactions in ideal reactors, non-ideal reactors; residence time; non-isothermal reactors; kinetics of heterogeneous catalytic reactions; diffusion effects in catalysis.

Instrumentation and Process Control: Measurement of process variables; sensors, transducers and their dynamics, dynamics of simple systems, dynamics such as CSTRs, transfer functions and responses of simple systems, process reaction curve, controller modes (P, PI, and PID); control valves; analysis of closed loop systems including stability, frequency response (including Bode plots) and controller tuning, cascade, feed forward control.

Plant Design and Economics: Design and sizing of chemical engineering equipment such as compressors, heat exchangers, multistage contactors; principles of process economics and cost estimation including total annualized cost, cost indexes, rate of return, payback period, discounted cash flow, optimization in Design.

Chemical Technology: Inorganic chemical industries; sulfuric acid, NaOH, fertilizers (Ammonia, Urea, SSP and TSP); natural products industries (Pulp and Paper, Sugar, Oil, and Fats); petroleum refining and petrochemicals; polymerization industries; polyethylene, polypropylene, PVC and polyester synthetic fibers.

CS - COMPUTER SCIENCE AND ENGINEERING

ENGINEERING MATHEMATICS

Mathematical Logic: Propositional Logic; First Order Logic.

Probability: Conditional Probability; Mean, Median, Mode and Standard Deviation; Random Variables; Distributions; uniform, normal, exponential, Poisson, Binomial.

Set Theory & Algebra: Sets; Relations; Functions; Groups; Partial Orders; Lattice; Boolean Algebra.

Combinatorics: Permutations; Combinations; Counting; Summation; generating functions; recurrence relations; asymptotics.

Graph Theory: Connectivity; spanning trees; Cut vertices & edges; covering; matching; independent sets; Colouring; Planarity; Isomorphism.

Linear Algebra: Algebra of matrices, determinants, systems of linear equations, Eigen values and Eigen vectors.

Numerical Methods: LU decomposition for systems of linear equations; numerical solutions of non linear algebraic equations by Secant, Bisection and Newton-Raphson Methods; Numerical integration by trapezoidal and Simpson's rules.

Calculus: Limit, Continuity & differentiability, Mean value Theorems, Theorems of integral calculus, evaluation of definite & improper integrals, Partial derivatives, Total derivatives, maxima & minima.

THEORY OF COMPUTATION

Formal Languages and Automata Theory: Regular languages and finite automata, Context free languages and Push-down automata, Recursively enumerable sets and Turing machines, Un-decidability;

Analysis of Algorithms and Computational Complexity: Asymptotic analysis (best, worst, average case) of time and space, Upper and lower bounds on the complexity of specific problems, NP-completeness.

COMPUTER HARDWARE

Digital Logic: Logic functions, Minimization, Design and synthesis of Combinational and Sequential circuits; Number representation and Computer Arithmetic (fixed and floating point);

Computer Organization: Machine instructions and addressing modes, ALU and Data-path, hardwired and micro-programmed control, Memory interface, I/O interface (Interrupt and DMA mode), Serial communication interface, Instruction pipelining, Cache, main and secondary storage.

SOFTWARE SYSTEMS

Data structures: Notion of abstract data types, Stack, Queue, List, Set, String, Tree, Binary search tree, Heap, Graph;

Programming Methodology: C programming, Program control (iteration, recursion, Functions), Scope, Binding, Parameter passing, Elementary concepts of Object oriented, Functional and Logic Programming;

Algorithms for problem solving: Tree and graph traversals, Connected components, Spanning trees, Shortest paths; Hashing, Sorting, Searching; Design techniques (Greedy, Dynamic Programming, Divide-and-conquer);

Compiler Design: Lexical analysis, Parsing, Syntax directed translation, Runtime environment, Code generation, Linking (static and dynamic); Operating Systems: Classical concepts (concurrency, synchronization, deadlock), Processes, threads and Inter-process communication, CPU scheduling, Memory management, File systems, I/O systems, Protection and security.

Databases: Relational model (ER-model, relational algebra, tuple calculus), Database design (integrity constraints, normal forms), Query languages (SQL), File structures (sequential files, indexing, B+ trees), Transactions and concurrency control;

Computer Networks: ISO/OSI stack, sliding window protocol, LAN Technologies (Ethernet, Token ring), TCP/UDP, IP, Basic concepts of switches, gateways, and routers.

CH - CHEMISTRY

PHYSICAL CHEMISTRY

Structure: Quantum theory - principles and techniques; applications to particle in a box, harmonic oscillator, rigid rotor and hydrogen atom; valence bond and molecular orbital theories and Huckel approximation, approximate techniques: variation and perturbation; symmetry, point groups; rotational, vibrational, electronic, NMR and ESR spectroscopy.

Equilibrium: First law of thermodynamics, heat, energy and work; second law of thermodynamics and entropy; third law and absolute entropy; free energy; partial molar quantities; ideal and non-ideal solutions; phase transformation: phase rule and phase diagrams- one, two, and three component systems; activity, activity coefficient, fugacity and fugacity coefficient ; chemical equilibrium, response of chemical equilibrium to temperature and pressure; colligative properties; kinetic theory of gases; thermodynamics of electrochemical cells; standard electrode potentials: applications - corrosion and energy conversion; molecular partition function (translational, rotational, vibrational and electronic).

Kinetics: Rates of chemical reactions, theories of reaction rates, collision and transition state theory; temperature dependence of chemical reactions; elementary reactions, consecutive elementary reactions; steady state approximation, kinetics of photochemical reactions and free radical polymerization, homogenous and heterogeneous catalysis.

INORGANIC CHEMISTRY

Non-Transition Elements: General characteristics, structure and reactions of simple and industrially important compounds, boranes, carboranes, silicates, silicones, diamond and graphite; hydrides, oxides and oxoacids of N, P, S and halogens; boron nitride, borazines and phosphazenes; xenon compounds. Shapes of molecules, hard-soft acid base concept.

Transition Elements: General characteristics of d and f block elements; coordination chemistry: structure and isomerism, stability, theories of metal-ligand bonding (CFT and LFT), electronic spectra and magnetic properties of transition metal complexes and lanthanides; metal carbonyls, metal-metal bonds and metal atom clusters, metallocenes; transition metal complexes with bonds to hydrogen, alkyls, alkenes, and arenes; metal carbenes; use of organometallic compounds as catalysts in organic synthesis; mechanisms of substitution and electron transfer reactions of coordination complexes. Role of metals with special reference to Na, K, Mg, Ca, Fe, Co, Zn, and Mo in biological systems.

Solids: Crystal systems and lattices, Miller planes, crystal packing, crystal defects; Bragg's Law; ionic crystals, band theory, metals and semiconductors. Spinels.

Instrumental methods of analysis: atomic absorption, UV-visible spectrometry, chromatographic and electro-analytical methods.

ORGANIC CHEMISTRY

Synthesis, reactions and mechanisms involving the following: Alkenes, alkynes, arenes, alcohols, phenols, aldehydes, ketones, carboxylic acids and their derivatives; halides, nitro compounds and amines; stereochemical and conformational effects on reactivity and specificity; reactions with diborane and peracids. Michael reaction, Robinson annulation, reactivity umpolung, acyl anion equivalents; molecular rearrangements involving electron deficient atoms.

Photochemistry: Basic principles, photochemistry of olefins, carbonyl compounds, arenes, photo oxidation and reduction.

Pericyclic reactions: Cycloadditions, electrocyclic reactions, sigmatropic reactions; Woodward-Hoffmann rules.

Heterocycles: Structural properties and reactions of furan, pyrrole, thiophene, pyridine, indole.

Biomolecules: Structure, properties and reactions of mono- and di-saccharides, physico-chemical properties of amino acids, structural features of proteins and nucleic acids.

Spectroscopy: Principles and applications of IR, UV-visible, NMR and mass spectrometry in the determination of structures of organic compounds.

EC - ELECTRONICS AND COMMUNICATION ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix Algebra, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Mean value theorems, Theorems of integral calculus, Evaluation of definite and improper integrals, Partial Derivatives, Maxima and minima, Multiple integrals, Fourier series. Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equation (linear and nonlinear), Higher order linear differential equations with constant coefficients, Method of variation of parameters, Cauchy's and Euler's equations, Initial and boundary value problems, Partial Differential Equations and variable separable method.

Complex variables: Analytic functions, Cauchy's integral theorem and integral formula, Taylor's and Laurent' series, Residue theorem, solution integrals.

Probability and Statistics: Sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Discrete and continuous distributions, Poisson, Normal and Binomial distribution, Correlation and regression analysis.

Numerical Methods: Solutions of non-linear algebraic equations, single and multi-step methods for differential equations.

Transform Theory: Fourier transform, Laplace transform, Z-transform.

ELECTRONICS & COMMUNICATION ENGINEERING

Networks: Network graphs: matrices associated with graphs; incidence, fundamental cut set and fundamental circuit matrices. Solution methods: nodal and mesh analysis. Network theorems: superposition, Thevenin and Norton's maximum power transfer, Wye-Delta transformation. Steady state sinusoidal analysis using phasors. Linear constant coefficient differential equations; time domain analysis of simple RLC circuits, Solution of network equations using Laplace transform: frequency domain analysis of RLC circuits. 2-port network parameters: driving point and transfer functions. State equations for networks.

Electronic Devices: Energy bands in silicon, intrinsic and extrinsic silicon. Carrier transport in silicon: diffusion current, drift current, mobility, resistivity. Generation and recombination of carriers. p-n junction diode, Zener diode, tunnel diode, BJT, JFET, MOS capacitor, MOSFET, LED, p-I-n and avalanche photo diode, LASERs. Device technology: integrated circuits fabrication process, oxidation, diffusion, ion implantation, photolithography, n-tub, p-tub and twin-tub CMOS process.

Analog Circuits: Equivalent circuits (large and small-signal) of diodes, BJTs, JFETs, and MOSFETs. Simple diode circuits, clipping, clamping, rectifier. Biasing and bias stability of transistor and FET amplifiers. Amplifiers: single-and multi-stage, differential, operational, feedback and power. Analysis of amplifiers; frequency response of amplifiers. Simple op-amp circuits. Filters. Sinusoidal oscillators; criterion for oscillation; single-transistor and op-amp configurations. Function generators and wave-shaping circuits. Power supplies.

Digital circuits: Boolean algebra, minimization of Boolean functions; logic gates digital IC families (DTL, TTL, ECL, MOS, CMOS). Combinational circuits: arithmetic circuits, code converters, multiplexers and decoders. Sequential circuits: latches and flip-flops, counters and shift-registers. Sample and hold circuits, ADCs, DACs. Semiconductor memories. Microprocessor(8085): architecture, programming, memory and I/O interfacing.

Signals and Systems: Definitions and properties of Laplace transform, continuous-time and discrete-time Fourier series, continuous-time and discrete-time Fourier Transform, z-transform. Sampling theorems. Linear Time-Invariant (LTI) Systems: definitions and properties; casuality, stability, impulse response, convolution, poles and zeros frequency response, group delay, phase delay. Signal transmission through LTI systems. Random signals and noise: probability, random variables, probability density function, autocorrelation, power spectral density.

Controls Systems: Basic control system components; block diagrammatic description, reduction of block diagrams. Open loop and closed loop (feedback) systems and stability analysis of these systems. Signal flow graphs and their use in determining transfer functions of systems; transient and steady state analysis of LTI control systems and frequency response. Tools and techniques for LTI control system analysis: root loci, Routh-Hurwitz criterion, Bode and Nyquist plots. Control system compensators: elements of lead and lag compensation, elements of Proportional-Integral-Derivative(PID) control. State variable representation and solution of state equation of LTI control systems.

Communications: Analog communication systems: amplitude and angle modulation and demodulation systems, spectral analysis of these operations, superheterodyne receivers; elements of hardware, realizations of analog communication systems; signal-to-noise ratio (SNR) calculations for amplitude modulation (AM) and frequency modulation (FM) for low noise conditions. Digital communication systems: pulse code modulation (PCM), differential pulse code modulation (DPCM), delta modulation (DM); digital modulation schemes-amplitude, phase and frequency shift keying schemes (ASK, PSK, FSK), matched filter receivers, bandwith consideration and probability of error calculations for these schemes.

Electromagnetics: Elements of vector calculus: divergence and curl; Gauss' and Stokes' theorems, Maxwell's equations: differential and integral forms. Wave equation, Poynting vector. Plane waves: propagation through various media; reflection and refraction; phase and group velocity; skin depth. Transmission lines: characteristic impedance; impedance transformation; Smith chart; impedance matching; pulse excitation. Waveguides: modes in rectangular waveguides; boundary conditions; cut-off frequencies; dispersion relations. Antennas: Dipole antennas; antenna arrays; radiation pattern; reciprocity theorem, antenna gain.

EE - ELECTRICAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix Algebra, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Mean value theorems, Theorems of integral calculus, Evaluation of definite and improper integrals, Partial Derivatives, Maxima and minima, Multiple integrals, Fourier series. Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equation (linear and nonlinear), Higher order linear differential equations with constant coefficients, Method of variation of parameters, Cauchy's and Euler's equations, Initial and boundary value problems, Partial Differential Equations and variable separable method.

Complex variables: Analytic functions, Cauchy's integral theorem and integral formula, Taylor's and Laurent' series, Residue theorem, solution integrals.

Probability and Statistics: Sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Discrete and continuous distributions, Poisson, Normal and Binomial distribution, Correlation and regression analysis.

Numerical Methods: Solutions of non-linear algebraic equations, single and multi-step methods for differential equations.

Transform Theory: Fourier transform, Laplace transform, Z-transform.

ELECTRICAL ENGINEERING

Electrical Circuits and Fields: Network graph, KCL, KVL, node/ cut set, mesh/ tie set analysis, transient response of d.c. and a.c. networks; sinusoidal steady-state analysis; resonance in electrical circuits; concepts of ideal voltage and current sources, network theorems, driving point, immittance and transfer functions of two port networks, elementary concepts of filters; three phase circuits; Fourier series and its application; Gauss theorem, electric field intensity and potential due to point, line, plane and spherical charge distribution, dielectrics, capacitance calculations for simple configurations; Ampere's and Biot-Savart's law, inductance calculations for simple configurations.

Electrical Machines: Single phase transformer - equivalent circuit, phasor diagram, tests, regulation and efficiency; three phase transformers - connections, parallel operation; auto transformer and three-winding transformer; principles of energy conversion, windings of rotating machines: D. C. generators and motors - characteristics, starting and speed control, armature reaction and commutation; three phase induction motors-performance characteristics, starting and speed control; single-phase induction motors; synchronous generators-performance, regulation, parallel operation; synchronous motors - starting, characteristics, applications, synchronous condensers; fractional horse power motors; permanent magnet and stepper motors.

Power Systems: Electric power generation - thermal, hydro, nuclear; transmission line parameters; steady-state performance of overhead transmission lines and cables and surge propagation; distribution systems, insulators, bundle conductors, corona and radio interference effects; per-unit quantities; bus admittance and impedance matrices; load flow; voltage control and power factor correction; economic operation; symmetrical components, analysis of symmetrical and unsymmetrical faults; principles of over current, differential and distance protections; concept of solid state relays and digital protection; circuit breakers; concept of system stability-swing curves and equal area criterion; basic concepts of HVDC transmission.

Control Systems: Principles of feedback; transfer function; block diagrams: steady-state errors; stability-Routh and Nyquist criteria; Bode plots; compensation; root loci; elementary state variable formulation; state transition matrix and response for Linear Time Invariant systems.

Electrical and Electronic Measurements: Bridges and potentiometers, PMMC, moving iron, dynamometer and induction type instruments; measurement of voltage, current, power, energy and power factor; instrument transformers; digital voltmeters and multimeters; phase, time and frequency measurement; Q-meter, oscilloscopes, potentiometric recorders, error analysis.

Analog and Digital Electronics: Characteristics of diodes, BJT, FET, SCR; amplifiers-biasing, equivalent circuit and frequency response; oscillators and feedback amplifiers, operational amplifiers- characteristics and applications; simple active filters; VCOs and timers; combinational and sequential logic circuits, multiplexer, Schmitt trigger, multivibrators, sample and hold circuits, A/D and D/A converters; microprocessors and their applications.

Power Electronics and Electric Drives: Semiconductor power devices-diodes, transistors, thyristors, triacs, GTOs, MOSFETs and IGBTs - static characteristics and principles of operation; triggering circuits; phase control rectifiers; bridge converters-fully controlled and half controlled; principles of choppers and inverters, basic concepts of adjustable speed dc and ac drives.

GG - GEOLOGY AND GEOPHYSICS

PART - I

Earth and planetary system; size, shape, internal structure and composition of the earth;

atmosphere and greenhouse effect; isostasy; elements of seismology; continents and continental processes; physical oceanography; palaeomagnetism, continental drift plate tectonics, geothermal energy.

Weathering; soil formation; action of river, wind and glacier; oceans and oceanic features; earthquakes, volcanoes, orogeny and mountain building; elements of structural geology; crystallography; classification, composition and properties of minerals and rocks; engineering properties of rocks and soils, role of geology in the construction of engineering structures.

Processes of ore formation, occurrence and distribution of ores on land and on ocean floor; coal and petroleum resources in India; ground water geology including well hydraulics, geological time scale and geochronology; stratigraphic principles and stratigraphy of India; basics concepts of gravity, magnetic and electrical prospecting for ores and ground water.

PART - IIA: GEOLOGY

Crystal symmetry, forms, twinning; crystal chemistry; optical mineralogy, classification of minerals, diagnostic properties of rock minerals.

Mineralogy, structure, texture and classification of igneous, sedimentary and metamorphic rock, their origin and evolution; application of thermodynamics; structure and petrology of sedimentary rocks; sedimentary processes and environments, sedimentary facies, basin studies; basement cover relationship;

Primary and secondary structures; geometry and genesis of folds, faults, joints, unconformities, cleavage, schistosity and lineation; methods of projection. Tectonites and their significance; shear zone; superposed folding.

Morphology, classification and geological significance of important invertebrates, vertebrates, microfossils and palaeoflora; stratigraphic principles and Indian stratigraphy; geomorphic processes and agents; development and evolution of landforms; slope and drainage; processes on deep oceanic and near-shore regions; quantitative and applied geomorphology; air photo interpretation and remote sensing; chemical and optical properties of ore minerals; formation and localization of ore deposits; prospecting and exploration of economic minerals; coal and petroleum geology; origin and distribution of mineral and fuel deposits in India; ore dressing and mineral economics.

Cosmic abundance; meteorites; geochemical evolution of the earth; geochemical cycles; distribution of major, minor and trace elements; isotope geochemistry; geochemistry of waters including solution equilibria and water rock interaction.

Engineering properties of rocks and soils; rocks as construction material; geology of dams, tunnels and excavation sites; natural hazards; the fly ash problem; ground water geology and exploration; water quality; impact of human activity; Remote sensing techniques for the interpretation of landforms and resource management.

PART - II B: GEOPHYSICS

The earth as a planet; different motions of the earth; gravity filed of the earth and its shape; geochronology; isostasy, seismology and interior of the earth; variation of density, velocity, pressure, temperature, electrical and magnetic properties inside the earth; earthquakes-causes and measurements; zonation and seismic hazards; geomagnetic field, palaeomagnetism; oceanic and continental lithosphere; plate tectonics; heat flow; upper and lower atmospheric phenomena.

Theories of scalar and vector potential fields; Laplace, Maxwell and Helmholtz equations for solution of different types of boundary value problems for Cartesian, cylindrical and spherical polar coordinates; Green's theorem; Image theory; integral equations and conformal transformations in potential theory; Eikonal equation and ray theory.

'G' and 'g' units of measurement, density of rocks, gravimeters, preparation, analysis and interpretation of gravity maps; derivative maps, analytical continuation; gravity anomaly type curves; calculation of mass.

Earth's magnetic field, units of measurement, magnetic susceptibility of rocks, magnetometers, corrections, preparation of magnetic maps, magnetic anomaly type curve, analytical continuation, interpretation and application; magnetic well logging.

Conduction of electricity through rocks, electrical conductivities of metals, metallic, non-metallic and rock forming minerals, D.C. resistivity units and methods of measurement, electrode configuration for sounding and profiling, application of filter theory, interpretation of resistivity field data, application; self potential origin, classification, field measurement, interpretation of induced polarization time frequency, phase domain; IP units and methods of measurement, interpretation and application; ground-water exploration.

Origin of electromagnetic field elliptic polarization, methods of measurement for different source-receiver configuration components in EM measurements, interpretation and applications; earth's natural electromagnetic field, tellurics, magneto-tellurics; geomagnetic depth sounding principles, methods of measurement, processing of data and interpretation.

Seismic methods of prospecting: Reflection, refraction and CDP surveys; land and marine seismic sources, generation and propagation of elastic waves, velocity increasing with depth, geophones, hydrophones, recording instruments (DFS), digital formats, field layouts, seismic noises and noise profile analysis, optimum geophone grouping, noise cancellation by shot and geophone arrays, 2D and 3D seismic data acquisition and processing, CDP stacking charts, binning, filtering, dip-moveout, static and dynamic corrections, deconvolution, migration, signal processing, Fourier and Hilbert transforms, attribute analysis, bright and dim spots, seismic stratigraphy, high resolution seismics, VSP.

Principles and techniques of geophysical well-logging, SP, resistivity, induction, micro gamma ray, neutron, density, sonic, temperature, dip meter, caliper, nuclear magnetic, cement bond logging. Quantitative evaluation of formations from well logs; well hydraulics and application of geophysical methods for groundwater study; application of bore hole geophysics in ground water, mineral and oil exploration. Remote sensing techniques and application of remote sensing methods in geophysics.

IN - INSTRUMENTATION ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix Algebra, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Mean value theorems, Theorems of integral calculus, Evaluation of definite and improper integrals, Partial Derivatives, Maxima and minima, Multiple integrals, Fourier series. Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equation (linear and nonlinear), Higher order linear differential equations with constant coefficients, Method of variation of parameters, Cauchy's and Euler's equations, Initial and boundary value problems, Partial Differential Equations and variable separable method.

Complex variables: Analytic functions, Cauchy's integral theorem and integral formula, Taylor's and Laurent' series, Residue theorem, solution integrals.

Probability and Statistics: Sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Discrete and continuous distributions, Poisson, Normal and Binomial distribution, Correlation and regression analysis.

Numerical Methods: Solutions of non-linear algebraic equations, single and multi-step methods for differential equations.

Transform Theory: Fourier transform, Laplace transform, Z-transform.

INSTRUMENTATION ENGINEERING

Measurement Basics and Metrology: Static and dynamic characteristics of measurement systems. Standards and calibration. Error and uncertainty analysis, statistical analysis of data, and curve fitting. Linear and angular measurements; Measurement of straightness, flatness, roundness and roughness.

Transducers, Mechanical Measurements and Industrial Instrumentation: Transducers - elastic, resistive, inductive, capacitive, thermo-electric, piezoelectric, photoelectric, electro-mechanical, electro-chemical, and ultrasonic. Measurement of displacement, velocity (linear and rotational), acceleration, shock, vibration, force, torque, power, strain, stress, pressure, flow, temperature, humidity, viscosity, and density. energy storing elements, suspension systems and dampers.

Analog Electronics: Characteristics of diodes, BJTs, JFETs and MOSFETs; Diode circuits; Amplifiers: single and multi-stage, feedback; Frequency response; Operational amplifiers - design, characteristic, linear and non-linear applications: difference amplifiers; instrumentation amplifiers; precision rectifiers, I-to-V converters, active filters, oscillators, comparators, signal generators, wave shaping circuits.

Digital Electronics: Combinational logic circuits, minimization of Boolean functions; IC families (TTL, MOS, CMOS), arithmetic circuits, multiplexer and decoders. Sequential circuits: flip-flops, counters, shift registers. Schmitt trigger, timers, and multivibrators. Analog switches, multiplexers, S/H circuits. Analog-to-digital and digital-to-analog converters. Basics of computer organization and architecture. 8-bit microprocessor (8085), applications, memory, I/O interfacing, and microcontrollers.

Signals and Systems: Vectors and matrices; Fourier series; Fourier transforms; Ordinary differential equations. Impulse and frequency responses of first and second order systems. Laplace transform and transfer function, convolution and correlation. Amplitude and frequency modulations and demodulations. Discrete time systems, difference equations, impulse and frequency responses; Z-transforms and transfer functions; IIR and FIR filters.

Electrical and Electronic Measurements: Measurement of R, L and C; bridges and potentiometers. Measurement of voltage, current, power, power factor, and energy; Instrument transformers; Q meter, waveform analyzers. Digital volt-meters and multi-meters. Time, phase and frequency measurements; Oscilloscope. Noise and interference in instrumentation.

Control Systems & Process Control: Principles of feedback; transfer function, signal flow graphs. Stability criteria, Bode plots, root-loci, Routh and Nyquist criteria. Compensation techniques; State space analysis. System components: mechanical, hydraulic, pneumatic, electrical and electronic; Servos and synchros; Stepper motors. On-off, cascade, P, PI, PID and feed-forward controls. Controller tuning and general frequency response.

Analytical, Optical and Biomedical Instrumentation: Principles of spectrometry, UV, visible, IR mass spectrometry, X-ray methods; nuclear radiation measurements, gas, solid and semi conductor lasers and their characteristics, interferometers, basics of fibre optics, transducers in biomedical applications, cardiovascular system measurements, instrumentation for clinical laboratory.

MA - MATHEMATICS

Linear Algebra: Finite dimensional vector spaces. Linear transformations and their matrix representations, rank; systems of linear equations, eigenvalues and eigenvectors, minimal polynomial, Cayley-Hamilton theorem, diagonalisation, Hermitian, Skew-Hermitian and unitary matrices. Finite dimensional inner product spaces, self-adjoint and Normal linear operators, spectral theorem, Quadratic forms.

Complex Analysis: Analytic functions, conformal mappings, bilinear transformations, complex integration: Cauchy's integral theorem and formula, Liouville's theorem, maximum modulus principle, Taylor and Laurent's series, residue theorem and applications for evaluating real integrals.

Real Analysis: Sequences and series of functions, uniform convergence, power series, Fourier series, functions of several variables, maxima, minima, multiple integrals, line, surface and volume integrals, theorems of Green, Stokes and Gauss; metric spaces, completeness, Weierstrass approximation theorem, compactness. Lebesgue measure, measurable functions; Lebesgue integral, Fatou's lemma, dominated convergence theorem.

Ordinary Differential Equations: First order ordinary differential equations, existence and uniqueness theorems, systems of linear first order ordinary differential equations, linear ordinary differential equations of higher order with constant coefficients; linear second order ordinary differential equations with variable coefficients, method of Laplace transforms for solving ordinary differential equations, series solutions; Legendre and Bessel functions and their orthogonality, Sturm Liouville system, Greeen's functions.

Algebra: Normal subgroups and homomorphisms theorems, automorphisms. Group actions, sylow's theorems and their applications groups of order less than or equal to 20, Finite p-groups. Euclidean domains, Principal ideal domains and unique factorizations domains. Prime ideals and maximal ideals in commutative rings.

Functional Analysis: Banach spaces, Hahn-Banach theorems, open mapping and closed graph theorems, principle of uniform boundedness; Hilbert spaces, orthonormal sets, Riesz representation theorem, self-adjoint, unitary and normal linear operators on Hilbert Spaces.

Numerical Analysis: Numerical solution of algebraic and transcendental equations; bisection, secant method, Newton-Raphson method, fixed point iteration, interpolation: existence and error of polynomial interpolation, Lagrange, Newton, Hermite(osculatory)interpolations; numerical differentiation and integration, Trapezoidal and Simpson rules; Gaussian quadrature; (Gauss-Legendre and Gauss-Chebyshev), method of undetermined parameters, least square and orthonormal polynomial approximation; numerical solution of systems of linear equations: direct and iterative methods, (Jacobi Gauss-Seidel and SOR) with convergence; matrix eigenvalue problems: Jacobi and Given's methods, numerical solution of ordinary differential equations: initial value problems, Taylor series method, Runge-Kutta methods, predictor-corrector methods; convergence and stability.

Partial Differential Equations: Linear and quasilinear first order partial differential equations, method of characteristics; second order linear equations in two variables and their classification; Cauchy, Dirichlet and Neumann problems, Green's functions; solutions of Laplace, wave and diffusion equations in two variables Fourier series and transform methods of solutions of the above equations and applications to physical problems.

Mechanics: Forces in three dimensions, Poinsot central axis, virtual work, Lagrange's equations for holonomic systems, theory of small oscillations, Hamiltonian equations;

Topology: Basic concepts of topology, product topology, connectedness, compactness, countability and separation axioms, Urysohn's Lemma, Tietze extension theorem, metrization theorems, Tychonoff theorem on compactness of product spaces.

Probability and Statistics: Probability space, conditional probability, Bayes' theorem, independence, Random variables, joint and conditional distributions, standard probability distributions and their properties, expectation, conditional expectation, moments. Weak and strong law of large numbers, central limit theorem. Sampling distributions, UMVU estimators, sufficiency and consistency, maximum likelihood estimators. Testing of hypotheses, Neyman-Pearson tests, monotone likelihood ratio, likelihood ratio tests, standard parametric tests based on normal, X2 ,t, F-distributions. Linear regression and test for linearity of regression. Interval estimation.

Linear Programming: Linear programming problem and its formulation, convex sets their properties, graphical method, basic feasible solution, simplex method, big-M and two phase methods, infeasible and unbounded LPP's, alternate optima. Dual problem and duality theorems, dual simplex method and its application in post optimality analysis, interpretation of dual variables. Balanced and unbalanced transportation problems, unimodular property and u-v method for solving transportation problems. Hungarian method for solving assignment problems.

Calculus of Variations and Integral Equations: Variational problems with fixed boundaries; sufficient conditions for extremum, Linear integral equations of Fredholm and Volterra type, their iterative solutions. Fredholm alternative.

ME - MECHANICAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

APPLIED MECHANICS AND DESIGN

Engineering Mechanics: Equivalent force systems, free-body concepts, equations of equilibrium, trusses and frames, virtual work and minimum potential energy. Kinematics and dynamics of particles and rigid bodies, impulse and momentum (linear and angular), energy methods, central force motion.

Strength of Materials: Stress and strain, stress-strain relationship and elastic constants, Mohr's circle for plane stress and plane strain, shear force and bending moment diagrams, bending and shear stresses, deflection of beams, torsion of circular shafts, thin and thick cylinders, Euler's theory of columns, strain energy methods, thermal stresses.

Theory of Machines: Displacement, velocity and acceleration, analysis of plane mechanisms, dynamic analysis of slider-crank mechanism, planar cams and followers, gear tooth profiles, kinematics of gears, governors and flywheels, balancing of reciprocating and rotating masses.

Vibrations: Free and forced vibration of single degree freedom systems, effect of damping, vibration isolation, resonance, critical speed of rotors.

Design of Machine Elements: Design for static and dynamic loading, failure theories, fatigue strength; design of bolted, riveted and welded joints; design of shafts and keys; design of spur gears, rolling and sliding contact bearings; brakes and clutches; belt, rope and chain drives.

FLUID MECHANICS AND THERMAL SCIENCES

Fluid Mechanics: Fluid properties, fluid statics, manometry, buoyancy; control-volume analysis of mass, momentum and energy; fluid acceleration; differential equations of continuity and momentum; Bernoulli's equation; viscous flow of incompressible fluids; boundary layer; elementary turbulent flow; flow through pipes, head losses in pipes, bends etc.

Heat-Transfer: Modes of heat transfer; one dimensional heat conduction, resistance concept, electrical analogy, unsteady heat conduction, fins; dimensionless parameters in free and forced convective heat transfer, various correlations for heat transfer in flow over flat plates and through pipes; thermal boundary layer; effect of turbulence; radiative heat transfer, black and grey surfaces, shape factors, network analysis; heat exchanger performance, LMTD and NTU methods.

Thermodynamics: Zeroth, First and Second laws of thermodynamics; thermodynamic system and processes; irreversibility and availability; behaviour of ideal and real gases, properties of pure substances, calculation of work and heat in ideal processes; analysis of thermodynamic cycles related to energy conversion; Carnot, Rankine, Otto, Diesel, Brayton and vapour compression cycles.

Power Plant Engineering: Steam generators; steam power cycles; steam turbines; impulse and reaction principles, velocity diagrams, pressure and velocity compounding; reheating and reheat factor; condensers and feed heaters.

I.C. Engines: Requirements and suitability of fuels in IC engines, fuel ratings, fuel-air mixture requirements; normal combustion in SI and CI engines; engine performance calculations.

Refrigeration and air-conditioning: Refrigerant compressors, expansion devices, condensers and evaporators; properties of moist air, psychrometric chart, basic psychometric processes.

Turbomachinery: Components of gas turbines; compression processes, centrifugal and axial flow compressors; axial flow turbines, elementary theory; hydraulic turbines; Euler-turbine equation; specific speed, Pelton-wheel, Francis and Kaplan turbines; centrifugal pumps.

MANUFACTURING AND INDUSTRIAL ENGINEERING

Engineering Materials: Structure and properties of engineering materials and their applications, heat treatment.

Metal Casting: Casting processes (expendable and non-expendable) -pattern, moulds and cores, heating and pouring, solidification and cooling, gating design, design considerations, defects.

Forming Processes: Stress-strain diagrams for ductile and brittle material, Plastic deformation and yield criteria, fundamentals of hot and cold working processes, Bulk metal forming processes (forging, rolling, extrusion, drawing), sheet metal working processes (punching, blanking, bending, deep drawing, coining, spinning, load estimation using homogeneous deformation methods, defects). processing of powder metals- atomization, compaction, sintering, secondary and finishing operations. forming and shaping of plastics- extrusion, injection moulding.

Joining Processes: Physics of welding, fusion and non-fusion welding processes, brazing and soldering, adhesive bonding, design considerations in welding, weld quality defects.

Machining and Machine Tool Operations: Mechanics of machining, single and multi-point cutting tools, tool geometry and materials, tool life and wear, cutting fluids, machinability, economics of machining, non-traditional machining processes.

Metrology and Inspection: Limits, fits and tolerances, linear and angular measurements, comparators, gauge design, interferometry, form and finish measurement, measurement of screw threads, alignment and testing methods.

Tool Engineering: Principles of work holding, design of jigs and fixtures.

Computer Integrated Manufacturing: Basic concepts of CAD, CAM and their integration tools.

Manufacturing Analysis: Part-print analysis, tolerance analysis in manufacturing and assembly, time and cost analysis.

Work-Study: Method study, work measurement, time study, work sampling, job evaluation, merit rating.

Production Planning and Control: Forecasting models, aggregate production planning, master scheduling, materials requirements planning.

Inventory Control: Deterministic and probabilistic models, safety stock inventory control systems.

Operations Research: Linear programming, simplex and duplex method, transportation, assignment, network flow models, simple queuing models, PERT and CPM

MN - MINING ENGINEERING

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

MINING ENGINEERING

Mechanics: Equivalent force systems, equations of equilibrium, two dimensional frames and trusses, free body diagrams, friction forces, particle kinematics and dynamics.

Mine Development, Geomechanics and Strata Control: Drivages for underground mine development, drilling methods and machines, explosives, blasting devices and practices, shaft sinking. Physico-mechanical properties of rocks, rock mass classification, ground control instrumentation and stress measurement techniques, theories of rock failure, ground vibrations, stress distribution around mine openings, subsidence, design of supports in roadways and workings, stability of open pits, slopes.

Mining Methods and Machinery: Surface mining - layout, development, loading, transportation and mechanization, continuous surface mining systems. Underground coal mining - bord and pillar system, longwall mining, thick seam mining methods. Underground metal mining: different stoping methods, stope mechanization, ore handling systems, mine filling. Generation and transmission of mechanical, hydraulic, and pneumatic power. Materials handling - haulages, conveyors, ropeways, face and development machinery, hoisting systems, and pumps.

Ventilation, Underground Hazards and Surface Environment: Underground atmosphere, heat load sources and thermal environment, air cooling, mechanics of air flow distribution, natural and mechanical ventilation, mine fans and their usage, auxiliary ventilation. Subsurface hazards from fires, explosions, gases, dust, and inundation, rescue apparatus and practices, safety in mines, accident analysis, noise, mine lighting. Air and water pollution: causes, dispersion, quality standards, and control.

Surveying, Mine Planning and Systems Engineering: Fundamentals of engineering surveying, Levels and levelling, Theodolite, tacheometry, triangulation, contouring, errors and adjustments, correlation, underground surveying, curves, photogrammetry, field astronomy, GPS fundamentals. Principles of planning - Sampling methods and practices, reserve estimation techniques, basics of geostatistics, optimization of facility location, cash flow concepts and mine valuation, open pit design. Work study, concepts of reliability, reliability of series and parallel systems. Linear programming, transportation and assignment problems, queueing, network analysis, inventory control.

MT - METALLURGICAL ENGINEERING

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

METALLURGICAL ENGINEERING

Thermodynamics and Rate Processes: Laws of thermodynamics, activity, equilibrium constant, applications to metallurgical systems, solutions, phase equilibria, basic kinetic laws, order of reactions, rate constants and rate limiting steps principles of electro chemistry, aqueous, corrosion and protection of metals, oxidation and high temperature corrosion - characterization and control; momentum transfer - concepts of viscosity, shell balances, Bernoulli's equation; heat transfer - conduction, convection and heat transfer coefficient relations, radiation, mass transfer - diffusion and Fick's laws.

Extractive Metallurgy: Flotation, gravity and other methods of mineral processing; agglomeration, pyro-hydro-and electro-metallurgical processes; material and energy balances; principles and processes for the extraction of non-ferrous metals - aluminium, copper, zinc, lead, magnesium, nickel, titanium and other rare metals; iron and steel making - principles, blast furnace, direct reduction processes, primary and secondary steel making, deoxidation and inclusion in steel; ingot and continuous casting; stainless steel making, design of furnaces; fuels and refractories.

Physical Metallurgy: Crystal structure and bonding characteristics of metals, alloys, ceramics and polymers; solid solutions; solidification; phase transformation and binary phase diagrams; principles of heat treatment of steels, aluminum alloys and cast irons; recovery, recrystallization and grain growth; industrially important ferrous and non-ferrous alloys; elements of X-ray and electron diffraction; principles of scanning and transmission electron microscopy; elements of ceramics, composites and electronic materials; electronic basis of thermal, optical, electrical and magnetic properties of materials.

Mechanical Metallurgy: Elements of elasticity and plasticity; defects in crystals; elements of dislocation theory - types of dislocations, slip and twinning, stress fields of dislocations, dislocation interactions and reactions, methods of seeing dislocations; strengthening mechanisms; tensile, fatigue and creep behaviour; superplasticity; fracture - Griffith theory, ductile to brittle transition, fracture toughness; failure analysis; mechanical testing - tension, compression, torsion, hardness, impact, creep, fatigue, fracture toughness and formability tests.

Manufacturing Processes: Metal casting - patterns, moulds, melting, gating, feeding and casting processes, defects and castings, hot and cold working of metals; Metal forming - fundamentals of metal forming, rolling wire drawing, extrusion, forming, sheet metal forming processes, defects in forming; Metal joining - soldering, brazing and welding, common welding processes, welding metallurgy, problems associated with welding of steels and aluminium alloys, defects in welding, powder metallurgy; NDT methods - ultrasonic, radiography, eddy current, acoustic emission and magnetic.

PH - PHYSICS

Mathematical Physics: Linear vector space, matrices; vector calculus; linear differential equations; elements of complex analysis; Laplace transforms, Fourier analysis, elementary ideas about tensors.

Classical Mechanics: Conservation laws; central forces; collisions and scattering in laboratory and centre of mass reference frames; mechanics of system of particles; rigid body dynamics; moment of inertia tensor; noninertial frames and pseudo forces; variational principle; Lagrange's and Hamilton's formalisms; equation of motion, cyclic coordinates, Poisson bracket; periodic motion, small oscillations, normal modes; wave equation and wave propagation; special theory of relativity - Lorentz transformations, relativistic kinematics, mass-energy equivalence.

Electromagnetic Theory: Laplace and Poisson equations; conductors and dielectrics; boundary value problems; Ampere's and Biot-Savart's laws; Faraday's law; Maxwell's equations; scalar and vector potentials; Coulomb and Lorentz gauges; boundary conditions at interfaces; electromagnetic waves; interference, diffraction and polarization; radiation from moving charges.

Quantum Mechanics: Physical basis of quantum mechanics; uncertainty principle; Schrodinger equation; one and three dimensional potential problems; Particle in a box, harmonic oscillator, hydrogen atom; linear vectors and operators in Hilbert space; angular momentum and spin; addition of angular momentum; time independent perturbation theory; elementary scattering theory.

Atomic and Molecular Physics: Spectra of one-and many-electron atoms; LS and jj coupling; hyperfine structure; Zeeman and Stark effects; electric dipole transitions and selection rules; X-ray spectra; rotational and vibrational spectra of diatomic molecules; electronic transition in diatomic molecules, Franck-Condon principle; Raman effect; NMR and ESR; lasers.

Thermodynamics and Statistical Physics: Laws of thermodynamics; macrostates, phase space; probability ensembles; partition function, free energy, calculation of thermodynamic quantities; classical and quantum statistics; degenerate Fermi gas; black body radiation and Planck's distribution law; Bose-Einstein condensation; first and second order phase transitions, critical point.

Solid State Physics: Elements of crystallography; diffraction methods for structure determination; bonding in solids; elastic properties of solids; defects in crystals; lattice vibrations and thermal properties of solids; free electron theory; band theory of solids; metals, semiconductors and insulators; transport properties; optical, dielectric and magnetic properties of solids; elements of superconductivity.

Nuclear and Particle Physics: Rutheford scattering; basic properties of nuclei; radioactive decay; nuclear forces; two nucleon problem; nuclear reactions; conservation laws; fission and fusion; nuclear models; particle accelerators, detectors; elementary particles; photons, baryons, mesons and leptons; Quark model.

Electronics: Network analysis; semiconductor devices; bipolar transistors; FETs; power supplies, amplifier, oscillators; operational amplifiers; elements of digital electronics; logic circuits.

PI - PRODUCTION AND INDUSTRIAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

GENERAL ENGINEERING:

Engineering Materials: Structure and properties of engineering materials and their applications; effect of strain, strain rate and temperature on mechanical properties of metals and alloys; heat treatment of metals and alloys.

Applied Mechanics: Engineering mechanics - equivalent force systems, free body concepts, equations of equilibrium, virtual work and minimum potential energy; strength of materials-stress, strain and their relationship, Mohr's circle, deflection of beams, bending and shear stress, Euler's theory of columns.

Theory of Machines and Design: Analysis of planar mechanisms, plane cams and followers; governers and fly wheels; design of elements-failure theories; design of bolted, riveted and welded joints; design of shafts, keys, belt drives, brakes and clutches.

Thermal Engineering: Fluid machines - fluid statics, Bernoulli's equation, flow through pipes, equations of continuity and momentum; Thermodynamics - zeroth, First and Second laws of thermodynamics, thermodynamic system and processes, calculation of work and heat for systems and control volumes; Heat transfer - fundamentals of conduction, convection and radiation.

PRODUCTION ENGINEERING

Metal Casting: Casting processes; patterns-materials; allowances; moulds and cores - materials, making and testing; melting and founding of cast iron, steels and nonferrous metals and alloys; solidification; design of casting, gating and risering; casting defects and inspection.

Metal working: Stress-strain in elastic and plastic deformation; deformation mechanisms; hot and cold working-forging, rolling, extrusion, wire and tube drawing; sheet metal working; analysis of rolling, forging, extrusion and wire /rod drawing; metal working defects, high energy rate forming processes-explosive, magnetic, electro and electrohydraulic.

Metal Joining Processes: Welding processes - gas shielded metal arc, TIG, MIG, submerged arc, electroslag, thermit, resistance, pressure and forge welding; thermal cutting; other joining processes - soldering, brazing, braze welding; welding codes, welding symbols, design of welded joints, defects and inspection; introduction to modern welding processes - friction, ultrasonic, explosive, electron beam, laser and plasma.

Machining and Machine Tool Operations: Machining processes-turning, drilling, boring, milling, shaping, planing, sawing, gear cutting, thread production, broaching, grinding, lapping, honing super finishing; mechanics of cutting- Merchant's analysis, geometry of cutting tools, cutting forces, power requirements; selection of process parameters; tool materials, tool wear and tool life, cutting fluids, machinability; nontraditional machining processes and hybrid processes- EDM, CHM, ECM, USM, LBM, EBM, AJM, PAM AND WJM; economics of machining.

Metrology and Inspection: Limits and fits, linear and angular measurements by mechanical and optical methods, comparators; design of limit gauges; interferometry; measurement of straightness, flatness, roundness, squareness and symmetry; surface finish measurement; inspection of screw threads and gears; alignment testing.

Powder Metallurgy and Processing of Plastics: Production of powders, compaction, sintering; Polymers and composites; injection, compression and blow molding, extrusion, calendaring and thermoforming; molding of composites.

Tool Engineering: Work-holding-location and clamping; principles and methods; design of jigs and fixtures; design of press working tools, forging dies.

Manufacturing Analysis: Sources of errors in manufacturing; process capability; part-print analysis; tolerance analysis in manufacturing and assembly; process planning; parameter selection and comparison of production alternatives; time and cost analysis; Issues in choosing manufacturing technologies and strategies.

Computer Integrated Manufacturing: Basic concepts of CAD, CAM, CAPP, group technology, NC, CNC, DNC, FMS, Robotics and CIM.

INDUSTRIAL ENGINEERING

Product Design and Development: Principles of good product design, component and tolerance design; efficiency, quality and cost considerations; product life cycle; standardization, simplification, diversification, value analysis, concurrent engineering.

Engineering Economy and Costing: Financial statements; elementary cost accounting, methods of depreciation; break-even analysis, techniques for evaluation of capital investments.

Work System Design: Taylor's scientific management, Gilbreths's contributions; productivity concepts and measurements; method study, micro-motion study, principles of motion economy; human factors engineering, ergonomics; work measurement - time study, PMTS, work sampling; job evaluation, merit rating, wage administration, incentive systems; business process reengineering.

Logistics and Facility Design: Facility location factors, evaluation of alternatives, types of plant layout, evaluation; computer aided layout; assembly line balancing; material handling systems; supply chain management.

Production Planning and Inventory Control: Inventory Function costs, classifications - deterministic and probabilistic models; quantity discount; safety stock; inventory control system; Forecasting techniques - causal and time series models, moving average, exponential smoothing; trend and seasonality; aggregate production planning; master scheduling; bill of materials and material requirement planning; order control and flow control, routing, scheduling and priority dispatching; JIT; Kanban PULL systems; bottleneck scheduling and theory of constraints.

Operation Research: Linear programming - problem formulation, simplex method, duality and sensitivity analysis; transportation; assignment; network flow models, constrained optimization and Lagrange multipliers; simple queuing models; dynamic programming; simulation; PERT and CPM, time-cost trade-off, resource leveling.

Quality Control: Taguchi method; design of experiments; quality costs, statistical quality assurance, process control charts, acceptance sampling, zero defects; quality circles, total quality management.

Reliability and Maintenance: Reliability, availability and maintainability; probabilistic failure and repair times; system reliability; preventive maintenance and replacement, TPM.

Management Information System: Value of information; information storage and retrieval system - database and data structures; interactive systems; knowledge based systems.

Intellectual Property System: Definition of intellectual property, importance of IPR; TRIPS, and its implications, WIPO and Global IP structure, and IPS in India; patent, copyright, industrial design and trademark; meanings, rules and procedures, terms, infringements and remedies.

PY - PHARMACEUTICAL SCIENCES

Natural Products: Pharmacognosy & Phytochemistry - Chemistry, tests, isolation, characterization and estimation of phytopharmaceuticals belonging to the group of Alkaloids, Glycosides, Terpenoids, Steroids, Bioflavanoids, Purines, Guggul lipids. Pharmacognosy of crude drugs which contain the above constituents. Standardisation of raw materials and herbal products. WHO guide lines. Quantitative microscopy including modern techniques used for evaluation. Biotechnological principles and techniques for plant development Tissue culture.

Pharmacology: General pharmacological principles including Toxicology. Drug interaction. Pharmacology of drugs acting on Central nervous system, Cardiovascular system, Autonomic nervous system, Gastro intestinal system and Respiratory system. Pharmacology of Autocoids, Hormones, Chemotherapeutic agents including anticancer drugs. Bioassays. Immuno Pharmacology.

Medicinal Chemistry: Structure, nomenclature, classification, synthesis, SAR and metabolism of the following category of drugs which are official in Indian Pharmacopoeia and British Pharmacopoeia Hypnotics and Sedatives, Analgesics, NSAIDS, Neuroleptics, Antidepressants, Anxiolytics, Anticonvulsants, Antihistaminics, Local anaesthetics, Cardio Vascular drugs - Antianginal agents Vasodilators, Adrenergic & cholinergic drugs, Cardiotonic agents, Diuretics, Antihypertensive drugs, Hypoglycemic agents, Antilipedmic agents, Coagulants, Anticoagulants, Antiplatelet agents. Chemotherapeutic agents - Antibiotics, Antibacterials, Sulphadrugs. Antiproliozoal drugs, Antiviral, Antitubercular, Antimalarial, Anticancer, Antiamoebic drugs. Diagnostic agents. Preparation and storage and uses of official Radiopharmaceuticals. Vitamins and Hormones.

Pharmaceutics: Development, manufacturing standards, labeling, packing as per the pharmacopoeal requirements, Storage of different dosage forms and new drug delivery systems. Biopharmaceutics and Pharmacokinetics and their importance in formulation. Formulation and preparation of cosmetics - lipstick, shampoo, creams, nail preparations and dentifrices. Pharmaceutical calculations.

Pharmaceutical Jurisprudence: Legal aspects of manufacture, storage, sale of drugs. D and C act and rules. Pharmacy act.

Pharmaceutical Analysis: Principles, instrumentation and applications of the following. Absorption spectroscopy (UV, visible & IR), Fluorimetry, Flame photometry, Potentiometry, Conductometry and Plarography. Pharmacopoeial assays. Principles of NMR, ESR, Mass spectroscopy, X-ray diffraction analysis and different chromatographic methods.

Biochemistry and Clinical Pharmacy: Biochemical role of hormones, Vitamins, Enzymes, Nucleic acids. Bioenergetics. General principles of immunology. Immunological techniques. Adverse drug interaction.

Microbiology: Principles and methods of microbiological assays of the Pharmacopoeia. Methods of preparation of official sera and vaccines. Serological and diagnostic tests. Applications of microorganisms in Bio Conversions and in Pharmaceutical industry.

TF - TEXTILE ENGINEERING AND FIBRE SCIENCE

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

TEXTILE ENGINEERING & FIBRE SCIENCE

Textile Fibres: Classification of textile fibres according to their nature and origin; general characteristics of textile fibres-their chemical and physical structures and their properties; essential characteristics of fibre forming polymers; uses of natural and man-made fibres; physical and chemical methods of fibre and blend identification and blend analysis.

Melt Spinning processes with special reference to polyamide and polyester fibres; wet and dry spinning of viscose and acrylic fibres; post spinning operations-drawing, heat setting, texturing- false twist and air-jet, tow-to-top conversion. Methods of investigating fibre structure e.g. X-ray diffraction, birefringence, optical and electron microscopy, I.R. absorption, thermal methods; structure and morphology and principal natural and man-made fibres, mechanical properties of fibres, moisture sorption in fibres; fibre structure and property correlation.

Textile Testing: Sampling techniques, sample size and sampling errors; measurement of fibre length, fineness, crimp, strength and reflectance; measurement of cotton fibre maturity ad trash content; HVI and AFIS for fibre testing. Measurement of yarn count, twist and hairiness; tensile testing of fibres, yarn and fabrics; evenness testing of slivers, rovings and yarns; testing equipment for measurement test methods of fabric properties like thickness, compressibility, air permeability, drape, crease recovery, tear strength bursting strength and abrasion resistance. Correlation analysis, significance tests and analysis of variance; frequency distributions and control charts.

Yarn Manufacture and Yarn Structure: Modern methods of opening, cleaning and blending of fibrous materials; the technology of carding with particular reference to modern developments; causes of irregularity introduced by drafting, the development of modern drafting systems; principles and techniques of preparing material for combing; recent development in combers; functions and synchronization of various mechanisms concerned with roving production; forces acting on yarn and traveller, ring and traveller designs; causes of end breakages; properties of doubles yarns; new methods of yarn production such as rotor spinning, air jet spinning and friction spinning.

Yarn diameter; specific volume, packing coefficient; twist-strength relationship; fibre orientation in yarn; fibre migration.

Fabric Manufacture and Fabric Structure: Principles of cheese and cone winding processes and machines; random and precision winding; package faults and their remedies; yarn clearers and tensioners; different systems of yarn splicing; features of modern cone winding machines; different types of warping creels; features of modern beam and sectional warping machines; different sizing systems, sizing of spun and filament yarns, modern sizing machines; principles of pirn winding processes and machines; primary and secondary motions of loom, effect of their settings and timings on fabric formation, fabric appearance and weaving performance; dobby and jacquard shedding; mechanics of weft insertion with shuttle; warp and weft stop motions, warp protection, weft replenishment; functional principles of weft insertion systems of shuttleless weaving machines, principles of multiphase and circular looms. Principles of weft and warp knitting; basic weft and warp knitted structures; classification, production and areas of application of nonwoven fabrics.

Basic woven fabric constructions and their derivatives; crepe, cord, terry, gauze, lino and double cloth constructions.

Peirce's equations for fabric geometry; thickness, cover and maximum sett of woven fabrics

Textile Chemical Processing: Preparatory processes for natural-and and their blends; mercerization of cotton; machines for yarn and fabric mercerization.

Dyeing and printing of natural- and synthetic- fibre fabrics and their blends with different dye classes; dyeing and printing machines; styles of printing; fastness properties of dyed and printed textile materials.

Finishing of textile materials, wash and wear, durable press, soil release, water repellent, flame retardant and antistatic finishes; shrink-resistance finish for wool; heat setting of synthetic-fibre fabrics, finishing machines; energy efficient processes; pollution control.

XE - ENGINERING SCIENCES

The syllabi of the sections of this paper are as follows:

SECTION A. ENGINEERING MATHEMATICS (Compulsory)

Linear Algebra : Determinates, algebra of matrices, rank, inverse, system of linear equations, symmetric, skew-symmetric and orthogonal matrices. Hermitian, skew-hermitian and unitary matrices. eigenvalues and eigenvectors, diagonalisation of matrices, Cayley-Hamiltonian, quadratic forms.

Calculus : Functions of single variables, limit, continuity and differentiability, Mean value theorems, Intermediate forms and L'Hospital rule, Maxima and minima, Taylor's series, Fundamental and mean value-theorems of integral calculus. Evaluation of definite and improper integrals, Beta and Gamma functions, Functions of two variables, limit, continuity, partial derivatives, Euler's theorem for homogeneous functions, total derivatives, maxima and minima, Lagrange method of multipliers, double and triple integrals and their applications, sequence and series, tests for convergence, power series, Fourier Series, Fourier integrals.

Complex variable: Analytic functions, Cauchy's integral theorem and integral formula without proof. Taylor's and Laurent' series, Residue theorem (without proof) with application to the evaluation of real integarls.

Vector Calculus: Gradient, divergence and curl, vector identities, directional derivatives, line, surface and volume integrals, Stokes, Gauss and Green's theorems (without proofs) with applications.

Ordinary Differential Equations: First order equation (linear and nonlinear), higher order linear differential equations with constant coefficients, method of variation of paramaters, Cauchy's and Euler's equations, initial and boundary value problems, power series solutions, Legendre polynomials and Bessel's functions of the first kind.

Partial Differential Equations: Variables separable method, solutions of one dimensional heat, wave and Laplace equations.

Probability and Statistics: Definitions of probability and simple theorems, conditional probability, mean, mode and standard deviation, random variables, discrete and continuous distributions, Poisson, normal and Binomial distribution, correlation and regression

Numerical Methods: L-U decomposition for systems of linear equations,Newton-Raphson method, numerical integration(trapezoidal and Simpson's rule), numerical methods for first order differential equation (Euler method)

SECTION B. COMPUTATIONAL SCIENCE

Numerical Methods: Truncation errors, round off errors and their propagation; Interpolation; Lagrange, Newton's forward, backward and divided difference formulas, least square curve fitting, solution of non-linear equations of one variables using bisection, false position, secant and Newton Raphson methods; Rate of convergence of these methods, general iterative methods. Simple and multiple roots of polynomials. Solutions of system of linear algebraic equations using Gauss elimination methods, Jacobi and Gauss-Seidel iterative methods and their rate of convergence; ill conditioned and well conditioned system. eigen values and eigen vectors using power methods. Numerical integration using trapezoidal, Simpson's rule and other quadrature formulas. Numerical Differentiation. Solution of boundary value problems. Solution of initial value problems of ordinary differential equations using Euler's method, predictor corrector and Runge Kutta method.

Programming : Elementary concepts and terminology of a computer system and system software, Fortran77 and C programming.

Fortran : Program organization, arithmetic statements, transfer of control, Do loops, subscripted variables, functions and subroutines.

C language : Basic data types and declarations, flow of control- iterative statement, conditional statement, unconditional branching, arrays, functions and procedures.

SECTION C. ELECTRICAL SCIENCES

Electric Circuits: Ideal voltage and current sources; RLC circuits, steady state and transient analysis of DC circuits, network theorems; alternating currents and voltages, single-phase AC circuits, resonance; three-phase circuits.

Magnetic circuits: Mmf and flux, and their relationship with voltage and current; transformer, equivalent circuit of a practical transformer, three-phase transformer connections.

Electrical machines: Principle of operation, characteristics, efficiency and regulation of DC and synchronous machines; equivalent circuit and performance of three-phase and single-phase induction motors.

Electronic Circuits: Characteristics of p-n junction diodes, zener diodes, bipolar junction transistors (BJT) and junction field effect transistors (JFET); MOSFET's structure, characteristics, and operations; rectifiers, filters, and regulated power supplies; biasing circuits, different configurations of transistor amplifiers, class A, B and C of power amplifiers; linear applications of operational amplifiers; oscillators; tuned and phase shift types.

Digital circuits: Number systems, Boolean algebra; logic gates, combinational circuits, flip-flops (RS, JK, D and T) counters.

Measuring instruments: Moving coil, moving iron, and dynamometer type instruments; shunts, instrument transformers, cathode ray oscilloscopes; D/A and A/D converters.

SECTION D. FLUID MECHANICS

Fluid Properties: Relation between stress and strain rate for Newtonian fluids

Hydrostatics, buoyancy, manometry

Concept of local and convective accelerations; control volume analysis for mass, momentum and energy conservation.

Differential equations of continuity and momentum (Euler's equation of motion); concept of fluid rotation, stream function, potential function; Bernoulli's equation and its applications.

Qualitative ideas of boundary layers and its separation; streamlined and bluff bodies; drag and lift forces.

Fully-developed pipe flow; laminar and turbulent flows; friction factor; Darcy Weisbach relation; Moody's friction chart; losses in pipe fittings; flow measurements using venturimeter and orifice plates.

Dimensional analysis; similitude and concept of dynamic similarity; importance of dimensionless numbers in model studies.

SECTION E. MATERIALS SCIENCE

Atomic structure and bonding in materials: metals, ceramics and polymers.

Structure of materials: Crystal systems, unit cells and space lattice; determination of structures of simple crystals by X-ray diffraction; Miller indices for planes and directions. Packing geometry in metallic, ionic and covalent solids.

Concept of amorphous, single and polycrystalline structures and their effects on properties of materials.

Imperfections in crystalline solids and their role in influencing various properties.

Fick´s laws of diffusion and applications of diffusion in sintering, doping of semiconductors and surface hardening of metals.

Alloys: solid solution and solubility limit. Binary phase diagram, intermediate phases and intermetallic compounds; iron-iron carbide phase diagram. Phase transformation in steels. Cold and hot working of metals, recovery, recrystallization and grain growth.

Properties and applications of ferrous and nonferrous alloys.

Structure, properties, processing and applications of traditional and advanced ceramics.

Polymers: classification, polymerization, structure and properties, additives for polymer products, processing and application.

Composites: properties and application of various composites.

Corrosion and environmental degradation of materials (metals, ceramics and polymers).

Mechanical properties of materials: Stress-strain diagrams of metallic, ceramic and polymeric materials, modulus of elasticity, yield strength, plastic deformation and toughness, tensile strength and elongation at break; viscoelasticity, hardness, impact strength. ductile and brittle fracture. creep and fatigue properties of materials.

Heat capacity, thermal conductivity, thermal expansion of materials.

Concept of energy band diagram for materials; conductors, semiconductors and insulators in terms of energy bands. Electrical conductivity, effect of temperature on conductivity in materials, intrinsic and extrinsic semiconductors, dielectric properties of materials.

Refraction, reflection, absorption and transmission of electromagnetic radiation in solids.

Origin of magnetism in metallic and ceramic materials, paramagnetism, diamagnetism, antiferromagnetism, ferromagnetism, ferrimagnetism in materials and magnetic hysteresis.

Advanced materials: Smart materials exhibiting ferroelectric, piezoelectric, optoelectronic, semiconducting behaviour; lasers and optical fibers; photoconductivity and superconductivity in materials.

SECTION F. SOLID MECHANICS

Equivalent force systems; free-body diagrams; equilibrium equations; analysis of determinate and indeterminate trusses and frames; friction.

Simple relative motion of particles; force as function of position, time and speed; force acting on a body in motion; laws of motion; law of conservation of energy; law of conservation of momentum

Stresses and strains; principal stresses and strains; Mohr's circle; generalized Hooke's Law; equilibrium equations; compatibility conditions; yield criteria.

Axial, shear and bending moment diagrams; axial, shear and bending stresses; deflection (for symmetric bending); torsion in circular shafts; thin cylinders; energy methods (Castigliano's Theorems); Euler buckling.

SECTION G. THERMODYNAMICS

Basic Concepts: Continuum, macroscopic approach, thermodynamic system (closed and open or control volume); thermodynamic properties and equilibrium; state of a system, state diagram, path and process; different modes of work; Zeroth law of thermodynamics; concept of temperature; heat.

First Law of Thermodynamics: Energy, enthalpy, specific heats, first law applied to systems and control volumes, steady and unsteady flow analysis.

Second Law of Thermodynamics: Kelvin-Planck and Clausius statements, reversible and irreversible processes, Carnot theorems, thermodynamic temperature scale, Clausius inequality and concept of entropy, principle of increase of entropy; availability and irreversibility.

Properties of Pure Substances: Thermodynamic properties of pure substances in solid, liquid and vapour phases, P-V-T behaviour of simple compressible substances, phase rule, thermodynamic property tables and charts, ideal and real gases, equations of state, compressibility chart.

Thermodynamic Relations: T-ds relations, Maxwell equations, Joule-Thomson coefficient, coefficient of volume expansion, adiabatic and isothermal compressibilities, Clapeyron equation.

Ideal Gas Mixtures: Dalton's and Amagat's laws, calculations of properties, air-water vapour mixtures.

XL - LIFE SCIENCES

The syllabi of the Sections of this paper are as follows:

SECTION H. CHEMISTRY (Compulsory)

Atomic structure and periodicity: Quantum chemistry; Planck's quantum theory, wave particle duality, uncertainty principle, quantum mechanical model of hydrogen atom; electronic configuration of atoms; periodic table and periodic properties; ionization energy, election affinity, electronegativity, atomic size.

Structure and bonding: Ionic and covalent bonding M.O. and V.B. approaches for diatomic molecules, VSEPR theory and shape of molecules, hybridisation, resonance, dipole moment, structure parameters such as bond length, bond angle and bond energy, hydrogen bonding, van der Waals interactions. Ionic solids; ionic radii, lattice energy (Born-Haber Cycle).

s.p. and d Block Elements: Oxides, halides and hydrides of alkali and alkaline earth metals, B, Al, S, N, P and S, silicones, general characteristics of 3d elements, coordination complexes: valence bond and crystal field theory, color, geometry and magnetic properties.

Chemical Equilibria: Colligative properties of solutions, ionic equilibria in solution, solubility product, common ion effect, hydrolysis of salts, pH, buffer and their applications in chemical analysis.

Electrochemistry: Conductance, Kohlrausch law, Half Cell potentials, emf, Nernst equation, galvanic cells, thermodynamic aspects and their applications.

Reaction Kinetics: Rate constant, order of reaction, molecularity, activation energy, zero, first and second order kinetics, equilibrium constants (Kc, Kp and Kx) for homogeneous reactions, catalysis and elementary enzyme reactions.

Thermodynamics: First law, reversible and irreversible processes, internal energy, enthalpy, Kirchoff's equation, heat of reaction, Hess law, heat of formation, Second law, entropy, free energy, and work function. Gibbs-Helmholtz equation, Clausius-Clapeyron equation, free energy change and equilibrium constant, Troutons rule, Third law of thermodynamics.

Mechanistic Basis of Organic Reactions: Elementary treatment of SN1, SN2, E1 and E2 reactions, Hoffmann and Saytzeff rules, Addition reactions, Markonikoff rule and Kharash effect, Diels-Alder reaction, aromatic electrophilic substitution, orientation effect as exemplified by various functional groups.

Structure-Reactivity Correlations: Acids and bases, electronic and steric effects, optical and geometrical isomerism, tautomerism, concept of aromaticity

SECTION I. BIOCHEMISTRY

Organization of life. Importance of water. Cell structure and organelles. Structure and function of biomolecules: Carbohydrates, Lipids, Proteins and Nucleic acids. Biochemical separation techniques. Spectroscopic methods; UV-visible and fluorescence. Protein structure, folding and function: Myoglobin, Hemoglobin, Lysozyme, ribonuclease A, Carboxypeptidase and Chymotrypsin. Enzyme kinetics and regulation, Coenzymes.

Metabolism and bioenergitics. Generation and utilization of ATP. Photosynthesis. Major metabolic pathways and their regulation. Biological membranes. Transport across membranes. Signal transduction; hormones and neurotransmitters.

DNA replication, transcription and translation. Biochemical regulation of gene expression. Recombinant DNA technology and applications. Genomics and Proteomics.

The immune system. Active and passive immunity. Complement system. Antobody structure, function and diversity. Cells of the immune system: T, B and macrophages. T and B cell activation. Major histocompatibilty complex. T cell receptor. Immunological techniques: Immunodiffusion, immunoelectrophoresis, RIA and ELISA.

SECTION J. BIOTECHNOLOGY

Recombinant DNA technology for the production of therapeutic proteins. Micro array technology. Heterologous protein expression systems in bacteria, yeast etc.

Architecture of plant genome; plant tissue culture techniques; methods of gene transfer into plant cells; manipulation of phenotypic traits in plants; plant cell fermentations and production of secondary metabolites using suspension/ immobilized cell culture; methods for plant micro propagation; crop improvement and development of transgenic plants. Expression of animal proteins in plants.

Animal cell metabolism and regulation; cell cycle; primary cell culture; nutritional requirements for animal cell culture; techniques for the mass culture of animal cell lines; production of vaccines; growth hormones and interferons using animal cell culture; cytokines-production and therapeutic uses; hybridoma technology; vectors for gene transfer and expression in animal cells. Transgenic animals and molecular pharming.

Microbial production of industrial enzymes; methods for immobilization of enzymes; kinetics of soluble and immobilized enzymes; application of soluble and immobilized enzymes; enzyme-based sensors.

Microbial growth kinetics; batch, fed batch and continuous culture of microbial cells; media for industrial fermentations; sterilization of air and media; design features and operation of stirred tank, air-lift and fluidized bed reactors; aeration and agitation in aerobic fermentations; recovery and purification of fermentation products- filtration, centrifugation, cell disintegration, solvent extraction and chromatographic separations; industrial fermentations for the production of ethanol, citric acid, lysine, penicillin and other biomolecules; simple calculations based on material and energy balance of fermentation processes; application of microbes in the management of domestic and industrial wastes.

SECTION K. BOTANY

Anatomy: Roots, stem and leaves of land plants, meristems, vascular system, their ontogeny, structure and functions. Plant cell structure, organisation, organelles, cytoskeleton, cell wall and membranes.

Development: Cell cycle, cell division, senescence, hormonal regulation of growth; life cycle of an angiosperm, pollination, fertilization, embryogenesis, seed formation, seed storage proteins, seed dormancy and germination. Concept of cellular totipotency, organogenesis and somatic embryogenesis, somaclonal variation, embryo culture, in vitro fertilization.

Physiology and Biochemistry: Plant water relations, transport of minerals and solutes, N2 metabolism, proteins and nucleic acid, respiration, photophysiology, photosynthesis, photorespiration; biosynthesis, mechanism of action and physiological effects of plant growth regulators.

Genetics: Principles of Mendelian inheritance, linkage, recombination and genetic mapping; extrachromosomal inheritance; eukaryotic genome organization (chromatin structure) and regulation of gene expression, gene mutation, chromosome aberrations (numerical and structural), transposons.

Plant Breeding: Principles, methods - selection, hybridization, heterosis; male sterility, self and inter-specific incompatibility; haploidy; somatic cell hybridization; molecular marker-assisted selection; gene transfer methods viz. direct and vector-mediated, transgenic plants and their applications in agriculture.

Economic Botany: Economically important plants - cereals, pulses, plants yielding fiber, timber, sugar, beverages, oils, rubber, dyes, gums, drugs and narcotics - a general account.

Systematics: Systems of classification (non-phylogenetic vs. phylogenetic - outline), plant groups, molecular systematics.

Plant Pathology: Nature and classification of plant diseases, diseases of important crops caused by fungi, bacteria and viruses, and their control measures, mechanism(s) of pathogenesis and resistance, molecular detection of pathogens; plant-microbe beneficial interactions.

Ecology and Plant Geography: Ecosystems - types, dynamics, degradation, ecological succession; food chains; vegetation types of the world; pollution and global warming; speciation and extinction, conservation strategies, cryopreservation.

SECTION L. MICROBIOLOGY

Historical perspective - Discovery of the microbial world; Controversy over spontaneous generation; Role of microorganisms in transformation of organic matter and in the causation of diseases.

Methods in microbiology - Pure culture techniques; Theory and practice of sterilization; Principles of microbial nutrition; Construction of culture media; Enrichment culture techniques for isolation of chemoautotrophs, chemoheterotrophs and photosynthetic microorganisms.

Microbial evolution, systematics and taxonomy - Evolution of earth and earliest life forms; Primitive organisms and their metabolic strategies; New approaches to bacterial taxonomic classification including ribotyping; Nomenclature.

Microbial diversity - Bacteria, archea and their broad classification; Eukaryotic microbes, yeast, fungi, slime mold and protozoa; Viruses and their classification.

Microbial growth -The definition of growth, mathematical expression of growth, growth curve, measurement of growth and growth yields; Synchronous growth; Continuous culture.

Nutrition and metabolism - Overview of metabolism; Microbial nutrition; Energy classes of microorganisms; Culture media; Energetics, modes of ATP generation; ATP generation by heterotrophs; Fermentation; Glycolysis; Respiration; The citric acid cycle; Electron transport systems; Alternate modes of energy generation; Pathways (anabolism) in the biosynthesis of amino acids, purines, pyrimidines and fatty acids.

Metabolic diversity among microorganisms - Photosynthesis in microorganisms; Role of chlorophylls, carotenoids and phycobilins; Calvin cycle; Chemolithotrophy; Hydrogen- iron-nitrite-oxidizing bacteria; Nitrate and sulfate reduction; Methanogenesis and acetogenesis.

Prokaryotic cells: structure-function - Cells walls of eubacteria (peptidoglycan) and related molecules; Outer-membrane of gram-negative bacteria; Cell wall and cell membrane synthesis; Flagella and motility; Cell inclusions like endospores, gas vesicles.

Microbial diseases and host parasite relationships - Normal microflora of skin; Oral cavity; Gastrointestinal tract; Entry of pathogens into the host; Infectious disease transmission; Respiratory infections caused by bacteria and viruses; Tuberculosis; Sexually transmitted diseases including AIDS; Diseases transmitted by animals (Rabies, plague), insects and ticks (rikettsias, Lyme disease, malaria); Food and water borne diseases; Public health and water quality; Pahtogenic fungi; Emerging and resurgent infectious diseases.

Chemotherapy/Antibiotics - Antimicrobial agents; Sulfa drugs; Antibiotics; Pencillins and cephalosporins; Broad-spectrum antibiotics; Antibiotics from prokaryotes; Antifungal antibiotics; Mode of action; Resistance to antibiotics.

Microbial genetics - Genes, mutation and mutagenesis - UV and chemical mutagnes; Types of mutations; Ames test for mutagenesis; Methods of genetic analysis. Bacterial genetic system - Transformation; Conjugation; Transduction; Recombination; Plasmids and Transposons; Bacterial genetic map with reference to E. coli. Viruses and their genetic system - Phage ? and its life cycle; RNA phages; RNA viruses; Retroviruses; Genetic systems of yeast and Neurospora; Extrachromosomal inheritance and mitochondrial genetics; Basic concept of genomics.

SECTION M. ZOOLOGY

Animal world: Animal diversity, distribution, systematic and classification of animals, the phylogenetic relationship.

Evolution: Origin of life, history of life on earth, evolutionary theories, natural selection, adaptation, speciation.

Genetics: Principles of inheritance, molecular basis of heredity, the genetic material, transmission of genetic material, mutations, cytoplasmic inheritance.

Biochemistry and Molecular Biology: Nucleic acids, proteins and other biological macromolecules. Replication, transcription and translation, regulation of gene expression, organization of genome, Kreb's cycle, glycolysis, enzyme catalysis, hormones and their action.

Cell Biology: Structure of cell, cellular organelles and their structure and function, cell cycle, cell division, cellular differentiation, chromosome and chromatin structure. Eukaryotic gene organisation and expression.

Animal Anatomy and Physiology: Comparative physiology, the respiratory system, circulatory system, digestive system, the nervous system, the excretory system, the endocrine system, the reproductive system, the skeletal system, osmoregulation.

Parasitology and Immunology: Nature of parasite, host-parasite relation, protozoan and helminthic parasites, the immune response, cellular and humoral immune response, evolution of the immune system.

Development Biology: Embryonic development, cellular differentiation, organogenesis, metamorphosis, genetic basis of development.

Ecology: The ecosystem, habitats the food chain, population dynamics, species diversity, zoogeography, biogeochemical cycles, conservation biology.

Animal Behaviour: Types of behaviours, courtship, mating and territoriality, instinct, learning and memory, social behaviour across the animal taxa, communication, pheromones, evolution of animal behaviour.

IT - INFORMATION TECHNOLOGY

ENGINEERING MATHEMATICS

Mathematical Logic: Propositional Logic; First Order Logic.

Probability: Conditional Probability; Mean, Median, Mode and Standard Deviation; Random Variables; Distributions; uniform, normal, exponential, Poisson, Binomial.

Set Theory & Algebra: Sets; Relations; Functions; Groups; Partial Orders; Lattice; Boolean Algebra.

Combinatorics: Permutations; Combinations; Counting; Summation; generating functions; recurrence relations; asymptotics.

Graph Theory: Connectivity; spanning trees; Cut vertices & edges; covering; matching; independent sets; Colouring; Planarity; Isomorphism.

Linear Algebra: Algebra of matrices, determinants, systems of linear equations, Eigen values and Eigen vectors.

Numerical Methods: LU decomposition for systems of linear equations; numerical solutions of non linear algebraic equations by Secant, Bisection and Newton-Raphson Methods; Numerical integration by trapezoidal and Simpson's rules.

Calculus: Limit, Continuity & differentiability, Mean value Theorems, Theorems of integral calculus, evaluation of definite & improper integrals, Partial derivatives, Total derivatives, maxima & minima.

FORMAL LANGUAGES AND AUTOMATA

Regular Languages: finite automata, regular expressions, regular grammar.

Context free languages: push down automata, context free grammars

COMPUTER HARDWARE

Digital Logic: Logic functions, minimization, design and synthesis of combinatorial and sequential circuits, number representation and computer arithmetic (fixed and floating point)

Computer organization: Machine instructions and addressing modes, ALU and data path, hardwired and microprogrammed control, memory interface, I/O interface (interrupt and DMA mode), serial communication interface, instruction pipelining, cache, main and secondary storage

SOFTWARE SYSTEMS

Data structures and Algorithms: the notion of abstract data types, stack, queue, list, set, string, tree, binary search tree, heap, graph, tree and graph traversals, connected components, spanning trees, shortest paths, hashing, sorting, searching, design techniques (greedy, dynamic, divide and conquer), asymptotic analysis (best, worst, average cases) of time and space, upper and lower bounds, intractability

Programming Methodology: C programming, program control (iteration, recursion, functions), scope, binding, parameter passing, elementary concepts of object oriented programming

Operating Systems (in the context of Unix): classical concepts (concurrency, synchronization, deadlock), processes, threads and interprocess communication, CPU scheduling, memory management, file systems, I/O systems, protection and security

Information Systems and Software Engineering: information gathering, requirement and feasibility analysis, data flow diagrams, process specifications, input/output design, process life cycle, planning and managing the project, design, coding, testing, implementation, maintenance.

Databases: relational model, database design, integrity constraints, normal forms, query languages (SQL), file structures (sequential, indexed), b-trees, transaction and concurrency control

Data Communication: data encoding and transmission, data link control, multiplexing, packet switching, LAN architecture, LAN systems (Ethernet, token ring), Network devices: switches, gateways, routers

Networks: ISO/OSI stack, sliding window protocols, routing protocols, TCP/UDP, application layer protocols & systems (http, smtp, dns, ftp), network security

Web technologies: three tier web based architecture; JSP, ASP, J2EE, .NET systems; html, XML

AG - AGRICULTURAL ENGINEERING

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

FARM MACHINERY AND POWER:

Sources of power on the farm-human, animal, mechanical, electrical, wind, solar and biomass; design and selection of machine elements - gears, pulleys, chains and sprockets and belts; overload safety devices used in farm machinery; measurement of force, torque, speed, displacement and acceleration on machine elements.

Soil tillage; forces acting on a tillage tool; hitch systems and hitching of tillage implements; functional requirements, principles of working, construction and operation of manual, animal and power operated equipment for tillage. sowing, planting, fertilizer application, inter-cultivation, spraying, mowing, chaff cutting, harvesting, threshing and transport; testing of agricultural machinery and equipment; calculation of performance parameters -field capacity, efficiency, application rate and losses; cost analysis of implements and tractors.

Thermodynamic principles of I.C. engines; I.C. engine cycles; engine components; fuels and combustion; lubricants and their properties; I.C. engine systems - fuel, cooling, lubrication, ignition, electrical, intake and exhaust; selection, operation, maintenance and repair of I.C. engines; power efficiencies and measurement; calculation of power, torque, fuel consumption, heat load and power losses.

Tractors and power tillers - type, selection, maintenance and repair; tractor clutches and brakes; power transmission systems - gear trains, differential, final drives and power take-off; mechanics of tractor chassis; traction theory; three point hitches- free link and restrained link operations; mechanical steering and hydraulic control systems used in tractors; human engineering and safety in tractor design; tractor tests and performance.

SOIL AND WATER CONSERVATION ENGINEERING:

Ideal and real fluids, properties of fluids; hydrostatic pressure and its measurement; hydrostatic forces on plane and curved surface; continuity equation; Bernoulli's theorem; laminar and turbulent flow in pipes, Darcy-Weisbach and Hazen-Williams equations, Moody's diagram; flow through orifices and notches; flow in open channels.

Engineering properties of soils, fundamental definitions and relationships; index properties of soils; permeability and seepage analysis; shear strength, Mohr's circle of stresses; active and passive earth pressures; stability of slopes.

Hydrological cycle; precipitation measurement, analysis of precipitation data; abstraction from precipitation; runoff; hydrograph analysis, unit hydrograph theory and application; stream flow measurement; flood routing, hydrological reservoir and channel routing.

Mechanics of soil erosion, factors affecting erosion; soil loss estimation; biological and engineering measures to control erosion, terraces and bunds; vegetative waterways; gully control structures, drop, drop inlet and chute spillways; farm ponds; earthen dams; principles of watershed management.

Water requirement of crops; consumptive use and evapo-transpiration; irrigation scheduling; irrigation efficiencies; design of prismatic and silt loaded channels; methods of irrigation water application; design and evaluation of irrigation methods; drainage coefficient; surface and subsurface drainage systems; leaching requirement and salinity control; irrigation and drainage water quality; classification of pumps; pump characteristics; pump selection; types of aquifer; evaluation of aquifer properties; well hydraulics; ground water recharge.

AGRICULTURAL PROCESSING AND FOOD ENGINEERING:

Steady state heat transfer in conduction, convection and radiation; transient heat transfer in simple geometry; condensation and boiling heat transfer; working principles of heat exchangers; diffusive and convective mass transfer; simultaneous heat and mass transfer in agricultural processing operations.

Material and energy balances in food processing systems; water activity, sorption and desorption isotherms; centrifugal separation of solids, liquids and gases; kinetics of microbial death - pasteurisation and sterilization of liquid foods; preservation of food by cooling and freezing; psychrometry - properties of air-vapour mixture; concentration and dehydration of liquid foods - evaporators, tray, drum and spray dryers.

Mechanics and energy requirement in size reduction of granular solids; particle size analysis for comminuted solids; size separation by screening; fluidisation of granular solids; cleaning and grading efficiency and effectiveness of grain cleaners; conditioning and hydrothermal treatments for grains; dehydration of food grains; processes and machines for processing of cereals, pulses and oilseeds; design considerations for grain silos.

AR - ARCHITECTURE AND PLANNING

City planning: Historical development of cities; principles of city planning; new towns; survey methods, site planning, planning regulations and building bye-laws.

Housing: Concept of shelter; housing policies and design; community planning; role of government agencies; finance and management.

Landscape Design: Principles of landscape design and site planning; history and landscape styles; landscape elements and materials; planting design.

Computer Aided Design: Application of computers in architecture and planning; understanding elements of hardware and software; computer graphics; programming languages - C and Visual Basic and usage of packages such as AutoCAD.

Environmental and Building Science: Elements of environmental science; ecological principles concerning environment; role of micro-climate in design; climatic control through design elements; thermal comfort; elements of solar architecture; principles of lighting and illumination; basic principles of architectural acoustics; air pollution, noise pollution and their control.

Visual and Urban Design: Principles of visual composition; proportion, scale, rhythm, symmetry, harmony, balance, form and colour; sense of place and space, division of space; focal point, vista, imageability, visual survey.

History of Architecture: Indian - Indus valley, Vedic, Buddhist, Indo-Aryan, Dravidian and Mughal periods; European - Egyptian, Greek, Roman, medieval and renaissance periods.

Development of Contemporary Architecture: Architectural developments and impacts on society since industrial revolution; influence of modern art on architecture; works of national and international architects; post modernism in architecture.

Building Services: Water supply, Sewerage and Drainage systems; Sanitary fittings and fixtures; principles of electrification of buildings; elevators, their standards and uses; air-conditioning systems; fire fighting systems.

Building Construction and Management: Building construction techniques, methods and details; building systems and prefabrication of building elements; principles of modular coordination; estimation, specification, valuation, professional practice; project management, PERT, CPM.

Materials and Structural Systems: Behavioural characteristics of all types of building materials e.g. mud, timber, bamboo, brick, concrete, steel, glass, FRP; principles of strength of materials; design of structural elements in wood, steel and RCC; elastic and limit state design; complex structural systems; principles of pre-stressing.

Planning Theory: Planning process; multilevel planning; comprehensive planning; central place theory; settlement pattern; land use and land utilization.

Techniques of Planning: Planning surveys; Preparation of urban and regional structure plans, development plans, action plans; site planning principles and design; statistical methods; application of remote sensing techniques in urban and regional planning.

Traffic and Transportation Planning: Principles of traffic engineering and transportation planning; methods of conducting surveys; design of roads, intersections and parking areas; hierarchy of roads and levels of services; traffic and transport management in urban areas; traffic safety and traffic laws; public transportation planning; modes of transportation.

Services and Amenities: Principles and design of water supply systems, sewerage systems, solid waste disposal systems, power supply and communication systems; Health, education, recreation and demography related standards at various levels of the settlements.

Development Administration and Management: Planning laws; development control and zoning regulations; laws relating to land acquisition; development enforcements, land ceiling; regional and urban plan preparations; planning and municipal administration; taxation, revenue resources and fiscal management; public participation and role of NGO.

CE - CIVIL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

STRUCTURAL ENGINEERING

Mechanics: Bending moments and shear forces in statically determinate beams; simple stress and strain: relationship; stress and strain in two dimensions, principal stresses, stress transformation, Mohr's circle; simple bending theory; flexural shear stress; thin-walled pressure vessels; uniform torsion.

Structural Analysis: Analysis of statically determinate trusses, arches and frames; displacements in statically determinate structures and analysis of statically indeterminate structures by force/energy methods; analysis by displacement methods (slope-deflection and moment-distribution methods); influence lines for determinate and indeterminate structures; basic concepts of matrix methods of structural analysis.

Concrete Structures: Basic working stress and limit states design concepts; analysis of ultimate load capacity and design of members subject to flexure, shear, compression and torsion (beams, columns and isolated footings); basic elements of prestressed concrete: analysis of beam sections at transfer and service loads.

Steel Structures: Analysis and design of tension and compression members, beams and beam-columns, column bases; connections - simple and eccentric, beam-column connections, plate girders and trusses; plastic analysis of beams and frames.

GEOTECHNICAL ENGINEERING

Soil Mechanics: Origin of soils; soil classification; three-phase system, fundamental definitions, relationship and inter-relationships; permeability and seepage; effective stress principle: consolidation, compaction; shear strength.

Foundation Engineering: Sub-surface investigation - scope, drilling bore holes, sampling, penetrometer tests, plate load test; earth pressure theories, effect of water table, layered soils; stability of slopes - infinite slopes, finite slopes; foundation types - foundation design requirements; shallow foundations; bearing capacity, effect of shape, water table and other factors, stress distribution, settlement analysis in sands and clays; deep foundations - pile types, dynamic and static formulae, load capacity of piles in sands and clays.

WATER RESOURCES ENGINEERING

Fluid Mechanics and Hydraulics: Hydrostatics, applications of Bernoulli equation, laminar and turbulent flow in pipes, pipe networks; concept of boundary layer and its growth; uniform flow, critical flow and gradually varied flow in channels, specific energy concept, hydraulic jump; forces on immersed bodies; flow measurement in channels; tanks and pipes; dimensional analysis and hydraulic modeling. Applications of momentum equation, potential flow, kinematics of flow; velocity triangles and specific speed of pumps and turbines.

Hydrology: Hydrologic cycle; rainfall; evaporation infiltration, unit hydrographs, flood estimation, reservoir design, reservoir and channel routing, well hydraulics.

Irrigation: Duty, delta, estimation of evapo-transpiration; crop water requirements; design of lined and unlined canals; waterways; head works, gravity dams and Ogee spillways. Designs of weirs on permeable foundation, irrigation methods.

ENVIRONMENTAL ENGINEERING

Water requirements; quality and standards, basic unit processes and operations for water treatment, distribution of water. Sewage and sewerage treatment: quantity and characteristic of waste water sewerage; primary and secondary treatment of waste water; sludge disposal; effluent discharge standards.

TRANSPORTATION ENGINEERING

Highway planning; geometric design of highways; testing and specifications of paving materials; design of flexible and rigid pavements.

CH - CHEMICAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

CHEMICAL ENGINEERING

Process Calculations and Thermodynamics: Laws of conservation of mass and energy; use of tie components; recycle, bypass and purge calculations; degree of freedom analysis.

First and Second laws of thermodynamics and their applications; equations of state and thermodynamic properties of real systems; phase equilibria; fugacity, excess properties and correlations of activity coefficients; chemical reaction equilibria.

Fluid Mechanics and Mechanical Operations: Fluid statics, Newtonian and non-Newtonian fluids, Bernoulli equation, Macroscopic friction factors, energy balance, dimensional analysis, shell balances, flow through pipeline systems, flow meters, pumps and compressors, packed and fluidized beds, elementary boundary layer theory, size reduction and size separation; free and hindered settling; centrifuge and cyclones; thickening and classification, filtration, mixing and agitation; conveying of solids.

Heat Transfer: Conduction, convection and radiation, heat transfer coefficients, steady and unsteady heat conduction, boiling, condensation and evaporation; types of heat exchangers and evaporators and their design.

Mass Transfer: Fick's law, molecular diffusion in fluids, mass transfer coefficients, film, penetration and surface renewal theories; momentum, heat and mass transfer analogies; stagewise and continuous contacting and stage efficiencies; HTU & NTU concepts design and operation of equipment for distillation, absorption, leaching, liquid-liquid extraction, crystallization, drying, humidification, dehumidification and adsorption.

Chemical Reaction Engineering: Theories of reaction rates; kinetics of homogeneous reactions, interpretation of kinetic data, single and multiple reactions in ideal reactors, non-ideal reactors; residence time; non-isothermal reactors; kinetics of heterogeneous catalytic reactions; diffusion effects in catalysis.

Instrumentation and Process Control: Measurement of process variables; sensors, transducers and their dynamics, dynamics of simple systems, dynamics such as CSTRs, transfer functions and responses of simple systems, process reaction curve, controller modes (P, PI, and PID); control valves; analysis of closed loop systems including stability, frequency response (including Bode plots) and controller tuning, cascade, feed forward control.

Plant Design and Economics: Design and sizing of chemical engineering equipment such as compressors, heat exchangers, multistage contactors; principles of process economics and cost estimation including total annualized cost, cost indexes, rate of return, payback period, discounted cash flow, optimization in Design.

Chemical Technology: Inorganic chemical industries; sulfuric acid, NaOH, fertilizers (Ammonia, Urea, SSP and TSP); natural products industries (Pulp and Paper, Sugar, Oil, and Fats); petroleum refining and petrochemicals; polymerization industries; polyethylene, polypropylene, PVC and polyester synthetic fibers.

CS - COMPUTER SCIENCE AND ENGINEERING

ENGINEERING MATHEMATICS

Mathematical Logic: Propositional Logic; First Order Logic.

Probability: Conditional Probability; Mean, Median, Mode and Standard Deviation; Random Variables; Distributions; uniform, normal, exponential, Poisson, Binomial.

Set Theory & Algebra: Sets; Relations; Functions; Groups; Partial Orders; Lattice; Boolean Algebra.

Combinatorics: Permutations; Combinations; Counting; Summation; generating functions; recurrence relations; asymptotics.

Graph Theory: Connectivity; spanning trees; Cut vertices & edges; covering; matching; independent sets; Colouring; Planarity; Isomorphism.

Linear Algebra: Algebra of matrices, determinants, systems of linear equations, Eigen values and Eigen vectors.

Numerical Methods: LU decomposition for systems of linear equations; numerical solutions of non linear algebraic equations by Secant, Bisection and Newton-Raphson Methods; Numerical integration by trapezoidal and Simpson's rules.

Calculus: Limit, Continuity & differentiability, Mean value Theorems, Theorems of integral calculus, evaluation of definite & improper integrals, Partial derivatives, Total derivatives, maxima & minima.

THEORY OF COMPUTATION

Formal Languages and Automata Theory: Regular languages and finite automata, Context free languages and Push-down automata, Recursively enumerable sets and Turing machines, Un-decidability;

Analysis of Algorithms and Computational Complexity: Asymptotic analysis (best, worst, average case) of time and space, Upper and lower bounds on the complexity of specific problems, NP-completeness.

COMPUTER HARDWARE

Digital Logic: Logic functions, Minimization, Design and synthesis of Combinational and Sequential circuits; Number representation and Computer Arithmetic (fixed and floating point);

Computer Organization: Machine instructions and addressing modes, ALU and Data-path, hardwired and micro-programmed control, Memory interface, I/O interface (Interrupt and DMA mode), Serial communication interface, Instruction pipelining, Cache, main and secondary storage.

SOFTWARE SYSTEMS

Data structures: Notion of abstract data types, Stack, Queue, List, Set, String, Tree, Binary search tree, Heap, Graph;

Programming Methodology: C programming, Program control (iteration, recursion, Functions), Scope, Binding, Parameter passing, Elementary concepts of Object oriented, Functional and Logic Programming;

Algorithms for problem solving: Tree and graph traversals, Connected components, Spanning trees, Shortest paths; Hashing, Sorting, Searching; Design techniques (Greedy, Dynamic Programming, Divide-and-conquer);

Compiler Design: Lexical analysis, Parsing, Syntax directed translation, Runtime environment, Code generation, Linking (static and dynamic); Operating Systems: Classical concepts (concurrency, synchronization, deadlock), Processes, threads and Inter-process communication, CPU scheduling, Memory management, File systems, I/O systems, Protection and security.

Databases: Relational model (ER-model, relational algebra, tuple calculus), Database design (integrity constraints, normal forms), Query languages (SQL), File structures (sequential files, indexing, B+ trees), Transactions and concurrency control;

Computer Networks: ISO/OSI stack, sliding window protocol, LAN Technologies (Ethernet, Token ring), TCP/UDP, IP, Basic concepts of switches, gateways, and routers.

CH - CHEMISTRY

PHYSICAL CHEMISTRY

Structure: Quantum theory - principles and techniques; applications to particle in a box, harmonic oscillator, rigid rotor and hydrogen atom; valence bond and molecular orbital theories and Huckel approximation, approximate techniques: variation and perturbation; symmetry, point groups; rotational, vibrational, electronic, NMR and ESR spectroscopy.

Equilibrium: First law of thermodynamics, heat, energy and work; second law of thermodynamics and entropy; third law and absolute entropy; free energy; partial molar quantities; ideal and non-ideal solutions; phase transformation: phase rule and phase diagrams- one, two, and three component systems; activity, activity coefficient, fugacity and fugacity coefficient ; chemical equilibrium, response of chemical equilibrium to temperature and pressure; colligative properties; kinetic theory of gases; thermodynamics of electrochemical cells; standard electrode potentials: applications - corrosion and energy conversion; molecular partition function (translational, rotational, vibrational and electronic).

Kinetics: Rates of chemical reactions, theories of reaction rates, collision and transition state theory; temperature dependence of chemical reactions; elementary reactions, consecutive elementary reactions; steady state approximation, kinetics of photochemical reactions and free radical polymerization, homogenous and heterogeneous catalysis.

INORGANIC CHEMISTRY

Non-Transition Elements: General characteristics, structure and reactions of simple and industrially important compounds, boranes, carboranes, silicates, silicones, diamond and graphite; hydrides, oxides and oxoacids of N, P, S and halogens; boron nitride, borazines and phosphazenes; xenon compounds. Shapes of molecules, hard-soft acid base concept.

Transition Elements: General characteristics of d and f block elements; coordination chemistry: structure and isomerism, stability, theories of metal-ligand bonding (CFT and LFT), electronic spectra and magnetic properties of transition metal complexes and lanthanides; metal carbonyls, metal-metal bonds and metal atom clusters, metallocenes; transition metal complexes with bonds to hydrogen, alkyls, alkenes, and arenes; metal carbenes; use of organometallic compounds as catalysts in organic synthesis; mechanisms of substitution and electron transfer reactions of coordination complexes. Role of metals with special reference to Na, K, Mg, Ca, Fe, Co, Zn, and Mo in biological systems.

Solids: Crystal systems and lattices, Miller planes, crystal packing, crystal defects; Bragg's Law; ionic crystals, band theory, metals and semiconductors. Spinels.

Instrumental methods of analysis: atomic absorption, UV-visible spectrometry, chromatographic and electro-analytical methods.

ORGANIC CHEMISTRY

Synthesis, reactions and mechanisms involving the following: Alkenes, alkynes, arenes, alcohols, phenols, aldehydes, ketones, carboxylic acids and their derivatives; halides, nitro compounds and amines; stereochemical and conformational effects on reactivity and specificity; reactions with diborane and peracids. Michael reaction, Robinson annulation, reactivity umpolung, acyl anion equivalents; molecular rearrangements involving electron deficient atoms.

Photochemistry: Basic principles, photochemistry of olefins, carbonyl compounds, arenes, photo oxidation and reduction.

Pericyclic reactions: Cycloadditions, electrocyclic reactions, sigmatropic reactions; Woodward-Hoffmann rules.

Heterocycles: Structural properties and reactions of furan, pyrrole, thiophene, pyridine, indole.

Biomolecules: Structure, properties and reactions of mono- and di-saccharides, physico-chemical properties of amino acids, structural features of proteins and nucleic acids.

Spectroscopy: Principles and applications of IR, UV-visible, NMR and mass spectrometry in the determination of structures of organic compounds.

EC - ELECTRONICS AND COMMUNICATION ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix Algebra, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Mean value theorems, Theorems of integral calculus, Evaluation of definite and improper integrals, Partial Derivatives, Maxima and minima, Multiple integrals, Fourier series. Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equation (linear and nonlinear), Higher order linear differential equations with constant coefficients, Method of variation of parameters, Cauchy's and Euler's equations, Initial and boundary value problems, Partial Differential Equations and variable separable method.

Complex variables: Analytic functions, Cauchy's integral theorem and integral formula, Taylor's and Laurent' series, Residue theorem, solution integrals.

Probability and Statistics: Sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Discrete and continuous distributions, Poisson, Normal and Binomial distribution, Correlation and regression analysis.

Numerical Methods: Solutions of non-linear algebraic equations, single and multi-step methods for differential equations.

Transform Theory: Fourier transform, Laplace transform, Z-transform.

ELECTRONICS & COMMUNICATION ENGINEERING

Networks: Network graphs: matrices associated with graphs; incidence, fundamental cut set and fundamental circuit matrices. Solution methods: nodal and mesh analysis. Network theorems: superposition, Thevenin and Norton's maximum power transfer, Wye-Delta transformation. Steady state sinusoidal analysis using phasors. Linear constant coefficient differential equations; time domain analysis of simple RLC circuits, Solution of network equations using Laplace transform: frequency domain analysis of RLC circuits. 2-port network parameters: driving point and transfer functions. State equations for networks.

Electronic Devices: Energy bands in silicon, intrinsic and extrinsic silicon. Carrier transport in silicon: diffusion current, drift current, mobility, resistivity. Generation and recombination of carriers. p-n junction diode, Zener diode, tunnel diode, BJT, JFET, MOS capacitor, MOSFET, LED, p-I-n and avalanche photo diode, LASERs. Device technology: integrated circuits fabrication process, oxidation, diffusion, ion implantation, photolithography, n-tub, p-tub and twin-tub CMOS process.

Analog Circuits: Equivalent circuits (large and small-signal) of diodes, BJTs, JFETs, and MOSFETs. Simple diode circuits, clipping, clamping, rectifier. Biasing and bias stability of transistor and FET amplifiers. Amplifiers: single-and multi-stage, differential, operational, feedback and power. Analysis of amplifiers; frequency response of amplifiers. Simple op-amp circuits. Filters. Sinusoidal oscillators; criterion for oscillation; single-transistor and op-amp configurations. Function generators and wave-shaping circuits. Power supplies.

Digital circuits: Boolean algebra, minimization of Boolean functions; logic gates digital IC families (DTL, TTL, ECL, MOS, CMOS). Combinational circuits: arithmetic circuits, code converters, multiplexers and decoders. Sequential circuits: latches and flip-flops, counters and shift-registers. Sample and hold circuits, ADCs, DACs. Semiconductor memories. Microprocessor(8085): architecture, programming, memory and I/O interfacing.

Signals and Systems: Definitions and properties of Laplace transform, continuous-time and discrete-time Fourier series, continuous-time and discrete-time Fourier Transform, z-transform. Sampling theorems. Linear Time-Invariant (LTI) Systems: definitions and properties; casuality, stability, impulse response, convolution, poles and zeros frequency response, group delay, phase delay. Signal transmission through LTI systems. Random signals and noise: probability, random variables, probability density function, autocorrelation, power spectral density.

Controls Systems: Basic control system components; block diagrammatic description, reduction of block diagrams. Open loop and closed loop (feedback) systems and stability analysis of these systems. Signal flow graphs and their use in determining transfer functions of systems; transient and steady state analysis of LTI control systems and frequency response. Tools and techniques for LTI control system analysis: root loci, Routh-Hurwitz criterion, Bode and Nyquist plots. Control system compensators: elements of lead and lag compensation, elements of Proportional-Integral-Derivative(PID) control. State variable representation and solution of state equation of LTI control systems.

Communications: Analog communication systems: amplitude and angle modulation and demodulation systems, spectral analysis of these operations, superheterodyne receivers; elements of hardware, realizations of analog communication systems; signal-to-noise ratio (SNR) calculations for amplitude modulation (AM) and frequency modulation (FM) for low noise conditions. Digital communication systems: pulse code modulation (PCM), differential pulse code modulation (DPCM), delta modulation (DM); digital modulation schemes-amplitude, phase and frequency shift keying schemes (ASK, PSK, FSK), matched filter receivers, bandwith consideration and probability of error calculations for these schemes.

Electromagnetics: Elements of vector calculus: divergence and curl; Gauss' and Stokes' theorems, Maxwell's equations: differential and integral forms. Wave equation, Poynting vector. Plane waves: propagation through various media; reflection and refraction; phase and group velocity; skin depth. Transmission lines: characteristic impedance; impedance transformation; Smith chart; impedance matching; pulse excitation. Waveguides: modes in rectangular waveguides; boundary conditions; cut-off frequencies; dispersion relations. Antennas: Dipole antennas; antenna arrays; radiation pattern; reciprocity theorem, antenna gain.

EE - ELECTRICAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix Algebra, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Mean value theorems, Theorems of integral calculus, Evaluation of definite and improper integrals, Partial Derivatives, Maxima and minima, Multiple integrals, Fourier series. Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equation (linear and nonlinear), Higher order linear differential equations with constant coefficients, Method of variation of parameters, Cauchy's and Euler's equations, Initial and boundary value problems, Partial Differential Equations and variable separable method.

Complex variables: Analytic functions, Cauchy's integral theorem and integral formula, Taylor's and Laurent' series, Residue theorem, solution integrals.

Probability and Statistics: Sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Discrete and continuous distributions, Poisson, Normal and Binomial distribution, Correlation and regression analysis.

Numerical Methods: Solutions of non-linear algebraic equations, single and multi-step methods for differential equations.

Transform Theory: Fourier transform, Laplace transform, Z-transform.

ELECTRICAL ENGINEERING

Electrical Circuits and Fields: Network graph, KCL, KVL, node/ cut set, mesh/ tie set analysis, transient response of d.c. and a.c. networks; sinusoidal steady-state analysis; resonance in electrical circuits; concepts of ideal voltage and current sources, network theorems, driving point, immittance and transfer functions of two port networks, elementary concepts of filters; three phase circuits; Fourier series and its application; Gauss theorem, electric field intensity and potential due to point, line, plane and spherical charge distribution, dielectrics, capacitance calculations for simple configurations; Ampere's and Biot-Savart's law, inductance calculations for simple configurations.

Electrical Machines: Single phase transformer - equivalent circuit, phasor diagram, tests, regulation and efficiency; three phase transformers - connections, parallel operation; auto transformer and three-winding transformer; principles of energy conversion, windings of rotating machines: D. C. generators and motors - characteristics, starting and speed control, armature reaction and commutation; three phase induction motors-performance characteristics, starting and speed control; single-phase induction motors; synchronous generators-performance, regulation, parallel operation; synchronous motors - starting, characteristics, applications, synchronous condensers; fractional horse power motors; permanent magnet and stepper motors.

Power Systems: Electric power generation - thermal, hydro, nuclear; transmission line parameters; steady-state performance of overhead transmission lines and cables and surge propagation; distribution systems, insulators, bundle conductors, corona and radio interference effects; per-unit quantities; bus admittance and impedance matrices; load flow; voltage control and power factor correction; economic operation; symmetrical components, analysis of symmetrical and unsymmetrical faults; principles of over current, differential and distance protections; concept of solid state relays and digital protection; circuit breakers; concept of system stability-swing curves and equal area criterion; basic concepts of HVDC transmission.

Control Systems: Principles of feedback; transfer function; block diagrams: steady-state errors; stability-Routh and Nyquist criteria; Bode plots; compensation; root loci; elementary state variable formulation; state transition matrix and response for Linear Time Invariant systems.

Electrical and Electronic Measurements: Bridges and potentiometers, PMMC, moving iron, dynamometer and induction type instruments; measurement of voltage, current, power, energy and power factor; instrument transformers; digital voltmeters and multimeters; phase, time and frequency measurement; Q-meter, oscilloscopes, potentiometric recorders, error analysis.

Analog and Digital Electronics: Characteristics of diodes, BJT, FET, SCR; amplifiers-biasing, equivalent circuit and frequency response; oscillators and feedback amplifiers, operational amplifiers- characteristics and applications; simple active filters; VCOs and timers; combinational and sequential logic circuits, multiplexer, Schmitt trigger, multivibrators, sample and hold circuits, A/D and D/A converters; microprocessors and their applications.

Power Electronics and Electric Drives: Semiconductor power devices-diodes, transistors, thyristors, triacs, GTOs, MOSFETs and IGBTs - static characteristics and principles of operation; triggering circuits; phase control rectifiers; bridge converters-fully controlled and half controlled; principles of choppers and inverters, basic concepts of adjustable speed dc and ac drives.

GG - GEOLOGY AND GEOPHYSICS

PART - I

Earth and planetary system; size, shape, internal structure and composition of the earth; atmosphere and greenhouse effect; isostasy; elements of seismology; continents and continental processes; physical oceanography; palaeomagnetism, continental drift plate tectonics, geothermal energy.

Weathering; soil formation; action of river, wind and glacier; oceans and oceanic features; earthquakes, volcanoes, orogeny and mountain building; elements of structural geology; crystallography; classification, composition and properties of minerals and rocks; engineering properties of rocks and soils, role of geology in the construction of engineering structures.

Processes of ore formation, occurrence and distribution of ores on land and on ocean floor; coal and petroleum resources in India; ground water geology including well hydraulics, geological time scale and geochronology; stratigraphic principles and stratigraphy of India; basics concepts of gravity, magnetic and electrical prospecting for ores and ground water.

PART - IIA: GEOLOGY

Crystal symmetry, forms, twinning; crystal chemistry; optical mineralogy, classification of minerals, diagnostic properties of rock minerals.

Mineralogy, structure, texture and classification of igneous, sedimentary and metamorphic rock, their origin and evolution; application of thermodynamics; structure and petrology of sedimentary rocks; sedimentary processes and environments, sedimentary facies, basin studies; basement cover relationship;

Primary and secondary structures; geometry and genesis of folds, faults, joints, unconformities, cleavage, schistosity and lineation; methods of projection. Tectonites and their significance; shear zone; superposed folding.

Morphology, classification and geological significance of important invertebrates, vertebrates, microfossils and palaeoflora; stratigraphic principles and Indian stratigraphy; geomorphic processes and agents; development and evolution of landforms; slope and drainage; processes on deep oceanic and near-shore regions; quantitative and applied geomorphology; air photo interpretation and remote sensing; chemical and optical properties of ore minerals; formation and localization of ore deposits; prospecting and exploration of economic minerals; coal and petroleum geology; origin and distribution of mineral and fuel deposits in India; ore dressing and mineral economics.

Cosmic abundance; meteorites; geochemical evolution of the earth; geochemical cycles; distribution of major, minor and trace elements; isotope geochemistry; geochemistry of waters including solution equilibria and water rock interaction.

Engineering properties of rocks and soils; rocks as construction material; geology of dams, tunnels and excavation sites; natural hazards; the fly ash problem; ground water geology and exploration; water quality; impact of human activity; Remote sensing techniques for the interpretation of landforms and resource management.

PART - II B: GEOPHYSICS

The earth as a planet; different motions of the earth; gravity filed of the earth and its shape; geochronology; isostasy, seismology and interior of the earth; variation of density, velocity, pressure, temperature, electrical and magnetic properties inside the earth; earthquakes-causes and measurements; zonation and seismic hazards; geomagnetic field, palaeomagnetism; oceanic and continental lithosphere; plate tectonics; heat flow; upper and lower atmospheric phenomena.

Theories of scalar and vector potential fields; Laplace, Maxwell and Helmholtz equations for solution of different types of boundary value problems for Cartesian, cylindrical and spherical polar coordinates; Green's theorem; Image theory; integral equations and conformal transformations in potential theory; Eikonal equation and ray theory.

'G' and 'g' units of measurement, density of rocks, gravimeters, preparation, analysis and interpretation of gravity maps; derivative maps, analytical continuation; gravity anomaly type curves; calculation of mass.

Earth's magnetic field, units of measurement, magnetic susceptibility of rocks, magnetometers, corrections, preparation of magnetic maps, magnetic anomaly type curve, analytical continuation, interpretation and application; magnetic well logging.

Conduction of electricity through rocks, electrical conductivities of metals, metallic, non-metallic and rock forming minerals, D.C. resistivity units and methods of measurement, electrode configuration for sounding and profiling, application of filter theory, interpretation of resistivity field data, application; self potential origin, classification, field measurement, interpretation of induced polarization time frequency, phase domain; IP units and methods of measurement, interpretation and application; ground-water exploration.

Origin of electromagnetic field elliptic polarization, methods of measurement for different source-receiver configuration components in EM measurements, interpretation and applications; earth's natural electromagnetic field, tellurics, magneto-tellurics; geomagnetic depth sounding principles, methods of measurement, processing of data and interpretation.

Seismic methods of prospecting: Reflection, refraction and CDP surveys; land and marine seismic sources, generation and propagation of elastic waves, velocity increasing with depth, geophones, hydrophones, recording instruments (DFS), digital formats, field layouts, seismic noises and noise profile analysis, optimum geophone grouping, noise cancellation by shot and geophone arrays, 2D and 3D seismic data acquisition and processing, CDP stacking charts, binning, filtering, dip-moveout, static and dynamic corrections, deconvolution, migration, signal processing, Fourier and Hilbert transforms, attribute analysis, bright and dim spots, seismic stratigraphy, high resolution seismics, VSP.

Principles and techniques of geophysical well-logging, SP, resistivity, induction, micro gamma ray, neutron, density, sonic, temperature, dip meter, caliper, nuclear magnetic, cement bond logging. Quantitative evaluation of formations from well logs; well hydraulics and application of geophysical methods for groundwater study; application of bore hole geophysics in ground water, mineral and oil exploration. Remote sensing techniques and application of remote sensing methods in geophysics.

IN - INSTRUMENTATION ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix Algebra, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Mean value theorems, Theorems of integral calculus, Evaluation of definite and improper integrals, Partial Derivatives, Maxima and minima, Multiple integrals, Fourier series. Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equation (linear and nonlinear), Higher order linear differential equations with constant coefficients, Method of variation of parameters, Cauchy's and Euler's equations, Initial and boundary value problems, Partial Differential Equations and variable separable method.

Complex variables: Analytic functions, Cauchy's integral theorem and integral formula, Taylor's and Laurent' series, Residue theorem, solution integrals.

Probability and Statistics: Sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Discrete and continuous distributions, Poisson, Normal and Binomial distribution, Correlation and regression analysis.

Numerical Methods: Solutions of non-linear algebraic equations, single and multi-step methods for differential equations.

Transform Theory: Fourier transform, Laplace transform, Z-transform.

INSTRUMENTATION ENGINEERING

Measurement Basics and Metrology: Static and dynamic characteristics of measurement systems. Standards and calibration. Error and uncertainty analysis, statistical analysis of data, and curve fitting. Linear and angular measurements; Measurement of straightness, flatness, roundness and roughness.

Transducers, Mechanical Measurements and Industrial Instrumentation: Transducers - elastic, resistive, inductive, capacitive, thermo-electric, piezoelectric, photoelectric, electro-mechanical, electro-chemical, and ultrasonic. Measurement of displacement, velocity (linear and rotational), acceleration, shock, vibration, force, torque, power, strain, stress, pressure, flow, temperature, humidity, viscosity, and density. energy storing elements, suspension systems and dampers.

Analog Electronics: Characteristics of diodes, BJTs, JFETs and MOSFETs; Diode circuits; Amplifiers: single and multi-stage, feedback; Frequency response; Operational amplifiers - design, characteristic, linear and non-linear applications: difference amplifiers; instrumentation amplifiers; precision rectifiers, I-to-V converters, active filters, oscillators, comparators, signal generators, wave shaping circuits.

Digital Electronics: Combinational logic circuits, minimization of Boolean functions; IC families (TTL, MOS, CMOS), arithmetic circuits, multiplexer and decoders. Sequential circuits: flip-flops, counters, shift registers. Schmitt trigger, timers, and multivibrators. Analog switches, multiplexers, S/H circuits. Analog-to-digital and digital-to-analog converters. Basics of computer organization and architecture. 8-bit microprocessor (8085), applications, memory, I/O interfacing, and microcontrollers.

Signals and Systems: Vectors and matrices; Fourier series; Fourier transforms; Ordinary differential equations. Impulse and frequency responses of first and second order systems. Laplace transform and transfer function, convolution and correlation. Amplitude and frequency modulations and demodulations. Discrete time systems, difference equations, impulse and frequency responses; Z-transforms and transfer functions; IIR and FIR filters.

Electrical and Electronic Measurements: Measurement of R, L and C; bridges and potentiometers. Measurement of voltage, current, power, power factor, and energy; Instrument transformers; Q meter, waveform analyzers. Digital volt-meters and multi-meters. Time, phase and frequency measurements; Oscilloscope. Noise and interference in instrumentation.

Control Systems & Process Control: Principles of feedback; transfer function, signal flow graphs. Stability criteria, Bode plots, root-loci, Routh and Nyquist criteria. Compensation techniques; State space analysis. System components: mechanical, hydraulic, pneumatic, electrical and electronic; Servos and synchros; Stepper motors. On-off, cascade, P, PI, PID and feed-forward controls. Controller tuning and general frequency response.

Analytical, Optical and Biomedical Instrumentation: Principles of spectrometry, UV, visible, IR mass spectrometry, X-ray methods; nuclear radiation measurements, gas, solid and semi conductor lasers and their characteristics, interferometers, basics of fibre optics, transducers in biomedical applications, cardiovascular system measurements, instrumentation for clinical laboratory.

MA - MATHEMATICS

Linear Algebra: Finite dimensional vector spaces. Linear transformations and their matrix representations, rank; systems of linear equations, eigenvalues and eigenvectors, minimal polynomial, Cayley-Hamilton theorem, diagonalisation, Hermitian, Skew-Hermitian and unitary matrices. Finite dimensional inner product spaces, self-adjoint and Normal linear operators, spectral theorem, Quadratic forms.

Complex Analysis: Analytic functions, conformal mappings, bilinear transformations, complex integration: Cauchy's integral theorem and formula, Liouville's theorem, maximum modulus principle, Taylor and Laurent's series, residue theorem and applications for evaluating real integrals.

Real Analysis: Sequences and series of functions, uniform convergence, power series, Fourier series, functions of several variables, maxima, minima, multiple integrals, line, surface and volume integrals, theorems of Green, Stokes and Gauss; metric spaces, completeness, Weierstrass approximation theorem, compactness. Lebesgue measure, measurable functions; Lebesgue integral, Fatou's lemma, dominated convergence theorem.

Ordinary Differential Equations: First order ordinary differential equations, existence and uniqueness theorems, systems of linear first order ordinary differential equations, linear ordinary differential equations of higher order with constant coefficients; linear second order ordinary differential equations with variable coefficients, method of Laplace transforms for solving ordinary differential equations, series solutions; Legendre and Bessel functions and their orthogonality, Sturm Liouville system, Greeen's functions.

Algebra: Normal subgroups and homomorphisms theorems, automorphisms. Group actions, sylow's theorems and their applications groups of order less than or equal to 20, Finite p-groups. Euclidean domains, Principal ideal domains and unique factorizations domains. Prime ideals and maximal ideals in commutative rings.

Functional Analysis: Banach spaces, Hahn-Banach theorems, open mapping and closed graph theorems, principle of uniform boundedness; Hilbert spaces, orthonormal sets, Riesz representation theorem, self-adjoint, unitary and normal linear operators on Hilbert Spaces.

Numerical Analysis: Numerical solution of algebraic and transcendental equations; bisection, secant method, Newton-Raphson method, fixed point iteration, interpolation: existence and error of polynomial interpolation, Lagrange, Newton, Hermite(osculatory)interpolations; numerical differentiation and integration, Trapezoidal and Simpson rules; Gaussian quadrature; (Gauss-Legendre and Gauss-Chebyshev), method of undetermined parameters, least square and orthonormal polynomial approximation; numerical solution of systems of linear equations: direct and iterative methods, (Jacobi Gauss-Seidel and SOR) with convergence; matrix eigenvalue problems: Jacobi and Given's methods, numerical solution of ordinary differential equations: initial value problems, Taylor series method, Runge-Kutta methods, predictor-corrector methods; convergence and stability.

Partial Differential Equations: Linear and quasilinear first order partial differential equations, method of characteristics; second order linear equations in two variables and their classification; Cauchy, Dirichlet and Neumann problems, Green's functions; solutions of Laplace, wave and diffusion equations in two variables Fourier series and transform methods of solutions of the above equations and applications to physical problems.

Mechanics: Forces in three dimensions, Poinsot central axis, virtual work, Lagrange's equations for holonomic systems, theory of small oscillations, Hamiltonian equations;

Topology: Basic concepts of topology, product topology, connectedness, compactness, countability and separation axioms, Urysohn's Lemma, Tietze extension theorem, metrization theorems, Tychonoff theorem on compactness of product spaces.

Probability and Statistics: Probability space, conditional probability, Bayes' theorem, independence, Random variables, joint and conditional distributions, standard probability distributions and their properties, expectation, conditional expectation, moments. Weak and strong law of large numbers, central limit theorem. Sampling distributions, UMVU estimators, sufficiency and consistency, maximum likelihood estimators. Testing of hypotheses, Neyman-Pearson tests, monotone likelihood ratio, likelihood ratio tests, standard parametric tests based on normal, X2 ,t, F-distributions. Linear regression and test for linearity of regression. Interval estimation.

Linear Programming: Linear programming problem and its formulation, convex sets their properties, graphical method, basic feasible solution, simplex method, big-M and two phase methods, infeasible and unbounded LPP's, alternate optima. Dual problem and duality theorems, dual simplex method and its application in post optimality analysis, interpretation of dual variables. Balanced and unbalanced transportation problems, unimodular property and u-v method for solving transportation problems. Hungarian method for solving assignment problems.

Calculus of Variations and Integral Equations: Variational problems with fixed boundaries; sufficient conditions for extremum, Linear integral equations of Fredholm and Volterra type, their iterative solutions. Fredholm alternative.

ME - MECHANICAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

APPLIED MECHANICS AND DESIGN

Engineering Mechanics: Equivalent force systems, free-body concepts, equations of equilibrium, trusses and frames, virtual work and minimum potential energy. Kinematics and dynamics of particles and rigid bodies, impulse and momentum (linear and angular), energy methods, central force motion.

Strength of Materials: Stress and strain, stress-strain relationship and elastic constants, Mohr's circle for plane stress and plane strain, shear force and bending moment diagrams, bending and shear stresses, deflection of beams, torsion of circular shafts, thin and thick cylinders, Euler's theory of columns, strain energy methods, thermal stresses.

Theory of Machines: Displacement, velocity and acceleration, analysis of plane mechanisms, dynamic analysis of slider-crank mechanism, planar cams and followers, gear tooth profiles, kinematics of gears, governors and flywheels, balancing of reciprocating and rotating masses.

Vibrations: Free and forced vibration of single degree freedom systems, effect of damping, vibration isolation, resonance, critical speed of rotors.

Design of Machine Elements: Design for static and dynamic loading, failure theories, fatigue strength; design of bolted, riveted and welded joints; design of shafts and keys; design of spur gears, rolling and sliding contact bearings; brakes and clutches; belt, rope and chain drives.

FLUID MECHANICS AND THERMAL SCIENCES

Fluid Mechanics: Fluid properties, fluid statics, manometry, buoyancy; control-volume analysis of mass, momentum and energy; fluid acceleration; differential equations of continuity and momentum; Bernoulli's equation; viscous flow of incompressible fluids; boundary layer; elementary turbulent flow; flow through pipes, head losses in pipes, bends etc.

Heat-Transfer: Modes of heat transfer; one dimensional heat conduction, resistance concept, electrical analogy, unsteady heat conduction, fins; dimensionless parameters in free and forced convective heat transfer, various correlations for heat transfer in flow over flat plates and through pipes; thermal boundary layer; effect of turbulence; radiative heat transfer, black and grey surfaces, shape factors, network analysis; heat exchanger performance, LMTD and NTU methods.

Thermodynamics: Zeroth, First and Second laws of thermodynamics; thermodynamic system and processes; irreversibility and availability; behaviour of ideal and real gases, properties of pure substances, calculation of work and heat in ideal processes; analysis of thermodynamic cycles related to energy conversion; Carnot, Rankine, Otto, Diesel, Brayton and vapour compression cycles.

Power Plant Engineering: Steam generators; steam power cycles; steam turbines; impulse and reaction principles, velocity diagrams, pressure and velocity compounding; reheating and reheat factor; condensers and feed heaters.

I.C. Engines: Requirements and suitability of fuels in IC engines, fuel ratings, fuel-air mixture requirements; normal combustion in SI and CI engines; engine performance calculations.

Refrigeration and air-conditioning: Refrigerant compressors, expansion devices, condensers and evaporators; properties of moist air, psychrometric chart, basic psychometric processes.

Turbomachinery: Components of gas turbines; compression processes, centrifugal and axial flow compressors; axial flow turbines, elementary theory; hydraulic turbines; Euler-turbine equation; specific speed, Pelton-wheel, Francis and Kaplan turbines; centrifugal pumps.

MANUFACTURING AND INDUSTRIAL ENGINEERING

Engineering Materials: Structure and properties of engineering materials and their applications, heat treatment.

Metal Casting: Casting processes (expendable and non-expendable) -pattern, moulds and cores, heating and pouring, solidification and cooling, gating design, design considerations, defects.

Forming Processes: Stress-strain diagrams for ductile and brittle material, Plastic deformation and yield criteria, fundamentals of hot and cold working processes, Bulk metal forming processes (forging, rolling, extrusion, drawing), sheet metal working processes (punching, blanking, bending, deep drawing, coining, spinning, load estimation using homogeneous deformation methods, defects). processing of powder metals- atomization, compaction, sintering, secondary and finishing operations. forming and shaping of plastics- extrusion, injection moulding.

Joining Processes: Physics of welding, fusion and non-fusion welding processes, brazing and soldering, adhesive bonding, design considerations in welding, weld quality defects.

Machining and Machine Tool Operations: Mechanics of machining, single and multi-point cutting tools, tool geometry and materials, tool life and wear, cutting fluids, machinability, economics of machining, non-traditional machining processes.

Metrology and Inspection: Limits, fits and tolerances, linear and angular measurements, comparators, gauge design, interferometry, form and finish measurement, measurement of screw threads, alignment and testing methods.

Tool Engineering: Principles of work holding, design of jigs and fixtures.

Computer Integrated Manufacturing: Basic concepts of CAD, CAM and their integration tools.

Manufacturing Analysis: Part-print analysis, tolerance analysis in manufacturing and assembly, time and cost analysis.

Work-Study: Method study, work measurement, time study, work sampling, job evaluation, merit rating.

Production Planning and Control: Forecasting models, aggregate production planning, master scheduling, materials requirements planning.

Inventory Control: Deterministic and probabilistic models, safety stock inventory control systems.

Operations Research: Linear programming, simplex and duplex method, transportation, assignment, network flow models, simple queuing models, PERT and CPM

MN - MINING ENGINEERING

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

MINING ENGINEERING

Mechanics: Equivalent force systems, equations of equilibrium, two dimensional frames and trusses, free body diagrams, friction forces, particle kinematics and dynamics.

Mine Development, Geomechanics and Strata Control: Drivages for underground mine development, drilling methods and machines, explosives, blasting devices and practices, shaft sinking. Physico-mechanical properties of rocks, rock mass classification, ground control instrumentation and stress measurement techniques, theories of rock failure, ground vibrations, stress distribution around mine openings, subsidence, design of supports in roadways and workings, stability of open pits, slopes.

Mining Methods and Machinery: Surface mining - layout, development, loading, transportation and mechanization, continuous surface mining systems. Underground coal mining - bord and pillar system, longwall mining, thick seam mining methods. Underground metal mining: different stoping methods, stope mechanization, ore handling systems, mine filling. Generation and transmission of mechanical, hydraulic, and pneumatic power. Materials handling - haulages, conveyors, ropeways, face and development machinery, hoisting systems, and pumps.

Ventilation, Underground Hazards and Surface Environment: Underground atmosphere, heat load sources and thermal environment, air cooling, mechanics of air flow distribution, natural and mechanical ventilation, mine fans and their usage, auxiliary ventilation. Subsurface hazards from fires, explosions, gases, dust, and inundation, rescue apparatus and practices, safety in mines, accident analysis, noise, mine lighting. Air and water pollution: causes, dispersion, quality standards, and control.

Surveying, Mine Planning and Systems Engineering: Fundamentals of engineering surveying, Levels and levelling, Theodolite, tacheometry, triangulation, contouring, errors and adjustments, correlation, underground surveying, curves, photogrammetry, field astronomy, GPS fundamentals. Principles of planning - Sampling methods and practices, reserve estimation techniques, basics of geostatistics, optimization of facility location, cash flow concepts and mine valuation, open pit design. Work study, concepts of reliability, reliability of series and parallel systems. Linear programming, transportation and assignment problems, queueing, network analysis, inventory control.

MT - METALLURGICAL ENGINEERING

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

METALLURGICAL ENGINEERING

Thermodynamics and Rate Processes: Laws of thermodynamics, activity, equilibrium constant, applications to metallurgical systems, solutions, phase equilibria, basic kinetic laws, order of reactions, rate constants and rate limiting steps principles of electro chemistry, aqueous, corrosion and protection of metals, oxidation and high temperature corrosion - characterization and control; momentum transfer - concepts of viscosity, shell balances, Bernoulli's equation; heat transfer - conduction, convection and heat transfer coefficient relations, radiation, mass transfer - diffusion and Fick's laws.

Extractive Metallurgy: Flotation, gravity and other methods of mineral processing; agglomeration, pyro-hydro-and electro-metallurgical processes; material and energy balances; principles and processes for the extraction of non-ferrous metals - aluminium, copper, zinc, lead, magnesium, nickel, titanium and other rare metals; iron and steel making - principles, blast furnace, direct reduction processes, primary and secondary steel making, deoxidation and inclusion in steel; ingot and continuous casting; stainless steel making, design of furnaces; fuels and refractories.

Physical Metallurgy: Crystal structure and bonding characteristics of metals, alloys, ceramics and polymers; solid solutions; solidification; phase transformation and binary phase diagrams; principles of heat treatment of steels, aluminum alloys and cast irons; recovery, recrystallization and grain growth; industrially important ferrous and non-ferrous alloys; elements of X-ray and electron diffraction; principles of scanning and transmission electron microscopy; elements of ceramics, composites and electronic materials; electronic basis of thermal, optical, electrical and magnetic properties of materials.

Mechanical Metallurgy: Elements of elasticity and plasticity; defects in crystals; elements of dislocation theory - types of dislocations, slip and twinning, stress fields of dislocations, dislocation interactions and reactions, methods of seeing dislocations; strengthening mechanisms; tensile, fatigue and creep behaviour; superplasticity; fracture - Griffith theory, ductile to brittle transition, fracture toughness; failure analysis; mechanical testing - tension, compression, torsion, hardness, impact, creep, fatigue, fracture toughness and formability tests.

Manufacturing Processes: Metal casting - patterns, moulds, melting, gating, feeding and casting processes, defects and castings, hot and cold working of metals; Metal forming - fundamentals of metal forming, rolling wire drawing, extrusion, forming, sheet metal forming processes, defects in forming; Metal joining - soldering, brazing and welding, common welding processes, welding metallurgy, problems associated with welding of steels and aluminium alloys, defects in welding, powder metallurgy; NDT methods - ultrasonic, radiography, eddy current, acoustic emission and magnetic.

PH - PHYSICS

Mathematical Physics: Linear vector space, matrices; vector calculus; linear differential equations; elements of complex analysis; Laplace transforms, Fourier analysis, elementary ideas about tensors.

Classical Mechanics: Conservation laws; central forces; collisions and scattering in laboratory and centre of mass reference frames; mechanics of system of particles; rigid body dynamics; moment of inertia tensor; noninertial frames and pseudo forces; variational principle; Lagrange's and Hamilton's formalisms; equation of motion, cyclic coordinates, Poisson bracket; periodic motion, small oscillations, normal modes; wave equation and wave propagation; special theory of relativity - Lorentz transformations, relativistic kinematics, mass-energy equivalence.

Electromagnetic Theory: Laplace and Poisson equations; conductors and dielectrics; boundary value problems; Ampere's and Biot-Savart's laws; Faraday's law; Maxwell's equations; scalar and vector potentials; Coulomb and Lorentz gauges; boundary conditions at interfaces; electromagnetic waves; interference, diffraction and polarization; radiation from moving charges.

Quantum Mechanics: Physical basis of quantum mechanics; uncertainty principle; Schrodinger equation; one and three dimensional potential problems; Particle in a box, harmonic oscillator, hydrogen atom; linear vectors and operators in Hilbert space; angular momentum and spin; addition of angular momentum; time independent perturbation theory; elementary scattering theory.

Atomic and Molecular Physics: Spectra of one-and many-electron atoms; LS and jj coupling; hyperfine structure; Zeeman and Stark effects; electric dipole transitions and selection rules; X-ray spectra; rotational and vibrational spectra of diatomic molecules; electronic transition in diatomic molecules, Franck-Condon principle; Raman effect; NMR and ESR; lasers.

Thermodynamics and Statistical Physics: Laws of thermodynamics; macrostates, phase space; probability ensembles; partition function, free energy, calculation of thermodynamic quantities; classical and quantum statistics; degenerate Fermi gas; black body radiation and Planck's distribution law; Bose-Einstein condensation; first and second order phase transitions, critical point.

Solid State Physics: Elements of crystallography; diffraction methods for structure determination; bonding in solids; elastic properties of solids; defects in crystals; lattice vibrations and thermal properties of solids; free electron theory; band theory of solids; metals, semiconductors and insulators; transport properties; optical, dielectric and magnetic properties of solids; elements of superconductivity.

Nuclear and Particle Physics: Rutheford scattering; basic properties of nuclei; radioactive decay; nuclear forces; two nucleon problem; nuclear reactions; conservation laws; fission and fusion; nuclear models; particle accelerators, detectors; elementary particles; photons, baryons, mesons and leptons; Quark model.

Electronics: Network analysis; semiconductor devices; bipolar transistors; FETs; power supplies, amplifier, oscillators; operational amplifiers; elements of digital electronics; logic circuits.

PI - PRODUCTION AND INDUSTRIAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

GENERAL ENGINEERING:

Engineering Materials: Structure and properties of engineering materials and their applications; effect of strain, strain rate and temperature on mechanical properties of metals and alloys; heat treatment of metals and alloys.

Applied Mechanics: Engineering mechanics - equivalent force systems, free body concepts, equations of equilibrium, virtual work and minimum potential energy; strength of materials-stress, strain and their relationship, Mohr's circle, deflection of beams, bending and shear stress, Euler's theory of columns.

Theory of Machines and Design: Analysis of planar mechanisms, plane cams and followers; governers and fly wheels; design of elements-failure theories; design of bolted, riveted and welded joints; design of shafts, keys, belt drives, brakes and clutches.

Thermal Engineering: Fluid machines - fluid statics, Bernoulli's equation, flow through pipes, equations of continuity and momentum; Thermodynamics - zeroth, First and Second laws of thermodynamics, thermodynamic system and processes, calculation of work and heat for systems and control volumes; Heat transfer - fundamentals of conduction, convection and radiation.

PRODUCTION ENGINEERING

Metal Casting: Casting processes; patterns-materials; allowances; moulds and cores - materials, making and testing; melting and founding of cast iron, steels and nonferrous metals and alloys; solidification; design of casting, gating and risering; casting defects and inspection.

Metal working: Stress-strain in elastic and plastic deformation; deformation mechanisms; hot and cold working-forging, rolling, extrusion, wire and tube drawing; sheet metal working; analysis of rolling, forging, extrusion and wire /rod drawing; metal working defects, high energy rate forming processes-explosive, magnetic, electro and electrohydraulic.

Metal Joining Processes: Welding processes - gas shielded metal arc, TIG, MIG, submerged arc, electroslag, thermit, resistance, pressure and forge welding; thermal cutting; other joining processes - soldering, brazing, braze welding; welding codes, welding symbols, design of welded joints, defects and inspection; introduction to modern welding processes - friction, ultrasonic, explosive, electron beam, laser and plasma.

Machining and Machine Tool Operations: Machining processes-turning, drilling, boring, milling, shaping, planing, sawing, gear cutting, thread production, broaching, grinding, lapping, honing super finishing; mechanics of cutting- Merchant's analysis, geometry of cutting tools, cutting forces, power requirements; selection of process parameters; tool materials, tool wear and tool life, cutting fluids, machinability; nontraditional machining processes and hybrid processes- EDM, CHM, ECM, USM, LBM, EBM, AJM, PAM AND WJM; economics of machining.

Metrology and Inspection: Limits and fits, linear and angular measurements by mechanical and optical methods, comparators; design of limit gauges; interferometry; measurement of straightness, flatness, roundness, squareness and symmetry; surface finish measurement; inspection of screw threads and gears; alignment testing.

Powder Metallurgy and Processing of Plastics: Production of powders, compaction, sintering; Polymers and composites; injection, compression and blow molding, extrusion, calendaring and thermoforming; molding of composites.

Tool Engineering: Work-holding-location and clamping; principles and methods; design of jigs and fixtures; design of press working tools, forging dies.

Manufacturing Analysis: Sources of errors in manufacturing; process capability; part-print analysis; tolerance analysis in manufacturing and assembly; process planning; parameter selection and comparison of production alternatives; time and cost analysis; Issues in choosing manufacturing technologies and strategies.

Computer Integrated Manufacturing: Basic concepts of CAD, CAM, CAPP, group technology, NC, CNC, DNC, FMS, Robotics and CIM.

INDUSTRIAL ENGINEERING

Product Design and Development: Principles of good product design, component and tolerance design; efficiency, quality and cost considerations; product life cycle; standardization, simplification, diversification, value analysis, concurrent engineering.

Engineering Economy and Costing: Financial statements; elementary cost accounting, methods of depreciation; break-even analysis, techniques for evaluation of capital investments.

Work System Design: Taylor's scientific management, Gilbreths's contributions; productivity concepts and measurements; method study, micro-motion study, principles of motion economy; human factors engineering, ergonomics; work measurement - time study, PMTS, work sampling; job evaluation, merit rating, wage administration, incentive systems; business process reengineering.

Logistics and Facility Design: Facility location factors, evaluation of alternatives, types of plant layout, evaluation; computer aided layout; assembly line balancing; material handling systems; supply chain management.

Production Planning and Inventory Control: Inventory Function costs, classifications - deterministic and probabilistic models; quantity discount; safety stock; inventory control system; Forecasting techniques - causal and time series models, moving average, exponential smoothing; trend and seasonality; aggregate production planning; master scheduling; bill of materials and material requirement planning; order control and flow control, routing, scheduling and priority dispatching; JIT; Kanban PULL systems; bottleneck scheduling and theory of constraints.

Operation Research: Linear programming - problem formulation, simplex method, duality and sensitivity analysis; transportation; assignment; network flow models, constrained optimization and Lagrange multipliers; simple queuing models; dynamic programming; simulation; PERT and CPM, time-cost trade-off, resource leveling.

Quality Control: Taguchi method; design of experiments; quality costs, statistical quality assurance, process control charts, acceptance sampling, zero defects; quality circles, total quality management.

Reliability and Maintenance: Reliability, availability and maintainability; probabilistic failure and repair times; system reliability; preventive maintenance and replacement, TPM.

Management Information System: Value of information; information storage and retrieval system - database and data structures; interactive systems; knowledge based systems.

Intellectual Property System: Definition of intellectual property, importance of IPR; TRIPS, and its implications, WIPO and Global IP structure, and IPS in India; patent, copyright, industrial design and trademark; meanings, rules and procedures, terms, infringements and remedies.

PY - PHARMACEUTICAL SCIENCES

Natural Products: Pharmacognosy & Phytochemistry - Chemistry, tests, isolation, characterization and estimation of phytopharmaceuticals belonging to the group of Alkaloids, Glycosides, Terpenoids, Steroids, Bioflavanoids, Purines, Guggul lipids. Pharmacognosy of crude drugs which contain the above constituents. Standardisation of raw materials and herbal products. WHO guide lines. Quantitative microscopy including modern techniques used for evaluation. Biotechnological principles and techniques for plant development Tissue culture.

Pharmacology: General pharmacological principles including Toxicology. Drug interaction. Pharmacology of drugs acting on Central nervous system, Cardiovascular system, Autonomic nervous system, Gastro intestinal system and Respiratory system. Pharmacology of Autocoids, Hormones, Chemotherapeutic agents including anticancer drugs. Bioassays. Immuno

Pharmacology.

Medicinal Chemistry: Structure, nomenclature, classification, synthesis, SAR and metabolism of the following category of drugs which are official in Indian Pharmacopoeia and British Pharmacopoeia Hypnotics and Sedatives, Analgesics, NSAIDS, Neuroleptics, Antidepressants, Anxiolytics, Anticonvulsants, Antihistaminics, Local anaesthetics, Cardio Vascular drugs - Antianginal agents Vasodilators, Adrenergic & cholinergic drugs, Cardiotonic agents, Diuretics, Antihypertensive drugs, Hypoglycemic agents, Antilipedmic agents, Coagulants, Anticoagulants, Antiplatelet agents. Chemotherapeutic agents - Antibiotics, Antibacterials, Sulphadrugs. Antiproliozoal drugs, Antiviral, Antitubercular, Antimalarial, Anticancer, Antiamoebic drugs. Diagnostic agents. Preparation and storage and uses of official Radiopharmaceuticals. Vitamins and Hormones.

Pharmaceutics: Development, manufacturing standards, labeling, packing as per the pharmacopoeal requirements, Storage of different dosage forms and new drug delivery systems. Biopharmaceutics and Pharmacokinetics and their importance in formulation. Formulation and preparation of cosmetics - lipstick, shampoo, creams, nail preparations and dentifrices. Pharmaceutical calculations.

Pharmaceutical Jurisprudence: Legal aspects of manufacture, storage, sale of drugs. D and C act and rules. Pharmacy act.

Pharmaceutical Analysis: Principles, instrumentation and applications of the following. Absorption spectroscopy (UV, visible & IR), Fluorimetry, Flame photometry, Potentiometry, Conductometry and Plarography. Pharmacopoeial assays. Principles of NMR, ESR, Mass spectroscopy, X-ray diffraction analysis and different chromatographic methods.

Biochemistry and Clinical Pharmacy: Biochemical role of hormones, Vitamins, Enzymes, Nucleic acids. Bioenergetics. General principles of immunology. Immunological techniques. Adverse drug interaction.

Microbiology: Principles and methods of microbiological assays of the Pharmacopoeia. Methods of preparation of official sera and vaccines. Serological and diagnostic tests. Applications of microorganisms in Bio Conversions and in Pharmaceutical industry.

TF - TEXTILE ENGINEERING AND FIBRE SCIENCE

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

TEXTILE ENGINEERING & FIBRE SCIENCE

Textile Fibres: Classification of textile fibres according to their nature and origin; general characteristics of textile fibres-their chemical and physical structures and their properties; essential characteristics of fibre forming polymers; uses of natural and man-made fibres; physical and chemical methods of fibre and blend identification and blend analysis.

Melt Spinning processes with special reference to polyamide and polyester fibres; wet and dry spinning of viscose and acrylic fibres; post spinning operations-drawing, heat setting, texturing- false twist and air-jet, tow-to-top conversion. Methods of investigating fibre structure e.g. X-ray diffraction, birefringence, optical and electron microscopy, I.R. absorption, thermal methods; structure and morphology and principal natural and man-made fibres, mechanical properties of fibres, moisture sorption in fibres; fibre structure and property correlation.

Textile Testing: Sampling techniques, sample size and sampling errors; measurement of fibre length, fineness, crimp, strength and reflectance; measurement of cotton fibre maturity ad trash content; HVI and AFIS for fibre testing. Measurement of yarn count, twist and hairiness; tensile testing of fibres, yarn and fabrics; evenness testing of slivers, rovings and yarns; testing equipment for measurement test methods of fabric properties like thickness, compressibility, air permeability, drape, crease recovery, tear strength bursting strength and abrasion resistance. Correlation analysis, significance tests and analysis of variance; frequency distributions and control charts.

Yarn Manufacture and Yarn Structure: Modern methods of opening, cleaning and blending of fibrous materials; the technology of carding with particular reference to modern developments; causes of irregularity introduced by drafting, the development of modern drafting systems; principles and techniques of preparing material for combing; recent development in combers; functions and synchronization of various mechanisms concerned with roving production; forces acting on yarn and traveller, ring and traveller designs; causes of end breakages; properties of doubles yarns; new methods of yarn production such as rotor spinning, air jet spinning and friction spinning.

Yarn diameter; specific volume, packing coefficient; twist-strength relationship; fibre orientation in yarn; fibre migration.

Fabric Manufacture and Fabric Structure: Principles of cheese and cone winding processes and machines; random and precision winding; package faults and their remedies; yarn clearers and tensioners; different systems of yarn splicing; features of modern cone winding machines; different types of warping creels; features of modern beam and sectional warping machines; different sizing systems, sizing of spun and filament yarns, modern sizing machines; principles of pirn winding processes and machines; primary and secondary motions of loom, effect of their settings and timings on fabric formation, fabric appearance and weaving performance; dobby and jacquard shedding; mechanics of weft insertion with shuttle; warp and weft stop motions, warp protection, weft replenishment; functional principles of weft insertion systems of shuttleless weaving machines, principles of multiphase and circular looms. Principles of weft and warp knitting; basic weft and warp knitted structures; classification, production and areas of application of nonwoven fabrics.

Basic woven fabric constructions and their derivatives; crepe, cord, terry, gauze, lino and double cloth constructions.

Peirce's equations for fabric geometry; thickness, cover and maximum sett of woven fabrics

Textile Chemical Processing: Preparatory processes for natural-and and their blends; mercerization of cotton; machines for yarn and fabric mercerization.

Dyeing and printing of natural- and synthetic- fibre fabrics and their blends with different dye classes; dyeing and printing machines; styles of printing; fastness properties of dyed and printed textile materials.

Finishing of textile materials, wash and wear, durable press, soil release, water repellent, flame retardant and antistatic finishes; shrink-resistance finish for wool; heat setting of synthetic-fibre fabrics, finishing machines; energy efficient processes; pollution control.

XE - ENGINERING SCIENCES

The syllabi of the sections of this paper are as follows:

SECTION A. ENGINEERING MATHEMATICS (Compulsory)

Linear Algebra : Determinates, algebra of matrices, rank, inverse, system of linear equations, symmetric, skew-symmetric and orthogonal matrices. Hermitian, skew-hermitian and unitary matrices. eigenvalues and eigenvectors, diagonalisation of matrices, Cayley-Hamiltonian, quadratic forms.

Calculus : Functions of single variables, limit, continuity and differentiability, Mean value theorems, Intermediate forms and L'Hospital rule, Maxima and minima, Taylor's series, Fundamental and mean value-theorems of integral calculus. Evaluation of definite and improper integrals, Beta and Gamma functions, Functions of two variables, limit, continuity, partial derivatives, Euler's theorem for homogeneous functions, total derivatives, maxima and minima, Lagrange method of multipliers, double and triple integrals and their applications, sequence and series, tests for convergence, power series, Fourier Series, Fourier integrals.

Complex variable: Analytic functions, Cauchy's integral theorem and integral formula without proof. Taylor's and Laurent' series, Residue theorem (without proof) with application to the evaluation of real integarls.

Vector Calculus: Gradient, divergence and curl, vector identities, directional derivatives, line, surface and volume integrals, Stokes, Gauss and Green's theorems (without proofs) with applications.

Ordinary Differential Equations: First order equation (linear and nonlinear), higher order linear differential equations with constant coefficients, method of variation of paramaters, Cauchy's and Euler's equations, initial and boundary value problems, power series solutions, Legendre polynomials and Bessel's functions of the first kind.

Partial Differential Equations: Variables separable method, solutions of one dimensional heat, wave and Laplace equations.

Probability and Statistics: Definitions of probability and simple theorems, conditional probability, mean, mode and standard deviation, random variables, discrete and continuous distributions, Poisson, normal and Binomial distribution, correlation and regression

Numerical Methods: L-U decomposition for systems of linear equations,Newton-Raphson method, numerical integration(trapezoidal and Simpson's rule), numerical methods for first order differential equation (Euler method)

SECTION B. COMPUTATIONAL SCIENCE

Numerical Methods: Truncation errors, round off errors and their propagation; Interpolation; Lagrange, Newton's forward, backward and divided difference formulas, least square curve fitting, solution of non-linear equations of one variables using bisection, false position, secant and Newton Raphson methods; Rate of convergence of these methods, general iterative methods. Simple and multiple roots of polynomials. Solutions of system of linear algebraic equations using Gauss elimination methods, Jacobi and Gauss-Seidel iterative methods and their rate of convergence; ill conditioned and well conditioned system. eigen values and eigen vectors using power methods. Numerical integration using trapezoidal, Simpson's rule and other quadrature formulas. Numerical Differentiation. Solution of boundary value problems.

Solution of initial value problems of ordinary differential equations using Euler's method, predictor corrector and Runge Kutta method.

Programming : Elementary concepts and terminology of a computer system and system software, Fortran77 and C programming.

Fortran : Program organization, arithmetic statements, transfer of control, Do loops, subscripted variables, functions and subroutines.

C language : Basic data types and declarations, flow of control- iterative statement, conditional statement, unconditional branching, arrays, functions and procedures.

SECTION C. ELECTRICAL SCIENCES

Electric Circuits: Ideal voltage and current sources; RLC circuits, steady state and transient analysis of DC circuits, network theorems; alternating currents and voltages, single-phase AC circuits, resonance; three-phase circuits.

Magnetic circuits: Mmf and flux, and their relationship with voltage and current; transformer, equivalent circuit of a practical transformer, three-phase transformer connections.

Electrical machines: Principle of operation, characteristics, efficiency and regulation of DC and synchronous machines; equivalent circuit and performance of three-phase and single-phase induction motors.

Electronic Circuits: Characteristics of p-n junction diodes, zener diodes, bipolar junction transistors (BJT) and junction field effect transistors (JFET); MOSFET's structure, characteristics, and operations; rectifiers, filters, and regulated power supplies; biasing circuits, different configurations of transistor amplifiers, class A, B and C of power amplifiers; linear applications of operational amplifiers; oscillators; tuned and phase shift types.

Digital circuits: Number systems, Boolean algebra; logic gates, combinational circuits, flip-flops (RS, JK, D and T) counters.

Measuring instruments: Moving coil, moving iron, and dynamometer type instruments; shunts, instrument transformers, cathode ray oscilloscopes; D/A and A/D converters.

SECTION D. FLUID MECHANICS

Fluid Properties: Relation between stress and strain rate for Newtonian fluids

Hydrostatics, buoyancy, manometry

Concept of local and convective accelerations; control volume analysis for mass, momentum and energy conservation.

Differential equations of continuity and momentum (Euler's equation of motion); concept of fluid rotation, stream function, potential function; Bernoulli's equation and its applications.

Qualitative ideas of boundary layers and its separation; streamlined and bluff bodies; drag and lift forces.

Fully-developed pipe flow; laminar and turbulent flows; friction factor; Darcy Weisbach relation; Moody's friction chart; losses in pipe fittings; flow measurements using venturimeter and orifice plates.

Dimensional analysis; similitude and concept of dynamic similarity; importance of dimensionless numbers in model studies.

SECTION E. MATERIALS SCIENCE

Atomic structure and bonding in materials: metals, ceramics and polymers.

Structure of materials: Crystal systems, unit cells and space lattice; determination of structures of simple crystals by X-ray diffraction; Miller indices for planes and directions. Packing geometry in metallic, ionic and covalent solids.

Concept of amorphous, single and polycrystalline structures and their effects on properties of materials.

Imperfections in crystalline solids and their role in influencing various properties.

Fick´s laws of diffusion and applications of diffusion in sintering, doping of semiconductors and surface hardening of metals.

Alloys: solid solution and solubility limit. Binary phase diagram, intermediate phases and intermetallic compounds; iron-iron carbide phase diagram. Phase transformation in steels. Cold and hot working of metals, recovery, recrystallization and grain growth.

Properties and applications of ferrous and nonferrous alloys.

Structure, properties, processing and applications of traditional and advanced ceramics.

Polymers: classification, polymerization, structure and properties, additives for polymer products, processing and application.

Composites: properties and application of various composites.

Corrosion and environmental degradation of materials (metals, ceramics and polymers).

Mechanical properties of materials: Stress-strain diagrams of metallic, ceramic and polymeric materials, modulus of elasticity, yield strength, plastic deformation and toughness, tensile strength and elongation at break; viscoelasticity, hardness, impact strength. ductile and brittle fracture. creep and fatigue properties of materials.

Heat capacity, thermal conductivity, thermal expansion of materials.

Concept of energy band diagram for materials; conductors, semiconductors and insulators in terms of energy bands. Electrical conductivity, effect of temperature on conductivity in materials, intrinsic and extrinsic semiconductors, dielectric properties of materials.

Refraction, reflection, absorption and transmission of electromagnetic radiation in solids.

Origin of magnetism in metallic and ceramic materials, paramagnetism, diamagnetism, antiferromagnetism, ferromagnetism, ferrimagnetism in materials and magnetic hysteresis.

Advanced materials: Smart materials exhibiting ferroelectric, piezoelectric, optoelectronic, semiconducting behaviour; lasers and optical fibers; photoconductivity and superconductivity in materials.

SECTION F. SOLID MECHANICS

Equivalent force systems; free-body diagrams; equilibrium equations; analysis of determinate and indeterminate trusses and frames; friction.

Simple relative motion of particles; force as function of position, time and speed; force acting on a body in motion; laws of motion; law of conservation of energy; law of conservation of momentum

Stresses and strains; principal stresses and strains; Mohr's circle; generalized Hooke's Law; equilibrium equations; compatibility conditions; yield criteria.

Axial, shear and bending moment diagrams; axial, shear and bending stresses; deflection (for symmetric bending); torsion in circular shafts; thin cylinders; energy methods (Castigliano's Theorems); Euler buckling.

SECTION G. THERMODYNAMICS

Basic Concepts: Continuum, macroscopic approach, thermodynamic system (closed and open or control volume); thermodynamic properties and equilibrium; state of a system, state diagram, path and process; different modes of work; Zeroth law of thermodynamics; concept of temperature; heat.

First Law of Thermodynamics: Energy, enthalpy, specific heats, first law applied to systems and control volumes, steady and unsteady flow analysis.

Second Law of Thermodynamics: Kelvin-Planck and Clausius statements, reversible and irreversible processes, Carnot theorems, thermodynamic temperature scale, Clausius inequality and concept of entropy, principle of increase of entropy; availability and irreversibility.

Properties of Pure Substances: Thermodynamic properties of pure substances in solid, liquid and vapour phases, P-V-T behaviour of simple compressible substances, phase rule, thermodynamic property tables and charts, ideal and real gases, equations of state, compressibility chart.

Thermodynamic Relations: T-ds relations, Maxwell equations, Joule-Thomson coefficient, coefficient of volume expansion, adiabatic and isothermal compressibilities, Clapeyron equation.

Ideal Gas Mixtures: Dalton's and Amagat's laws, calculations of properties, air-water vapour mixtures.

XL - LIFE SCIENCES

The syllabi of the Sections of this paper are as follows:

SECTION H. CHEMISTRY (Compulsory)

Atomic structure and periodicity: Quantum chemistry; Planck's quantum theory, wave particle duality, uncertainty principle, quantum mechanical model of hydrogen atom; electronic configuration of atoms; periodic table and periodic properties; ionization energy, election affinity, electronegativity, atomic size.

Structure and bonding: Ionic and covalent bonding M.O. and V.B. approaches for diatomic molecules, VSEPR theory and shape of molecules, hybridisation, resonance, dipole moment, structure parameters such as bond length, bond angle and bond energy, hydrogen bonding, van der Waals interactions. Ionic solids; ionic radii, lattice energy (Born-Haber Cycle).

s.p. and d Block Elements: Oxides, halides and hydrides of alkali and alkaline earth metals, B, Al, S, N, P and S, silicones, general characteristics of 3d elements, coordination complexes: valence bond and crystal field theory, color, geometry and magnetic properties.

Chemical Equilibria: Colligative properties of solutions, ionic equilibria in solution, solubility product, common ion effect, hydrolysis of salts, pH, buffer and their applications in chemical analysis.

Electrochemistry: Conductance, Kohlrausch law, Half Cell potentials, emf, Nernst equation, galvanic cells, thermodynamic aspects and their applications.

Reaction Kinetics: Rate constant, order of reaction, molecularity, activation energy, zero, first and second order kinetics, equilibrium constants (Kc, Kp and Kx) for homogeneous reactions, catalysis and elementary enzyme reactions.

Thermodynamics: First law, reversible and irreversible processes, internal energy, enthalpy, Kirchoff's equation, heat of reaction, Hess law, heat of formation, Second law, entropy, free energy, and work function. Gibbs-Helmholtz equation, Clausius-Clapeyron equation, free energy change and equilibrium constant, Troutons rule, Third law of thermodynamics.

Mechanistic Basis of Organic Reactions: Elementary treatment of SN1, SN2, E1 and E2 reactions, Hoffmann and Saytzeff rules, Addition reactions, Markonikoff rule and Kharash effect, Diels-Alder reaction, aromatic electrophilic substitution, orientation effect as exemplified by various functional groups.

Structure-Reactivity Correlations: Acids and bases, electronic and steric effects, optical and geometrical isomerism, tautomerism, concept of aromaticity

SECTION I. BIOCHEMISTRY

Organization of life. Importance of water. Cell structure and organelles. Structure and function of biomolecules: Carbohydrates, Lipids, Proteins and Nucleic acids. Biochemical separation techniques. Spectroscopic methods; UV-visible and fluorescence. Protein structure, folding and function: Myoglobin, Hemoglobin, Lysozyme, ribonuclease A, Carboxypeptidase and Chymotrypsin. Enzyme kinetics and regulation, Coenzymes.

Metabolism and bioenergitics. Generation and utilization of ATP. Photosynthesis. Major metabolic pathways and their regulation. Biological membranes. Transport across membranes. Signal transduction; hormones and neurotransmitters.

DNA replication, transcription and translation. Biochemical regulation of gene expression. Recombinant DNA technology and applications. Genomics and Proteomics.

The immune system. Active and passive immunity. Complement system. Antobody structure, function and diversity. Cells of the immune system: T, B and macrophages. T and B cell activation. Major histocompatibilty complex. T cell receptor. Immunological techniques: Immunodiffusion, immunoelectrophoresis, RIA and ELISA.

SECTION J. BIOTECHNOLOGY

Recombinant DNA technology for the production of therapeutic proteins. Micro array technology. Heterologous protein expression systems in bacteria, yeast etc.

Architecture of plant genome; plant tissue culture techniques; methods of gene transfer into plant cells; manipulation of phenotypic traits in plants; plant cell fermentations and production of secondary metabolites using suspension/ immobilized cell culture; methods for plant micro propagation; crop improvement and development of transgenic plants. Expression of animal proteins in plants.

Animal cell metabolism and regulation; cell cycle; primary cell culture; nutritional requirements for animal cell culture; techniques for the mass culture of animal cell lines; production of vaccines; growth hormones and interferons using animal cell culture; cytokines-production and therapeutic uses; hybridoma technology; vectors for gene transfer and expression in animal cells. Transgenic animals and molecular pharming.

Microbial production of industrial enzymes; methods for immobilization of enzymes; kinetics of soluble and immobilized enzymes; application of soluble and immobilized enzymes; enzyme-based sensors.

Microbial growth kinetics; batch, fed batch and continuous culture of microbial cells; media for industrial fermentations; sterilization of air and media; design features and operation of stirred tank, air-lift and fluidized bed reactors; aeration and agitation in aerobic fermentations; recovery and purification of fermentation products- filtration, centrifugation, cell disintegration, solvent extraction and chromatographic separations; industrial fermentations for the production of ethanol, citric acid, lysine, penicillin and other biomolecules; simple calculations based on material and energy balance of fermentation processes; application of microbes in the management of domestic and industrial wastes.

SECTION K. BOTANY

Anatomy: Roots, stem and leaves of land plants, meristems, vascular system, their ontogeny, structure and functions. Plant cell structure, organisation, organelles, cytoskeleton, cell wall and membranes.

Development: Cell cycle, cell division, senescence, hormonal regulation of growth; life cycle of an angiosperm, pollination, fertilization, embryogenesis, seed formation, seed storage proteins, seed dormancy and germination. Concept of cellular totipotency, organogenesis and somatic embryogenesis, somaclonal variation, embryo culture, in vitro fertilization.

Physiology and Biochemistry: Plant water relations, transport of minerals and solutes, N2 metabolism, proteins and nucleic acid, respiration, photophysiology, photosynthesis, photorespiration; biosynthesis, mechanism of action and physiological effects of plant growth regulators.

Genetics: Principles of Mendelian inheritance, linkage, recombination and genetic mapping; extrachromosomal inheritance; eukaryotic genome organization (chromatin structure) and regulation of gene expression, gene mutation, chromosome aberrations (numerical and structural), transposons.

Plant Breeding: Principles, methods - selection, hybridization, heterosis; male sterility, self and inter-specific incompatibility; haploidy; somatic cell hybridization; molecular marker-assisted selection; gene transfer methods viz. direct and vector-mediated, transgenic plants and their applications in agriculture.

Economic Botany: Economically important plants - cereals, pulses, plants yielding fiber, timber, sugar, beverages, oils, rubber, dyes, gums, drugs and narcotics - a general account.

Systematics: Systems of classification (non-phylogenetic vs. phylogenetic - outline), plant groups, molecular systematics.

Plant Pathology: Nature and classification of plant diseases, diseases of important crops caused by fungi, bacteria and viruses, and their control measures, mechanism(s) of pathogenesis and resistance, molecular detection of pathogens; plant-microbe beneficial interactions.

Ecology and Plant Geography: Ecosystems - types, dynamics, degradation, ecological succession; food chains; vegetation types of the world; pollution and global warming; speciation and extinction, conservation strategies, cryopreservation.

SECTION L. MICROBIOLOGY

Historical perspective - Discovery of the microbial world; Controversy over spontaneous generation; Role of microorganisms in transformation of organic matter and in the causation of diseases.

Methods in microbiology - Pure culture techniques; Theory and practice of sterilization;

Principles of microbial nutrition; Construction of culture media; Enrichment culture techniques for isolation of chemoautotrophs, chemoheterotrophs and photosynthetic microorganisms.

Microbial evolution, systematics and taxonomy - Evolution of earth and earliest life forms; Primitive organisms and their metabolic strategies; New approaches to bacterial taxonomic classification including ribotyping; Nomenclature.

Microbial diversity - Bacteria, archea and their broad classification; Eukaryotic microbes, yeast, fungi, slime mold and protozoa; Viruses and their classification.

Microbial growth -The definition of growth, mathematical expression of growth, growth curve, measurement of growth and growth yields; Synchronous growth; Continuous culture.

Nutrition and metabolism - Overview of metabolism; Microbial nutrition; Energy classes of microorganisms; Culture media; Energetics, modes of ATP generation; ATP generation by heterotrophs; Fermentation; Glycolysis; Respiration; The citric acid cycle; Electron transport systems; Alternate modes of energy generation; Pathways (anabolism) in the biosynthesis of amino acids, purines, pyrimidines and fatty acids.

Metabolic diversity among microorganisms - Photosynthesis in microorganisms; Role of chlorophylls, carotenoids and phycobilins; Calvin cycle; Chemolithotrophy; Hydrogen- iron- nitrite-oxidizing bacteria; Nitrate and sulfate reduction; Methanogenesis and acetogenesis.

Prokaryotic cells: structure-function - Cells walls of eubacteria (peptidoglycan) and related molecules; Outer-membrane of gram-negative bacteria; Cell wall and cell membrane synthesis; Flagella and motility; Cell inclusions like endospores, gas vesicles.

Microbial diseases and host parasite relationships - Normal microflora of skin; Oral cavity; Gastrointestinal tract; Entry of pathogens into the host; Infectious disease transmission; Respiratory infections caused by bacteria and viruses; Tuberculosis; Sexually transmitted diseases including AIDS; Diseases transmitted by animals (Rabies, plague), insects and ticks (rikettsias, Lyme disease, malaria); Food and water borne diseases; Public health and water quality; Pahtogenic fungi; Emerging and resurgent infectious diseases.

Chemotherapy/Antibiotics - Antimicrobial agents; Sulfa drugs; Antibiotics; Pencillins and cephalosporins; Broad-spectrum antibiotics; Antibiotics from prokaryotes; Antifungal antibiotics; Mode of action; Resistance to antibiotics.

Microbial genetics - Genes, mutation and mutagenesis - UV and chemical mutagnes; Types of mutations; Ames test for mutagenesis; Methods of genetic analysis. Bacterial genetic system - Transformation; Conjugation; Transduction; Recombination; Plasmids and Transposons; Bacterial genetic map with reference to E. coli. Viruses and their genetic system - Phage ? and its life cycle; RNA phages; RNA viruses; Retroviruses; Genetic systems of yeast and Neurospora; Extrachromosomal inheritance and mitochondrial genetics; Basic concept of genomics.

SECTION M. ZOOLOGY

Animal world: Animal diversity, distribution, systematic and classification of animals, the phylogenetic relationship.

Evolution: Origin of life, history of life on earth, evolutionary theories, natural selection, adaptation, speciation.

Genetics: Principles of inheritance, molecular basis of heredity, the genetic material, transmission of genetic material, mutations, cytoplasmic inheritance.

Biochemistry and Molecular Biology: Nucleic acids, proteins and other biological macromolecules. Replication, transcription and translation, regulation of gene expression, organization of genome, Kreb's cycle, glycolysis, enzyme catalysis, hormones and their action.

Cell Biology: Structure of cell, cellular organelles and their structure and function, cell cycle, cell division, cellular differentiation, chromosome and chromatin structure. Eukaryotic gene organisation and expression.

Animal Anatomy and Physiology: Comparative physiology, the respiratory system, circulatory system, digestive system, the nervous system, the excretory system, the endocrine system, the reproductive system, the skeletal system, osmoregulation.

Parasitology and Immunology: Nature of parasite, host-parasite relation, protozoan and helminthic parasites, the immune response, cellular and humoral immune response, evolution of the immune system.

Development Biology: Embryonic development, cellular differentiation, organogenesis, metamorphosis, genetic basis of development.

Ecology: The ecosystem, habitats the food chain, population dynamics, species diversity, zoogeography, biogeochemical cycles, conservation biology.

Animal Behaviour: Types of behaviours, courtship, mating and territoriality, instinct, learning and memory, social behaviour across the animal taxa, communication, pheromones, evolution of animal behaviour.

IT - INFORMATION TECHNOLOGY

ENGINEERING MATHEMATICS

Mathematical Logic: Propositional Logic; First Order Logic.

Probability: Conditional Probability; Mean, Median, Mode and Standard Deviation; Random Variables; Distributions; uniform, normal, exponential, Poisson, Binomial.

Set Theory & Algebra: Sets; Relations; Functions; Groups; Partial Orders; Lattice; Boolean Algebra.

Combinatorics: Permutations; Combinations; Counting; Summation; generating functions; recurrence relations; asymptotics.

Graph Theory: Connectivity; spanning trees; Cut vertices & edges; covering; matching; independent sets; Colouring; Planarity; Isomorphism.

Linear Algebra: Algebra of matrices, determinants, systems of linear equations, Eigen values and Eigen vectors.

Numerical Methods: LU decomposition for systems of linear equations; numerical solutions of non linear algebraic equations by Secant, Bisection and Newton-Raphson Methods; Numerical integration by trapezoidal and Simpson's rules.

Calculus: Limit, Continuity & differentiability, Mean value Theorems, Theorems of integral calculus, evaluation of definite & improper integrals, Partial derivatives, Total derivatives, maxima & minima.

FORMAL LANGUAGES AND AUTOMATA

Regular Languages: finite automata, regular expressions, regular grammar.

Context free languages: push down automata, context free grammars

COMPUTER HARDWARE

Digital Logic: Logic functions, minimization, design and synthesis of combinatorial and sequential circuits, number representation and computer arithmetic (fixed and floating point)

Computer organization: Machine instructions and addressing modes, ALU and data path, hardwired and microprogrammed control, memory interface, I/O interface (interrupt and DMA mode), serial communication interface, instruction pipelining, cache, main and secondary storage

SOFTWARE SYSTEMS

Data structures and Algorithms: the notion of abstract data types, stack, queue, list, set, string, tree, binary search tree, heap, graph, tree and graph traversals, connected components, spanning trees, shortest paths, hashing, sorting, searching, design techniques (greedy, dynamic, divide and conquer), asymptotic analysis (best, worst, average cases) of time and space, upper and lower bounds, intractability

Programming Methodology: C programming, program control (iteration, recursion, functions), scope, binding, parameter passing, elementary concepts of object oriented programming

Operating Systems (in the context of Unix): classical concepts (concurrency, synchronization, deadlock), processes, threads and interprocess communication, CPU scheduling, memory management, file systems, I/O systems, protection and security

Information Systems and Software Engineering: information gathering, requirement and feasibility analysis, data flow diagrams, process specifications, input/output design, process life cycle, planning and managing the project, design, coding, testing, implementation, maintenance.

Databases: relational model, database design, integrity constraints, normal forms, query languages (SQL), file structures (sequential, indexed), b-trees, transaction and concurrency control

Data Communication: data encoding and transmission, data link control, multiplexing, packet switching, LAN architecture, LAN systems (Ethernet, token ring), Network devices: switches, gateways, routers

Networks: ISO/OSI stack, sliding window protocols, routing protocols, TCP/UDP, application layer protocols & systems (http, smtp, dns, ftp), network security

Web technologies: three tier web based architecture; JSP, ASP, J2EE, .NET systems; html, XML

AG - AGRICULTURAL ENGINEERING

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

FARM MACHINERY AND POWER:

Sources of power on the farm-human, animal, mechanical, electrical, wind, solar and biomass; design and selection of machine elements - gears, pulleys, chains and sprockets and belts; overload safety devices used in farm machinery; measurement of force, torque, speed, displacement and acceleration on machine elements.

Soil tillage; forces acting on a tillage tool; hitch systems and hitching of tillage implements; functional requirements, principles of working, construction and operation of manual, animal and power operated equipment for tillage. sowing, planting, fertilizer application, inter-cultivation, spraying, mowing, chaff cutting, harvesting, threshing and transport; testing of agricultural machinery and equipment; calculation of performance parameters -field capacity, efficiency, application rate and losses; cost analysis of implements and tractors.

Thermodynamic principles of I.C. engines; I.C. engine cycles; engine components; fuels and combustion; lubricants and their properties; I.C. engine systems - fuel, cooling, lubrication, ignition, electrical, intake and exhaust; selection, operation, maintenance and repair of I.C. engines; power efficiencies and measurement; calculation of power, torque, fuel consumption, heat load and power losses.

Tractors and power tillers - type, selection, maintenance and repair; tractor clutches and brakes; power transmission systems - gear trains, differential, final drives and power take-off; mechanics of tractor chassis; traction theory; three point hitches- free link and restrained link operations; mechanical steering and hydraulic control systems used in tractors; human engineering and safety in tractor design; tractor tests and performance.

SOIL AND WATER CONSERVATION ENGINEERING:

Ideal and real fluids, properties of fluids; hydrostatic pressure and its measurement; hydrostatic forces on plane and curved surface; continuity equation; Bernoulli's theorem; laminar and turbulent flow in pipes, Darcy-Weisbach and Hazen-Williams equations, Moody's diagram; flow through orifices and notches; flow in open channels.

Engineering properties of soils, fundamental definitions and relationships; index properties of soils; permeability and seepage analysis; shear strength, Mohr's circle of stresses; active and passive earth pressures; stability of slopes.

Hydrological cycle; precipitation measurement, analysis of precipitation data; abstraction from precipitation; runoff; hydrograph analysis, unit hydrograph theory and application; stream flow measurement; flood routing, hydrological reservoir and channel routing.

Mechanics of soil erosion, factors affecting erosion; soil loss estimation; biological and engineering measures to control erosion, terraces and bunds; vegetative waterways; gully control structures, drop, drop inlet and chute spillways; farm ponds; earthen dams; principles of watershed management.

Water requirement of crops; consumptive use and evapo-transpiration; irrigation scheduling; irrigation efficiencies; design of prismatic and silt loaded channels; methods of irrigation water application; design and evaluation of irrigation methods; drainage coefficient; surface and subsurface drainage systems; leaching requirement and salinity control; irrigation and drainage water quality; classification of pumps; pump characteristics; pump selection; types of aquifer; evaluation of aquifer properties; well hydraulics; ground water recharge.

AGRICULTURAL PROCESSING AND FOOD ENGINEERING:

Steady state heat transfer in conduction, convection and radiation; transient heat transfer in simple geometry; condensation and boiling heat transfer; working principles of heat exchangers; diffusive and convective mass transfer; simultaneous heat and mass transfer in agricultural processing operations.

Material and energy balances in food processing systems; water activity, sorption and desorption isotherms; centrifugal separation of solids, liquids and gases; kinetics of microbial death - pasteurisation and sterilization of liquid foods; preservation of food by cooling and freezing; psychrometry - properties of air-vapour mixture; concentration and dehydration of liquid foods - evaporators, tray, drum and spray dryers.

Mechanics and energy requirement in size reduction of granular solids; particle size analysis for comminuted solids; size separation by screening; fluidisation of granular solids; cleaning and grading efficiency and effectiveness of grain cleaners; conditioning and hydrothermal treatments for grains; dehydration of food grains; processes and machines for processing of cereals, pulses and oilseeds; design considerations for grain silos.

AR - ARCHITECTURE AND PLANNING

City planning: Historical development of cities; principles of city planning; new towns; survey methods, site planning, planning regulations and building bye-laws.

Housing: Concept of shelter; housing policies and design; community planning; role of government agencies; finance and management.

Landscape Design: Principles of landscape design and site planning; history and landscape styles; landscape elements and materials; planting design.

Computer Aided Design: Application of computers in architecture and planning; understanding elements of hardware and software; computer graphics; programming languages - C and Visual Basic and usage of packages such as AutoCAD.

Environmental and Building Science: Elements of environmental science; ecological principles concerning environment; role of micro-climate in design; climatic control through design elements; thermal comfort; elements of solar architecture; principles of lighting and illumination; basic principles of architectural acoustics; air pollution, noise pollution and their control.

Visual and Urban Design: Principles of visual composition; proportion, scale, rhythm, symmetry, harmony, balance, form and colour; sense of place and space, division of space; focal point, vista, imageability, visual survey.

History of Architecture: Indian - Indus valley, Vedic, Buddhist, Indo-Aryan, Dravidian and Mughal periods; European - Egyptian, Greek, Roman, medieval and renaissance periods.

Development of Contemporary Architecture: Architectural developments and impacts on society since industrial revolution; influence of modern art on architecture; works of national and international architects; post modernism in architecture.

Building Services: Water supply, Sewerage and Drainage systems; Sanitary fittings and fixtures; principles of electrification of buildings; elevators, their standards and uses; air-conditioning systems; fire fighting systems.

Building Construction and Management: Building construction techniques, methods and details; building systems and prefabrication of building elements; principles of modular coordination; estimation, specification, valuation, professional practice; project management, PERT, CPM.

Materials and Structural Systems: Behavioural characteristics of all types of building materials e.g. mud, timber, bamboo, brick, concrete, steel, glass, FRP; principles of strength of materials; design of structural elements in wood, steel and RCC; elastic and limit state design; complex structural systems; principles of pre-stressing.

Planning Theory: Planning process; multilevel planning; comprehensive planning; central place theory; settlement pattern; land use and land utilization.

Techniques of Planning: Planning surveys; Preparation of urban and regional structure plans, development plans, action plans; site planning principles and design; statistical methods; application of remote sensing techniques in urban and regional planning.

Traffic and Transportation Planning: Principles of traffic engineering and transportation planning; methods of conducting surveys; design of roads, intersections and parking areas; hierarchy of roads and levels of services; traffic and transport management in urban areas; traffic safety and traffic laws; public transportation planning; modes of transportation.

Services and Amenities: Principles and design of water supply systems, sewerage systems, solid waste disposal systems, power supply and communication systems; Health, education, recreation and demography related standards at various levels of the settlements.

Development Administration and Management: Planning laws; development control and zoning regulations; laws relating to land acquisition; development enforcements, land ceiling; regional and urban plan preparations; planning and municipal administration; taxation, revenue resources and fiscal management; public participation and role of NGO.

CE - CIVIL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

STRUCTURAL ENGINEERING

Mechanics: Bending moments and shear forces in statically determinate beams; simple stress and strain: relationship; stress and strain in two dimensions, principal stresses, stress transformation, Mohr's circle; simple bending theory; flexural shear stress; thin-walled pressure vessels; uniform torsion.

Structural Analysis: Analysis of statically determinate trusses, arches and frames; displacements in statically determinate structures and analysis of statically indeterminate structures by force/energy methods; analysis by displacement methods (slope-deflection and moment-distribution methods); influence lines for determinate and indeterminate structures; basic concepts of matrix methods of structural analysis.

Concrete Structures: Basic working stress and limit states design concepts; analysis of ultimate load capacity and design of members subject to flexure, shear, compression and torsion (beams, columns and isolated footings); basic elements of prestressed concrete: analysis of beam sections at transfer and service loads.

Steel Structures: Analysis and design of tension and compression members, beams and beam-columns, column bases; connections - simple and eccentric, beam-column connections, plate girders and trusses; plastic analysis of beams and frames.

GEOTECHNICAL ENGINEERING

Soil Mechanics: Origin of soils; soil classification; three-phase system, fundamental definitions, relationship and inter-relationships; permeability and seepage; effective stress principle: consolidation, compaction; shear strength.

Foundation Engineering: Sub-surface investigation - scope, drilling bore holes, sampling, penetrometer tests, plate load test; earth pressure theories, effect of water table, layered soils; stability of slopes - infinite slopes, finite slopes; foundation types - foundation design requirements; shallow foundations; bearing capacity, effect of shape, water table and other factors, stress distribution, settlement analysis in sands and clays; deep foundations - pile types, dynamic and static formulae, load capacity of piles in sands and clays.

WATER RESOURCES ENGINEERING

Fluid Mechanics and Hydraulics: Hydrostatics, applications of Bernoulli equation, laminar and turbulent flow in pipes, pipe networks; concept of boundary layer and its growth; uniform flow, critical flow and gradually varied flow in channels, specific energy concept, hydraulic jump; forces on immersed bodies; flow measurement in channels; tanks and pipes; dimensional analysis and hydraulic modeling. Applications of momentum equation, potential flow, kinematics of flow; velocity triangles and specific speed of pumps and turbines.

Hydrology: Hydrologic cycle; rainfall; evaporation infiltration, unit hydrographs, flood estimation, reservoir design, reservoir and channel routing, well hydraulics.

Irrigation: Duty, delta, estimation of evapo-transpiration; crop water requirements; design of lined and unlined canals; waterways; head works, gravity dams and Ogee spillways. Designs of weirs on permeable foundation, irrigation methods.

ENVIRONMENTAL ENGINEERING

Water requirements; quality and standards, basic unit processes and operations for water treatment, distribution of water. Sewage and sewerage treatment: quantity and characteristic of waste water sewerage; primary and secondary treatment of waste water; sludge disposal; effluent discharge standards.

TRANSPORTATION ENGINEERING

Highway planning; geometric design of highways; testing and specifications of paving materials; design of flexible and rigid pavements.

CH - CHEMICAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

CHEMICAL ENGINEERING

Process Calculations and Thermodynamics: Laws of conservation of mass and energy; use of tie components; recycle, bypass and purge calculations; degree of freedom analysis.

First and Second laws of thermodynamics and their applications; equations of state and thermodynamic properties of real systems; phase equilibria; fugacity, excess properties and correlations of activity coefficients; chemical reaction equilibria.

Fluid Mechanics and Mechanical Operations: Fluid statics, Newtonian and non-Newtonian fluids, Bernoulli equation, Macroscopic friction factors, energy balance, dimensional analysis, shell balances, flow through pipeline systems, flow meters, pumps and compressors, packed and fluidized beds, elementary boundary layer theory, size reduction and size separation; free and hindered settling; centrifuge and cyclones; thickening and classification, filtration, mixing and agitation; conveying of solids.

Heat Transfer: Conduction, convection and radiation, heat transfer coefficients, steady and unsteady heat conduction, boiling, condensation and evaporation; types of heat exchangers and evaporators and their design.

Mass Transfer: Fick's law, molecular diffusion in fluids, mass transfer coefficients, film, penetration and surface renewal theories; momentum, heat and mass transfer analogies; stagewise and continuous contacting and stage efficiencies; HTU & NTU concepts design and operation of equipment for distillation, absorption, leaching, liquid-liquid extraction, crystallization, drying, humidification, dehumidification and adsorption.

Chemical Reaction Engineering: Theories of reaction rates; kinetics of homogeneous reactions, interpretation of kinetic data, single and multiple reactions in ideal reactors, non-ideal reactors; residence time; non-isothermal reactors; kinetics of heterogeneous catalytic reactions; diffusion effects in catalysis.

Instrumentation and Process Control: Measurement of process variables; sensors, transducers and their dynamics, dynamics of simple systems, dynamics such as CSTRs, transfer functions and responses of simple systems, process reaction curve, controller modes (P, PI, and PID); control valves; analysis of closed loop systems including stability, frequency response (including Bode plots) and controller tuning, cascade, feed forward control.

Plant Design and Economics: Design and sizing of chemical engineering equipment such as compressors, heat exchangers, multistage contactors; principles of process economics and cost estimation including total annualized cost, cost indexes, rate of return, payback period, discounted cash flow, optimization in Design.

Chemical Technology: Inorganic chemical industries; sulfuric acid, NaOH, fertilizers (Ammonia, Urea, SSP and TSP); natural products industries (Pulp and Paper, Sugar, Oil, and Fats); petroleum refining and petrochemicals; polymerization industries; polyethylene, polypropylene, PVC and polyester synthetic fibers.

CS - COMPUTER SCIENCE AND ENGINEERING

ENGINEERING MATHEMATICS

Mathematical Logic: Propositional Logic; First Order Logic.

Probability: Conditional Probability; Mean, Median, Mode and Standard Deviation; Random Variables; Distributions; uniform, normal, exponential, Poisson, Binomial.

Set Theory & Algebra: Sets; Relations; Functions; Groups; Partial Orders; Lattice; Boolean Algebra.

Combinatorics: Permutations; Combinations; Counting; Summation; generating functions; recurrence relations; asymptotics.

Graph Theory: Connectivity; spanning trees; Cut vertices & edges; covering; matching; independent sets; Colouring; Planarity; Isomorphism.

Linear Algebra: Algebra of matrices, determinants, systems of linear equations, Eigen values and Eigen vectors.

Numerical Methods: LU decomposition for systems of linear equations; numerical solutions of non linear algebraic equations by Secant, Bisection and Newton-Raphson Methods; Numerical integration by trapezoidal and Simpson's rules.

Calculus: Limit, Continuity & differentiability, Mean value Theorems, Theorems of integral calculus, evaluation of definite & improper integrals, Partial derivatives, Total derivatives, maxima & minima.

THEORY OF COMPUTATION

Formal Languages and Automata Theory: Regular languages and finite automata, Context free languages and Push-down automata, Recursively enumerable sets and Turing machines, Un-decidability;

Analysis of Algorithms and Computational Complexity: Asymptotic analysis (best, worst, average case) of time and space, Upper and lower bounds on the complexity of specific problems, NP-completeness.

COMPUTER HARDWARE

Digital Logic: Logic functions, Minimization, Design and synthesis of Combinational and Sequential circuits; Number representation and Computer Arithmetic (fixed and floating point);

Computer Organization: Machine instructions and addressing modes, ALU and Data-path, hardwired and micro-programmed control, Memory interface, I/O interface (Interrupt and DMA mode), Serial communication interface, Instruction pipelining, Cache, main and secondary storage.

SOFTWARE SYSTEMS

Data structures: Notion of abstract data types, Stack, Queue, List, Set, String, Tree, Binary search tree, Heap, Graph;

Programming Methodology: C programming, Program control (iteration, recursion, Functions), Scope, Binding, Parameter passing, Elementary concepts of Object oriented, Functional and Logic Programming;

Algorithms for problem solving: Tree and graph traversals, Connected components, Spanning trees, Shortest paths; Hashing, Sorting, Searching; Design techniques (Greedy, Dynamic Programming, Divide-and-conquer);

Compiler Design: Lexical analysis, Parsing, Syntax directed translation, Runtime environment, Code generation, Linking (static and dynamic); Operating Systems: Classical concepts (concurrency, synchronization, deadlock), Processes, threads and Inter-process communication, CPU scheduling, Memory management, File systems, I/O systems, Protection and security.

Databases: Relational model (ER-model, relational algebra, tuple calculus), Database design (integrity constraints, normal forms), Query languages (SQL), File structures (sequential files, indexing, B+ trees), Transactions and concurrency control;

Computer Networks: ISO/OSI stack, sliding window protocol, LAN Technologies (Ethernet, Token ring), TCP/UDP, IP, Basic concepts of switches, gateways, and routers.

CH - CHEMISTRY

PHYSICAL CHEMISTRY

Structure: Quantum theory - principles and techniques; applications to particle in a box, harmonic oscillator, rigid rotor and hydrogen atom; valence bond and molecular orbital theories and Huckel approximation, approximate techniques: variation and perturbation; symmetry, point groups; rotational, vibrational, electronic, NMR and ESR spectroscopy.

Equilibrium: First law of thermodynamics, heat, energy and work; second law of thermodynamics and entropy; third law and absolute entropy; free energy; partial molar quantities; ideal and non-ideal solutions; phase transformation: phase rule and phase diagrams- one, two, and three component systems; activity, activity coefficient, fugacity and fugacity coefficient ; chemical equilibrium, response of chemical equilibrium to temperature and pressure; colligative properties; kinetic theory of gases; thermodynamics of electrochemical cells; standard electrode potentials: applications - corrosion and energy conversion; molecular partition function (translational, rotational, vibrational and electronic).

Kinetics: Rates of chemical reactions, theories of reaction rates, collision and transition state theory; temperature dependence of chemical reactions; elementary reactions, consecutive elementary reactions; steady state approximation, kinetics of photochemical reactions and free radical polymerization, homogenous and heterogeneous catalysis.

INORGANIC CHEMISTRY

Non-Transition Elements: General characteristics, structure and reactions of simple and industrially important compounds, boranes, carboranes, silicates, silicones, diamond and graphite; hydrides, oxides and oxoacids of N, P, S and halogens; boron nitride, borazines and phosphazenes; xenon compounds. Shapes of molecules, hard-soft acid base concept.

Transition Elements: General characteristics of d and f block elements; coordination chemistry: structure and isomerism, stability, theories of metal-ligand bonding (CFT and LFT), electronic spectra and magnetic properties of transition metal complexes and lanthanides; metal carbonyls, metal-metal bonds and metal atom clusters, metallocenes; transition metal complexes with bonds to hydrogen, alkyls, alkenes, and arenes; metal carbenes; use of organometallic compounds as catalysts in organic synthesis; mechanisms of substitution and electron transfer reactions of coordination complexes. Role of metals with special reference to Na, K, Mg, Ca, Fe, Co, Zn, and Mo in biological systems.

Solids: Crystal systems and lattices, Miller planes, crystal packing, crystal defects; Bragg's Law; ionic crystals, band theory, metals and semiconductors. Spinels.

Instrumental methods of analysis: atomic absorption, UV-visible spectrometry, chromatographic and electro-analytical methods.

ORGANIC CHEMISTRY

Synthesis, reactions and mechanisms involving the following: Alkenes, alkynes, arenes, alcohols, phenols, aldehydes, ketones, carboxylic acids and their derivatives; halides, nitro compounds and amines; stereochemical and conformational effects on reactivity and specificity; reactions with diborane and peracids. Michael reaction, Robinson annulation, reactivity umpolung, acyl anion equivalents; molecular rearrangements involving electron deficient atoms.

Photochemistry: Basic principles, photochemistry of olefins, carbonyl compounds, arenes, photo oxidation and reduction.

Pericyclic reactions: Cycloadditions, electrocyclic reactions, sigmatropic reactions; Woodward-Hoffmann rules.

Heterocycles: Structural properties and reactions of furan, pyrrole, thiophene, pyridine, indole.

Biomolecules: Structure, properties and reactions of mono- and di-saccharides, physico-chemical properties of amino acids, structural features of proteins and nucleic acids.

Spectroscopy: Principles and applications of IR, UV-visible, NMR and mass spectrometry in the determination of structures of organic compounds.

EC - ELECTRONICS AND COMMUNICATION ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix Algebra, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Mean value theorems, Theorems of integral calculus, Evaluation of definite and improper integrals, Partial Derivatives, Maxima and minima, Multiple integrals, Fourier series. Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equation (linear and nonlinear), Higher order linear differential equations with constant coefficients, Method of variation of parameters, Cauchy's and Euler's equations, Initial and boundary value problems, Partial Differential Equations and variable separable method.

Complex variables: Analytic functions, Cauchy's integral theorem and integral formula, Taylor's and Laurent' series, Residue theorem, solution integrals.

Probability and Statistics: Sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Discrete and continuous distributions, Poisson, Normal and Binomial distribution, Correlation and regression analysis.

Numerical Methods: Solutions of non-linear algebraic equations, single and multi-step methods for differential equations.

Transform Theory: Fourier transform, Laplace transform, Z-transform.

ELECTRONICS & COMMUNICATION ENGINEERING

Networks: Network graphs: matrices associated with graphs; incidence, fundamental cut set and fundamental circuit matrices. Solution methods: nodal and mesh analysis. Network theorems: superposition, Thevenin and Norton's maximum power transfer, Wye-Delta transformation. Steady state sinusoidal analysis using phasors. Linear constant coefficient differential equations; time domain analysis of simple RLC circuits, Solution of network equations using Laplace transform: frequency domain analysis of RLC circuits. 2-port network parameters: driving point and transfer functions. State equations for networks.

Electronic Devices: Energy bands in silicon, intrinsic and extrinsic silicon. Carrier transport in silicon: diffusion current, drift current, mobility, resistivity. Generation and recombination of carriers. p-n junction diode, Zener diode, tunnel diode, BJT, JFET, MOS capacitor, MOSFET, LED, p-I-n and avalanche photo diode, LASERs. Device technology: integrated circuits fabrication process, oxidation, diffusion, ion implantation, photolithography, n-tub, p-tub and twin-tub CMOS process.

Analog Circuits: Equivalent circuits (large and small-signal) of diodes, BJTs, JFETs, and MOSFETs. Simple diode circuits, clipping, clamping, rectifier. Biasing and bias stability of transistor and FET amplifiers. Amplifiers: single-and multi-stage, differential, operational, feedback and power. Analysis of amplifiers; frequency response of amplifiers. Simple op-amp circuits. Filters. Sinusoidal oscillators; criterion for oscillation; single-transistor and op-amp configurations. Function generators and wave-shaping circuits. Power supplies.

Digital circuits: Boolean algebra, minimization of Boolean functions; logic gates digital IC families (DTL, TTL, ECL, MOS, CMOS). Combinational circuits: arithmetic circuits, code converters, multiplexers and decoders. Sequential circuits: latches and flip-flops, counters and shift-registers. Sample and hold circuits, ADCs, DACs. Semiconductor memories. Microprocessor(8085): architecture, programming, memory and I/O interfacing.

Signals and Systems: Definitions and properties of Laplace transform, continuous-time and discrete-time Fourier series, continuous-time and discrete-time Fourier Transform, z-transform. Sampling theorems. Linear Time-Invariant (LTI) Systems: definitions and properties; casuality, stability, impulse response, convolution, poles and zeros frequency response, group delay, phase delay. Signal transmission through LTI systems. Random signals and noise: probability, random variables, probability density function, autocorrelation, power spectral density.

Controls Systems: Basic control system components; block diagrammatic description, reduction of block diagrams. Open loop and closed loop (feedback) systems and stability analysis of these systems. Signal flow graphs and their use in determining transfer functions of systems; transient and steady state analysis of LTI control systems and frequency response. Tools and techniques for LTI control system analysis: root loci, Routh-Hurwitz criterion, Bode and Nyquist plots. Control system compensators: elements of lead and lag compensation, elements of Proportional-Integral-Derivative(PID) control. State variable representation and solution of state equation of LTI control systems.

Communications: Analog communication systems: amplitude and angle modulation and demodulation systems, spectral analysis of these operations, superheterodyne receivers; elements of hardware, realizations of analog communication systems; signal-to-noise ratio (SNR) calculations for amplitude modulation (AM) and frequency modulation (FM) for low noise conditions. Digital communication systems: pulse code modulation (PCM), differential pulse code modulation (DPCM), delta modulation (DM); digital modulation schemes-amplitude, phase and frequency shift keying schemes (ASK, PSK, FSK), matched filter receivers, bandwith consideration and probability of error calculations for these schemes.

Electromagnetics: Elements of vector calculus: divergence and curl; Gauss' and Stokes' theorems, Maxwell's equations: differential and integral forms. Wave equation, Poynting vector. Plane waves: propagation through various media; reflection and refraction; phase and group velocity; skin depth. Transmission lines: characteristic impedance; impedance transformation; Smith chart; impedance matching; pulse excitation. Waveguides: modes in rectangular waveguides; boundary conditions; cut-off frequencies; dispersion relations. Antennas: Dipole antennas; antenna arrays; radiation pattern; reciprocity theorem, antenna gain.

EE - ELECTRICAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix Algebra, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Mean value theorems, Theorems of integral calculus, Evaluation of definite and improper integrals, Partial Derivatives, Maxima and minima, Multiple integrals, Fourier series. Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equation (linear and nonlinear), Higher order linear differential equations with constant coefficients, Method of variation of parameters, Cauchy's and Euler's equations, Initial and boundary value problems, Partial Differential Equations and variable separable method.

Complex variables: Analytic functions, Cauchy's integral theorem and integral formula, Taylor's and Laurent' series, Residue theorem, solution integrals.

Probability and Statistics: Sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Discrete and continuous distributions, Poisson, Normal and Binomial distribution, Correlation and regression analysis.

Numerical Methods: Solutions of non-linear algebraic equations, single and multi-step methods for differential equations.

Transform Theory: Fourier transform, Laplace transform, Z-transform.

ELECTRICAL ENGINEERING

Electrical Circuits and Fields: Network graph, KCL, KVL, node/ cut set, mesh/ tie set analysis, transient response of d.c. and a.c. networks; sinusoidal steady-state analysis; resonance in electrical circuits; concepts of ideal voltage and current sources, network theorems, driving point, immittance and transfer functions of two port networks, elementary concepts of filters; three phase circuits; Fourier series and its application; Gauss theorem, electric field intensity and potential due to point, line, plane and spherical charge distribution, dielectrics, capacitance calculations for simple configurations; Ampere's and Biot-Savart's law, inductance calculations for simple configurations.

Electrical Machines: Single phase transformer - equivalent circuit, phasor diagram, tests, regulation and efficiency; three phase transformers - connections, parallel operation; auto transformer and three-winding transformer; principles of energy conversion, windings of rotating machines: D. C. generators and motors - characteristics, starting and speed control, armature reaction and commutation; three phase induction motors-performance characteristics, starting and speed control; single-phase induction motors; synchronous generators-performance, regulation, parallel operation; synchronous motors - starting, characteristics, applications, synchronous condensers; fractional horse power motors; permanent magnet and stepper motors.

Power Systems: Electric power generation - thermal, hydro, nuclear; transmission line parameters; steady-state performance of overhead transmission lines and cables and surge propagation; distribution systems, insulators, bundle conductors, corona and radio interference effects; per-unit quantities; bus admittance and impedance matrices; load flow; voltage control and power factor correction; economic operation; symmetrical components, analysis of symmetrical and unsymmetrical faults; principles of over current, differential and distance protections; concept of solid state relays and digital protection; circuit breakers; concept of system stability-swing curves and equal area criterion; basic concepts of HVDC transmission.

Control Systems: Principles of feedback; transfer function; block diagrams: steady-state errors; stability-Routh and Nyquist criteria; Bode plots; compensation; root loci; elementary state variable formulation; state transition matrix and response for Linear Time Invariant systems.

Electrical and Electronic Measurements: Bridges and potentiometers, PMMC, moving iron, dynamometer and induction type instruments; measurement of voltage, current, power, energy and power factor; instrument transformers; digital voltmeters and multimeters; phase, time and frequency measurement; Q-meter, oscilloscopes, potentiometric recorders, error analysis.

Analog and Digital Electronics: Characteristics of diodes, BJT, FET, SCR; amplifiers-biasing, equivalent circuit and frequency response; oscillators and feedback amplifiers, operational amplifiers- characteristics and applications; simple active filters; VCOs and timers; combinational and sequential logic circuits, multiplexer, Schmitt trigger, multivibrators, sample and hold circuits, A/D and D/A converters; microprocessors and their applications.

Power Electronics and Electric Drives: Semiconductor power devices-diodes, transistors, thyristors, triacs, GTOs, MOSFETs and IGBTs - static characteristics and principles of operation; triggering circuits; phase control rectifiers; bridge converters-fully controlled and half controlled; principles of choppers and inverters, basic concepts of adjustable speed dc and ac drives.

GG - GEOLOGY AND GEOPHYSICS

PART - I

Earth and planetary system; size, shape, internal structure and composition of the earth; atmosphere and greenhouse effect; isostasy; elements of seismology; continents and continental processes; physical oceanography; palaeomagnetism, continental drift plate tectonics, geothermal energy.

Weathering; soil formation; action of river, wind and glacier; oceans and oceanic features; earthquakes, volcanoes, orogeny and mountain building; elements of structural geology; crystallography; classification, composition and properties of minerals and rocks; engineering properties of rocks and soils, role of geology in the construction of engineering structures.

Processes of ore formation, occurrence and distribution of ores on land and on ocean floor; coal and petroleum resources in India; ground water geology including well hydraulics, geological time scale and geochronology; stratigraphic principles and stratigraphy of India; basics concepts of gravity, magnetic and electrical prospecting for ores and ground water.

PART - IIA: GEOLOGY

Crystal symmetry, forms, twinning; crystal chemistry; optical mineralogy, classification of minerals, diagnostic properties of rock minerals.

Mineralogy, structure, texture and classification of igneous, sedimentary and metamorphic rock, their origin and evolution; application of thermodynamics; structure and petrology of sedimentary rocks; sedimentary processes and environments, sedimentary facies, basin studies; basement cover relationship;

Primary and secondary structures; geometry and genesis of folds, faults, joints, unconformities, cleavage, schistosity and lineation; methods of projection. Tectonites and their significance; shear zone; superposed folding.

Morphology, classification and geological significance of important invertebrates, vertebrates, microfossils and palaeoflora; stratigraphic principles and Indian stratigraphy; geomorphic processes and agents; development and evolution of landforms; slope and drainage; processes on deep oceanic and near-shore regions; quantitative and applied geomorphology; air photo interpretation and remote sensing; chemical and optical properties of ore minerals; formation and localization of ore deposits; prospecting and exploration of economic minerals; coal and petroleum geology; origin and distribution of mineral and fuel deposits in India; ore dressing and mineral economics.

Cosmic abundance; meteorites; geochemical evolution of the earth; geochemical cycles; distribution of major, minor and trace elements; isotope geochemistry; geochemistry of waters including solution equilibria and water rock interaction.

Engineering properties of rocks and soils; rocks as construction material; geology of dams, tunnels and excavation sites; natural hazards; the fly ash problem; ground water geology and exploration; water quality; impact of human activity; Remote sensing techniques for the interpretation of landforms and resource management.

PART - II B: GEOPHYSICS

The earth as a planet; different motions of the earth; gravity filed of the earth and its shape; geochronology; isostasy, seismology and interior of the earth; variation of density, velocity, pressure, temperature, electrical and magnetic properties inside the earth; earthquakes-causes and measurements; zonation and seismic hazards; geomagnetic field, palaeomagnetism; oceanic and continental lithosphere; plate tectonics; heat flow; upper and lower atmospheric phenomena.

Theories of scalar and vector potential fields; Laplace, Maxwell and Helmholtz equations for solution of different types of boundary value problems for Cartesian, cylindrical and spherical polar coordinates; Green's theorem; Image theory; integral equations and conformal transformations in potential theory; Eikonal equation and ray theory.

'G' and 'g' units of measurement, density of rocks, gravimeters, preparation, analysis and interpretation of gravity maps; derivative maps, analytical continuation; gravity anomaly type curves; calculation of mass.

Earth's magnetic field, units of measurement, magnetic susceptibility of rocks, magnetometers, corrections, preparation of magnetic maps, magnetic anomaly type curve, analytical continuation, interpretation and application; magnetic well logging.

Conduction of electricity through rocks, electrical conductivities of metals, metallic, non-metallic and rock forming minerals, D.C. resistivity units and methods of measurement, electrode configuration for sounding and profiling, application of filter theory, interpretation of resistivity field data, application; self potential origin, classification, field measurement, interpretation of induced polarization time frequency, phase domain; IP units and methods of measurement, interpretation and application; ground-water exploration.

Origin of electromagnetic field elliptic polarization, methods of measurement for different source-receiver configuration components in EM measurements, interpretation and applications; earth's natural electromagnetic field, tellurics, magneto-tellurics; geomagnetic depth sounding principles, methods of measurement, processing of data and interpretation.

Seismic methods of prospecting: Reflection, refraction and CDP surveys; land and marine seismic sources, generation and propagation of elastic waves, velocity increasing with depth, geophones, hydrophones, recording instruments (DFS), digital formats, field layouts, seismic noises and noise profile analysis, optimum geophone grouping, noise cancellation by shot and geophone arrays, 2D and 3D seismic data acquisition and processing, CDP stacking charts, binning, filtering, dip-moveout, static and dynamic corrections, deconvolution, migration, signal processing, Fourier and Hilbert transforms, attribute analysis, bright and dim spots, seismic stratigraphy, high resolution seismics, VSP.

Principles and techniques of geophysical well-logging, SP, resistivity, induction, micro gamma ray, neutron, density, sonic, temperature, dip meter, caliper, nuclear magnetic, cement bond logging. Quantitative evaluation of formations from well logs; well hydraulics and application of geophysical methods for groundwater study; application of bore hole geophysics in ground water, mineral and oil exploration. Remote sensing techniques and application of remote sensing methods in geophysics.

IN - INSTRUMENTATION ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix Algebra, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Mean value theorems, Theorems of integral calculus, Evaluation of definite and improper integrals, Partial Derivatives, Maxima and minima, Multiple integrals, Fourier series. Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equation (linear and nonlinear), Higher order linear differential equations with constant coefficients, Method of variation of parameters, Cauchy's and Euler's equations, Initial and boundary value problems, Partial Differential Equations and variable separable method.

Complex variables: Analytic functions, Cauchy's integral theorem and integral formula, Taylor's and Laurent' series, Residue theorem, solution integrals.

Probability and Statistics: Sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Discrete and continuous distributions, Poisson, Normal and Binomial distribution, Correlation and regression analysis.

Numerical Methods: Solutions of non-linear algebraic equations, single and multi-step methods for differential equations.

Transform Theory: Fourier transform, Laplace transform, Z-transform.

INSTRUMENTATION ENGINEERING

Measurement Basics and Metrology: Static and dynamic characteristics of measurement systems. Standards and calibration. Error and uncertainty analysis, statistical analysis of data, and curve fitting. Linear and angular measurements; Measurement of straightness, flatness, roundness and roughness.

Transducers, Mechanical Measurements and Industrial Instrumentation: Transducers - elastic, resistive, inductive, capacitive, thermo-electric, piezoelectric, photoelectric, electro-mechanical, electro-chemical, and ultrasonic. Measurement of displacement, velocity (linear and rotational), acceleration, shock, vibration, force, torque, power, strain, stress, pressure, flow, temperature, humidity, viscosity, and density. energy storing elements, suspension systems and dampers.

Analog Electronics: Characteristics of diodes, BJTs, JFETs and MOSFETs; Diode circuits; Amplifiers: single and multi-stage, feedback; Frequency response; Operational amplifiers - design, characteristic, linear and non-linear applications: difference amplifiers; instrumentation amplifiers; precision rectifiers, I-to-V converters, active filters, oscillators, comparators, signal generators, wave shaping circuits.

Digital Electronics: Combinational logic circuits, minimization of Boolean functions; IC families (TTL, MOS, CMOS), arithmetic circuits, multiplexer and decoders. Sequential circuits: flip-flops, counters, shift registers. Schmitt trigger, timers, and multivibrators. Analog switches, multiplexers, S/H circuits. Analog-to-digital and digital-to-analog converters. Basics of computer organization and architecture. 8-bit microprocessor (8085), applications, memory, I/O interfacing, and microcontrollers.

Signals and Systems: Vectors and matrices; Fourier series; Fourier transforms; Ordinary differential equations. Impulse and frequency responses of first and second order systems. Laplace transform and transfer function, convolution and correlation. Amplitude and frequency modulations and demodulations. Discrete time systems, difference equations, impulse and frequency responses; Z-transforms and transfer functions; IIR and FIR filters.

Electrical and Electronic Measurements: Measurement of R, L and C; bridges and potentiometers. Measurement of voltage, current, power, power factor, and energy; Instrument transformers; Q meter, waveform analyzers. Digital volt-meters and multi-meters. Time, phase and frequency measurements; Oscilloscope. Noise and interference in instrumentation.

Control Systems & Process Control: Principles of feedback; transfer function, signal flow graphs. Stability criteria, Bode plots, root-loci, Routh and Nyquist criteria. Compensation techniques; State space analysis. System components: mechanical, hydraulic, pneumatic, electrical and electronic; Servos and synchros; Stepper motors. On-off, cascade, P, PI, PID and feed-forward controls. Controller tuning and general frequency response.

Analytical, Optical and Biomedical Instrumentation: Principles of spectrometry, UV, visible, IR mass spectrometry, X-ray methods; nuclear radiation measurements, gas, solid and semi conductor lasers and their characteristics, interferometers, basics of fibre optics, transducers in biomedical applications, cardiovascular system measurements, instrumentation for clinical laboratory.

MA - MATHEMATICS

Linear Algebra: Finite dimensional vector spaces. Linear transformations and their matrix representations, rank; systems of linear equations, eigenvalues and eigenvectors, minimal polynomial, Cayley-Hamilton theorem, diagonalisation, Hermitian, Skew-Hermitian and unitary matrices. Finite dimensional inner product spaces, self-adjoint and Normal linear operators, spectral theorem, Quadratic forms.

Complex Analysis: Analytic functions, conformal mappings, bilinear transformations, complex integration: Cauchy's integral theorem and formula, Liouville's theorem, maximum modulus principle, Taylor and Laurent's series, residue theorem and applications for evaluating real integrals.

Real Analysis: Sequences and series of functions, uniform convergence, power series, Fourier series, functions of several variables, maxima, minima, multiple integrals, line, surface and volume integrals, theorems of Green, Stokes and Gauss; metric spaces, completeness, Weierstrass approximation theorem, compactness. Lebesgue measure, measurable functions; Lebesgue integral, Fatou's lemma, dominated convergence theorem.

Ordinary Differential Equations: First order ordinary differential equations, existence and uniqueness theorems, systems of linear first order ordinary differential equations, linear ordinary differential equations of higher order with constant coefficients; linear second order ordinary differential equations with variable coefficients, method of Laplace transforms for solving ordinary differential equations, series solutions; Legendre and Bessel functions and their orthogonality, Sturm Liouville system, Greeen's functions.

Algebra: Normal subgroups and homomorphisms theorems, automorphisms. Group actions, sylow's theorems and their applications groups of order less than or equal to 20, Finite p-groups. Euclidean domains, Principal ideal domains and unique factorizations domains. Prime ideals and maximal ideals in commutative rings.

Functional Analysis: Banach spaces, Hahn-Banach theorems, open mapping and closed graph theorems, principle of uniform boundedness; Hilbert spaces, orthonormal sets, Riesz representation theorem, self-adjoint, unitary and normal linear operators on Hilbert Spaces.

Numerical Analysis: Numerical solution of algebraic and transcendental equations; bisection, secant method, Newton-Raphson method, fixed point iteration, interpolation: existence and error of polynomial interpolation, Lagrange, Newton, Hermite(osculatory)interpolations; numerical differentiation and integration, Trapezoidal and Simpson rules; Gaussian quadrature; (Gauss-Legendre and Gauss-Chebyshev), method of undetermined parameters, least square and orthonormal polynomial approximation; numerical solution of systems of linear equations: direct and iterative methods, (Jacobi Gauss-Seidel and SOR) with convergence; matrix eigenvalue problems: Jacobi and Given's methods, numerical solution of ordinary differential equations: initial value problems, Taylor series method, Runge-Kutta methods, predictor-corrector methods; convergence and stability.

Partial Differential Equations: Linear and quasilinear first order partial differential equations, method of characteristics; second order linear equations in two variables and their classification; Cauchy, Dirichlet and Neumann problems, Green's functions; solutions of Laplace, wave and diffusion equations in two variables Fourier series and transform methods of solutions of the above equations and applications to physical problems.

Mechanics: Forces in three dimensions, Poinsot central axis, virtual work, Lagrange's equations for holonomic systems, theory of small oscillations, Hamiltonian equations;

Topology: Basic concepts of topology, product topology, connectedness, compactness, countability and separation axioms, Urysohn's Lemma, Tietze extension theorem, metrization theorems, Tychonoff theorem on compactness of product spaces.

Probability and Statistics: Probability space, conditional probability, Bayes' theorem, independence, Random variables, joint and conditional distributions, standard probability distributions and their properties, expectation, conditional expectation, moments. Weak and strong law of large numbers, central limit theorem. Sampling distributions, UMVU estimators, sufficiency and consistency, maximum likelihood estimators. Testing of hypotheses, Neyman-Pearson tests, monotone likelihood ratio, likelihood ratio tests, standard parametric tests based on normal, X2 ,t, F-distributions. Linear regression and test for linearity of regression. Interval estimation.

Linear Programming: Linear programming problem and its formulation, convex sets their properties, graphical method, basic feasible solution, simplex method, big-M and two phase methods, infeasible and unbounded LPP's, alternate optima. Dual problem and duality theorems, dual simplex method and its application in post optimality analysis, interpretation of dual variables. Balanced and unbalanced transportation problems, unimodular property and u-v method for solving transportation problems. Hungarian method for solving assignment problems.

Calculus of Variations and Integral Equations: Variational problems with fixed boundaries; sufficient conditions for extremum, Linear integral equations of Fredholm and Volterra type, their iterative solutions. Fredholm alternative.

ME - MECHANICAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

APPLIED MECHANICS AND DESIGN

Engineering Mechanics: Equivalent force systems, free-body concepts, equations of equilibrium, trusses and frames, virtual work and minimum potential energy. Kinematics and dynamics of particles and rigid bodies, impulse and momentum (linear and angular), energy methods, central force motion.

Strength of Materials: Stress and strain, stress-strain relationship and elastic constants, Mohr's circle for plane stress and plane strain, shear force and bending moment diagrams, bending and shear stresses, deflection of beams, torsion of circular shafts, thin and thick cylinders, Euler's theory of columns, strain energy methods, thermal stresses.

Theory of Machines: Displacement, velocity and acceleration, analysis of plane mechanisms, dynamic analysis of slider-crank mechanism, planar cams and followers, gear tooth profiles, kinematics of gears, governors and flywheels, balancing of reciprocating and rotating masses.

Vibrations: Free and forced vibration of single degree freedom systems, effect of damping, vibration isolation, resonance, critical speed of rotors.

Design of Machine Elements: Design for static and dynamic loading, failure theories, fatigue strength; design of bolted, riveted and welded joints; design of shafts and keys; design of spur gears, rolling and sliding contact bearings; brakes and clutches; belt, rope and chain drives.

FLUID MECHANICS AND THERMAL SCIENCES

Fluid Mechanics: Fluid properties, fluid statics, manometry, buoyancy; control-volume analysis of mass, momentum and energy; fluid acceleration; differential equations of continuity and momentum; Bernoulli's equation; viscous flow of incompressible fluids; boundary layer; elementary turbulent flow; flow through pipes, head losses in pipes, bends etc.

Heat-Transfer: Modes of heat transfer; one dimensional heat conduction, resistance concept, electrical analogy, unsteady heat conduction, fins; dimensionless parameters in free and forced convective heat transfer, various correlations for heat transfer in flow over flat plates and through pipes; thermal boundary layer; effect of turbulence; radiative heat transfer, black and grey surfaces, shape factors, network analysis; heat exchanger performance, LMTD and NTU methods.

Thermodynamics: Zeroth, First and Second laws of thermodynamics; thermodynamic system and processes; irreversibility and availability; behaviour of ideal and real gases, properties of pure substances, calculation of work and heat in ideal processes; analysis of thermodynamic cycles related to energy conversion; Carnot, Rankine, Otto, Diesel, Brayton and vapour compression cycles.

Power Plant Engineering: Steam generators; steam power cycles; steam turbines; impulse and reaction principles, velocity diagrams, pressure and velocity compounding; reheating and reheat factor; condensers and feed heaters.

I.C. Engines: Requirements and suitability of fuels in IC engines, fuel ratings, fuel-air mixture requirements; normal combustion in SI and CI engines; engine performance calculations.

Refrigeration and air-conditioning: Refrigerant compressors, expansion devices, condensers and evaporators; properties of moist air, psychrometric chart, basic psychometric processes.

Turbomachinery: Components of gas turbines; compression processes, centrifugal and axial flow compressors; axial flow turbines, elementary theory; hydraulic turbines; Euler-turbine equation; specific speed, Pelton-wheel, Francis and Kaplan turbines; centrifugal pumps.

MANUFACTURING AND INDUSTRIAL ENGINEERING

Engineering Materials: Structure and properties of engineering materials and their applications, heat treatment.

Metal Casting: Casting processes (expendable and non-expendable) -pattern, moulds and cores, heating and pouring, solidification and cooling, gating design, design considerations, defects.

Forming Processes: Stress-strain diagrams for ductile and brittle material, Plastic deformation and yield criteria, fundamentals of hot and cold working processes, Bulk metal forming processes (forging, rolling, extrusion, drawing), sheet metal working processes (punching, blanking, bending, deep drawing, coining, spinning, load estimation using homogeneous deformation methods, defects). processing of powder metals- atomization, compaction, sintering, secondary and finishing operations. forming and shaping of plastics- extrusion, injection moulding.

Joining Processes: Physics of welding, fusion and non-fusion welding processes, brazing and soldering, adhesive bonding, design considerations in welding, weld quality defects.

Machining and Machine Tool Operations: Mechanics of machining, single and multi-point cutting tools, tool geometry and materials, tool life and wear, cutting fluids, machinability, economics of machining, non-traditional machining processes.

Metrology and Inspection: Limits, fits and tolerances, linear and angular measurements, comparators, gauge design, interferometry, form and finish measurement, measurement of screw threads, alignment and testing methods.

Tool Engineering: Principles of work holding, design of jigs and fixtures.

Computer Integrated Manufacturing: Basic concepts of CAD, CAM and their integration tools.

Manufacturing Analysis: Part-print analysis, tolerance analysis in manufacturing and assembly, time and cost analysis.

Work-Study: Method study, work measurement, time study, work sampling, job evaluation, merit rating.

Production Planning and Control: Forecasting models, aggregate production planning, master scheduling, materials requirements planning.

Inventory Control: Deterministic and probabilistic models, safety stock inventory control systems.

Operations Research: Linear programming, simplex and duplex method, transportation, assignment, network flow models, simple queuing models, PERT and CPM

MN - MINING ENGINEERING

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

MINING ENGINEERING

Mechanics: Equivalent force systems, equations of equilibrium, two dimensional frames and trusses, free body diagrams, friction forces, particle kinematics and dynamics.

Mine Development, Geomechanics and Strata Control: Drivages for underground mine development, drilling methods and machines, explosives, blasting devices and practices, shaft sinking. Physico-mechanical properties of rocks, rock mass classification, ground control instrumentation and stress measurement techniques, theories of rock failure, ground vibrations, stress distribution around mine openings, subsidence, design of supports in roadways and workings, stability of open pits, slopes.

Mining Methods and Machinery: Surface mining - layout, development, loading, transportation and mechanization, continuous surface mining systems. Underground coal mining - bord and pillar system, longwall mining, thick seam mining methods. Underground metal mining: different stoping methods, stope mechanization, ore handling systems, mine filling.

Generation and transmission of mechanical, hydraulic, and pneumatic power. Materials handling - haulages, conveyors, ropeways, face and development machinery, hoisting systems, and pumps.

Ventilation, Underground Hazards and Surface Environment: Underground atmosphere, heat load sources and thermal environment, air cooling, mechanics of air flow distribution, natural and mechanical ventilation, mine fans and their usage, auxiliary ventilation. Subsurface hazards from fires, explosions, gases, dust, and inundation, rescue apparatus and practices, safety in mines, accident analysis, noise, mine lighting. Air and water pollution: causes, dispersion, quality standards, and control.

Surveying, Mine Planning and Systems Engineering: Fundamentals of engineering surveying, Levels and levelling, Theodolite, tacheometry, triangulation, contouring, errors and adjustments, correlation, underground surveying, curves, photogrammetry, field astronomy, GPS fundamentals. Principles of planning - Sampling methods and practices, reserve estimation techniques, basics of geostatistics, optimization of facility location, cash flow concepts and mine valuation, open pit design. Work study, concepts of reliability, reliability of series and parallel systems. Linear programming, transportation and assignment problems, queueing, network analysis, inventory control.

MT - METALLURGICAL ENGINEERING

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

METALLURGICAL ENGINEERING

Thermodynamics and Rate Processes: Laws of thermodynamics, activity, equilibrium constant, applications to metallurgical systems, solutions, phase equilibria, basic kinetic laws, order of reactions, rate constants and rate limiting steps principles of electro chemistry, aqueous, corrosion and protection of metals, oxidation and high temperature corrosion - characterization and control; momentum transfer - concepts of viscosity, shell balances, Bernoulli's equation; heat transfer - conduction, convection and heat transfer coefficient relations, radiation, mass transfer - diffusion and Fick's laws.

Extractive Metallurgy: Flotation, gravity and other methods of mineral processing; agglomeration, pyro-hydro-and electro-metallurgical processes; material and energy balances; principles and processes for the extraction of non-ferrous metals - aluminium, copper, zinc, lead, magnesium, nickel, titanium and other rare metals; iron and steel making - principles, blast furnace, direct reduction processes, primary and secondary steel making, deoxidation and inclusion in steel; ingot and continuous casting; stainless steel making, design of furnaces; fuels and refractories.

Physical Metallurgy: Crystal structure and bonding characteristics of metals, alloys, ceramics and polymers; solid solutions; solidification; phase transformation and binary phase diagrams; principles of heat treatment of steels, aluminum alloys and cast irons; recovery, recrystallization and grain growth; industrially important ferrous and non-ferrous alloys; elements of X-ray and electron diffraction; principles of scanning and transmission electron microscopy; elements of ceramics, composites and electronic materials; electronic basis of thermal, optical, electrical and magnetic properties of materials.

Mechanical Metallurgy: Elements of elasticity and plasticity; defects in crystals; elements of dislocation theory - types of dislocations, slip and twinning, stress fields of dislocations, dislocation interactions and reactions, methods of seeing dislocations; strengthening mechanisms; tensile, fatigue and creep behaviour; superplasticity; fracture - Griffith theory, ductile to brittle transition, fracture toughness; failure analysis; mechanical testing - tension, compression, torsion, hardness, impact, creep, fatigue, fracture toughness and formability tests.

Manufacturing Processes: Metal casting - patterns, moulds, melting, gating, feeding and casting processes, defects and castings, hot and cold working of metals; Metal forming - fundamentals of metal forming, rolling wire drawing, extrusion, forming, sheet metal forming processes, defects in forming; Metal joining - soldering, brazing and welding, common welding processes, welding metallurgy, problems associated with welding of steels and aluminium alloys, defects in welding, powder metallurgy; NDT methods - ultrasonic, radiography, eddy current, acoustic emission and magnetic.

PH - PHYSICS

Mathematical Physics: Linear vector space, matrices; vector calculus; linear differential equations; elements of complex analysis; Laplace transforms, Fourier analysis, elementary ideas about tensors.

Classical Mechanics: Conservation laws; central forces; collisions and scattering in laboratory and centre of mass reference frames; mechanics of system of particles; rigid body dynamics; moment of inertia tensor; noninertial frames and pseudo forces; variational principle; Lagrange's and Hamilton's formalisms; equation of motion, cyclic coordinates, Poisson bracket; periodic motion, small oscillations, normal modes; wave equation and wave propagation; special theory of relativity - Lorentz transformations, relativistic kinematics, mass-energy equivalence.

Electromagnetic Theory: Laplace and Poisson equations; conductors and dielectrics; boundary value problems; Ampere's and Biot-Savart's laws; Faraday's law; Maxwell's equations; scalar and vector potentials; Coulomb and Lorentz gauges; boundary conditions at interfaces; electromagnetic waves; interference, diffraction and polarization; radiation from moving charges.

Quantum Mechanics: Physical basis of quantum mechanics; uncertainty principle; Schrodinger equation; one and three dimensional potential problems; Particle in a box, harmonic oscillator, hydrogen atom; linear vectors and operators in Hilbert space; angular momentum and spin; addition of angular momentum; time independent perturbation theory; elementary scattering theory.

Atomic and Molecular Physics: Spectra of one-and many-electron atoms; LS and jj coupling; hyperfine structure; Zeeman and Stark effects; electric dipole transitions and selection rules; X-ray spectra; rotational and vibrational spectra of diatomic molecules; electronic transition in diatomic molecules, Franck-Condon principle; Raman effect; NMR and ESR; lasers.

Thermodynamics and Statistical Physics: Laws of thermodynamics; macrostates, phase space; probability ensembles; partition function, free energy, calculation of thermodynamic quantities; classical and quantum statistics; degenerate Fermi gas; black body radiation and Planck's distribution law; Bose-Einstein condensation; first and second order phase transitions, critical point.

Solid State Physics: Elements of crystallography; diffraction methods for structure determination; bonding in solids; elastic properties of solids; defects in crystals; lattice vibrations and thermal properties of solids; free electron theory; band theory of solids; metals, semiconductors and insulators; transport properties; optical, dielectric and magnetic properties of solids; elements of superconductivity.

Nuclear and Particle Physics: Rutheford scattering; basic properties of nuclei; radioactive decay; nuclear forces; two nucleon problem; nuclear reactions; conservation laws; fission and fusion; nuclear models; particle accelerators, detectors; elementary particles; photons, baryons, mesons and leptons; Quark model.

Electronics: Network analysis; semiconductor devices; bipolar transistors; FETs; power supplies, amplifier, oscillators; operational amplifiers; elements of digital electronics; logic circuits.

PI - PRODUCTION AND INDUSTRIAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

GENERAL ENGINEERING:

Engineering Materials: Structure and properties of engineering materials and their applications; effect of strain, strain rate and temperature on mechanical properties of metals and alloys; heat treatment of metals and alloys.

Applied Mechanics: Engineering mechanics - equivalent force systems, free body concepts, equations of equilibrium, virtual work and minimum potential energy; strength of materials-stress, strain and their relationship, Mohr's circle, deflection of beams, bending and shear stress, Euler's theory of columns.

Theory of Machines and Design: Analysis of planar mechanisms, plane cams and followers; governers and fly wheels; design of elements-failure theories; design of bolted, riveted and welded joints; design of shafts, keys, belt drives, brakes and clutches.

Thermal Engineering: Fluid machines - fluid statics, Bernoulli's equation, flow through pipes, equations of continuity and momentum; Thermodynamics - zeroth, First and Second laws of thermodynamics, thermodynamic system and processes, calculation of work and heat for systems and control volumes; Heat transfer - fundamentals of conduction, convection and radiation.

PRODUCTION ENGINEERING

Metal Casting: Casting processes; patterns-materials; allowances; moulds and cores - materials, making and testing; melting and founding of cast iron, steels and nonferrous metals and alloys; solidification; design of casting, gating and risering; casting defects and inspection.

Metal working: Stress-strain in elastic and plastic deformation; deformation mechanisms; hot and cold working-forging, rolling, extrusion, wire and tube drawing; sheet metal working; analysis of rolling, forging, extrusion and wire /rod drawing; metal working defects, high energy rate forming processes-explosive, magnetic, electro and electrohydraulic.

Metal Joining Processes: Welding processes - gas shielded metal arc, TIG, MIG, submerged arc, electroslag, thermit, resistance, pressure and forge welding; thermal cutting; other joining processes - soldering, brazing, braze welding; welding codes, welding symbols, design of welded joints, defects and inspection; introduction to modern welding processes - friction, ultrasonic, explosive, electron beam, laser and plasma.

Machining and Machine Tool Operations: Machining processes-turning, drilling, boring, milling, shaping, planing, sawing, gear cutting, thread production, broaching, grinding, lapping, honing super finishing; mechanics of cutting- Merchant's analysis, geometry of cutting tools, cutting forces, power requirements; selection of process parameters; tool materials, tool wear and tool life, cutting fluids, machinability; nontraditional machining processes and hybrid processes- EDM, CHM, ECM, USM, LBM, EBM, AJM, PAM AND WJM; economics of machining.

Metrology and Inspection: Limits and fits, linear and angular measurements by mechanical and optical methods, comparators; design of limit gauges; interferometry; measurement of straightness, flatness, roundness, squareness and symmetry; surface finish measurement; inspection of screw threads and gears; alignment testing.

Powder Metallurgy and Processing of Plastics: Production of powders, compaction, sintering; Polymers and composites; injection, compression and blow molding, extrusion, calendaring and thermoforming; molding of composites.

Tool Engineering: Work-holding-location and clamping; principles and methods; design of jigs and fixtures; design of press working tools, forging dies.

Manufacturing Analysis: Sources of errors in manufacturing; process capability; part-print analysis; tolerance analysis in manufacturing and assembly; process planning; parameter selection and comparison of production alternatives; time and cost analysis; Issues in choosing manufacturing technologies and strategies.

Computer Integrated Manufacturing: Basic concepts of CAD, CAM, CAPP, group technology, NC, CNC, DNC, FMS, Robotics and CIM.

INDUSTRIAL ENGINEERING

Product Design and Development: Principles of good product design, component and tolerance design; efficiency, quality and cost considerations; product life cycle; standardization, simplification, diversification, value analysis, concurrent engineering.

Engineering Economy and Costing: Financial statements; elementary cost accounting, methods of depreciation; break-even analysis, techniques for evaluation of capital investments.

Work System Design: Taylor's scientific management, Gilbreths's contributions; productivity concepts and measurements; method study, micro-motion study, principles of motion economy; human factors engineering, ergonomics; work measurement - time study, PMTS, work sampling; job evaluation, merit rating, wage administration, incentive systems; business process reengineering.

Logistics and Facility Design: Facility location factors, evaluation of alternatives, types of plant layout, evaluation; computer aided layout; assembly line balancing; material handling systems; supply chain management.

Production Planning and Inventory Control: Inventory Function costs, classifications - deterministic and probabilistic models; quantity discount; safety stock; inventory control system; Forecasting techniques - causal and time series models, moving average, exponential smoothing; trend and seasonality; aggregate production planning; master scheduling; bill of materials and material requirement planning; order control and flow control, routing, scheduling and priority dispatching; JIT; Kanban PULL systems; bottleneck scheduling and theory of constraints.

Operation Research: Linear programming - problem formulation, simplex method, duality and sensitivity analysis; transportation; assignment; network flow models, constrained optimization and Lagrange multipliers; simple queuing models; dynamic programming; simulation; PERT and CPM, time-cost trade-off, resource leveling.

Quality Control: Taguchi method; design of experiments; quality costs, statistical quality assurance, process control charts, acceptance sampling, zero defects; quality circles, total quality management.

Reliability and Maintenance: Reliability, availability and maintainability; probabilistic failure and repair times; system reliability; preventive maintenance and replacement, TPM.

Management Information System: Value of information; information storage and retrieval system - database and data structures; interactive systems; knowledge based systems.

Intellectual Property System: Definition of intellectual property, importance of IPR; TRIPS, and its implications, WIPO and Global IP structure, and IPS in India; patent, copyright, industrial design and trademark; meanings, rules and procedures, terms, infringements and remedies.

PY - PHARMACEUTICAL SCIENCES

Natural Products: Pharmacognosy & Phytochemistry - Chemistry, tests, isolation, characterization and estimation of phytopharmaceuticals belonging to the group of Alkaloids, Glycosides, Terpenoids, Steroids, Bioflavanoids, Purines, Guggul lipids. Pharmacognosy of crude drugs which contain the above constituents. Standardisation of raw materials and herbal products. WHO guide lines. Quantitative microscopy including modern techniques used for evaluation. Biotechnological principles and techniques for plant development Tissue culture.

Pharmacology: General pharmacological principles including Toxicology. Drug interaction. Pharmacology of drugs acting on Central nervous system, Cardiovascular system, Autonomic nervous system, Gastro intestinal system and Respiratory system. Pharmacology of Autocoids, Hormones, Chemotherapeutic agents including anticancer drugs. Bioassays. Immuno Pharmacology.

Medicinal Chemistry: Structure, nomenclature, classification, synthesis, SAR and metabolism of the following category of drugs which are official in Indian Pharmacopoeia and British Pharmacopoeia Hypnotics and Sedatives, Analgesics, NSAIDS, Neuroleptics, Antidepressants, Anxiolytics, Anticonvulsants, Antihistaminics, Local anaesthetics, Cardio Vascular drugs - Antianginal agents Vasodilators, Adrenergic & cholinergic drugs, Cardiotonic agents, Diuretics, Antihypertensive drugs, Hypoglycemic agents, Antilipedmic agents, Coagulants, Anticoagulants, Antiplatelet agents. Chemotherapeutic agents - Antibiotics, Antibacterials, Sulphadrugs. Antiproliozoal drugs, Antiviral, Antitubercular, Antimalarial, Anticancer, Antiamoebic drugs. Diagnostic agents. Preparation and storage and uses of official Radiopharmaceuticals. Vitamins and Hormones.

Pharmaceutics: Development, manufacturing standards, labeling, packing as per the pharmacopoeal requirements, Storage of different dosage forms and new drug delivery systems. Biopharmaceutics and Pharmacokinetics and their importance in formulation. Formulation and preparation of cosmetics - lipstick, shampoo, creams, nail preparations and dentifrices. Pharmaceutical calculations.

Pharmaceutical Jurisprudence: Legal aspects of manufacture, storage, sale of drugs. D and C act and rules. Pharmacy act.

Pharmaceutical Analysis: Principles, instrumentation and applications of the following. Absorption spectroscopy (UV, visible & IR), Fluorimetry, Flame photometry, Potentiometry, Conductometry and Plarography. Pharmacopoeial assays. Principles of NMR, ESR, Mass spectroscopy, X-ray diffraction analysis and different chromatographic methods.

Biochemistry and Clinical Pharmacy: Biochemical role of hormones, Vitamins, Enzymes, Nucleic acids. Bioenergetics. General principles of immunology. Immunological techniques. Adverse drug interaction.

Microbiology: Principles and methods of microbiological assays of the Pharmacopoeia. Methods of preparation of official sera and vaccines. Serological and diagnostic tests. Applications of microorganisms in Bio Conversions and in Pharmaceutical industry.

TF - TEXTILE ENGINEERING AND FIBRE SCIENCE

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

TEXTILE ENGINEERING & FIBRE SCIENCE

Textile Fibres: Classification of textile fibres according to their nature and origin; general characteristics of textile fibres-their chemical and physical structures and their properties; essential characteristics of fibre forming polymers; uses of natural and man-made fibres; physical and chemical methods of fibre and blend identification and blend analysis.

Melt Spinning processes with special reference to polyamide and polyester fibres; wet and dry spinning of viscose and acrylic fibres; post spinning operations-drawing, heat setting, texturing- false twist and air-jet, tow-to-top conversion. Methods of investigating fibre structure e.g. X-ray diffraction, birefringence, optical and electron microscopy, I.R. absorption, thermal methods; structure and morphology and principal natural and man-made fibres, mechanical properties of fibres, moisture sorption in fibres; fibre structure and property correlation.

Textile Testing: Sampling techniques, sample size and sampling errors; measurement of fibre length, fineness, crimp, strength and reflectance; measurement of cotton fibre maturity ad trash content; HVI and AFIS for fibre testing. Measurement of yarn count, twist and hairiness; tensile testing of fibres, yarn and fabrics; evenness testing of slivers, rovings and yarns; testing equipment for measurement test methods of fabric properties like thickness, compressibility, air permeability, drape, crease recovery, tear strength bursting strength and abrasion resistance. Correlation analysis, significance tests and analysis of variance; frequency distributions and control charts.

Yarn Manufacture and Yarn Structure: Modern methods of opening, cleaning and blending of fibrous materials; the technology of carding with particular reference to modern developments; causes of irregularity introduced by drafting, the development of modern drafting systems; principles and techniques of preparing material for combing; recent development in combers; functions and synchronization of various mechanisms concerned with roving production; forces acting on yarn and traveller, ring and traveller designs; causes of end breakages; properties of doubles yarns; new methods of yarn production such as rotor spinning, air jet spinning and friction spinning.

Yarn diameter; specific volume, packing coefficient; twist-strength relationship; fibre orientation in yarn; fibre migration.

Fabric Manufacture and Fabric Structure: Principles of cheese and cone winding processes and machines; random and precision winding; package faults and their remedies; yarn clearers and tensioners; different systems of yarn splicing; features of modern cone winding machines; different types of warping creels; features of modern beam and sectional warping machines; different sizing systems, sizing of spun and filament yarns, modern sizing machines; principles of pirn winding processes and machines; primary and secondary motions of loom, effect of their settings and timings on fabric formation, fabric appearance and weaving performance; dobby and jacquard shedding; mechanics of weft insertion with shuttle; warp and weft stop motions, warp protection, weft replenishment; functional principles of weft insertion systems of shuttleless weaving machines, principles of multiphase and circular looms. Principles of weft and warp knitting; basic weft and warp knitted structures; classification, production and areas of application of nonwoven fabrics.

Basic woven fabric constructions and their derivatives; crepe, cord, terry, gauze, lino and double cloth constructions.

Peirce's equations for fabric geometry; thickness, cover and maximum sett of woven fabrics

Textile Chemical Processing: Preparatory processes for natural-and and their blends; mercerization of cotton; machines for yarn and fabric mercerization.

Dyeing and printing of natural- and synthetic- fibre fabrics and their blends with different dye classes; dyeing and printing machines; styles of printing; fastness properties of dyed and printed textile materials.

Finishing of textile materials, wash and wear, durable press, soil release, water repellent, flame retardant and antistatic finishes; shrink-resistance finish for wool; heat setting of synthetic-fibre fabrics, finishing machines; energy efficient processes; pollution control.

XE - ENGINERING SCIENCES

The syllabi of the sections of this paper are as follows:

SECTION A. ENGINEERING MATHEMATICS (Compulsory)

Linear Algebra : Determinates, algebra of matrices, rank, inverse, system of linear equations, symmetric, skew-symmetric and orthogonal matrices. Hermitian, skew-hermitian and unitary matrices. eigenvalues and eigenvectors, diagonalisation of matrices, Cayley-Hamiltonian, quadratic forms.

Calculus : Functions of single variables, limit, continuity and differentiability, Mean value theorems, Intermediate forms and L'Hospital rule, Maxima and minima, Taylor's series, Fundamental and mean value-theorems of integral calculus. Evaluation of definite and improper integrals, Beta and Gamma functions, Functions of two variables, limit, continuity, partial derivatives, Euler's theorem for homogeneous functions, total derivatives, maxima and minima, Lagrange method of multipliers, double and triple integrals and their applications, sequence and series, tests for convergence, power series, Fourier Series, Fourier integrals.

Complex variable: Analytic functions, Cauchy's integral theorem and integral formula without proof. Taylor's and Laurent' series, Residue theorem (without proof) with application to the evaluation of real integarls.

Vector Calculus: Gradient, divergence and curl, vector identities, directional derivatives, line, surface and volume integrals, Stokes, Gauss and Green's theorems (without proofs) with applications.

Ordinary Differential Equations: First order equation (linear and nonlinear), higher order linear differential equations with constant coefficients, method of variation of paramaters, Cauchy's and Euler's equations, initial and boundary value problems, power series solutions, Legendre polynomials and Bessel's functions of the first kind.

Partial Differential Equations: Variables separable method, solutions of one dimensional heat, wave and Laplace equations.

Probability and Statistics: Definitions of probability and simple theorems, conditional probability, mean, mode and standard deviation, random variables, discrete and continuous distributions, Poisson, normal and Binomial distribution, correlation and regression

Numerical Methods: L-U decomposition for systems of linear equations,Newton-Raphson method, numerical integration(trapezoidal and Simpson's rule), numerical methods for first order differential equation (Euler method)

SECTION B. COMPUTATIONAL SCIENCE

Numerical Methods: Truncation errors, round off errors and their propagation; Interpolation; Lagrange, Newton's forward, backward and divided difference formulas, least square curve fitting, solution of non-linear equations of one variables using bisection, false position, secant and Newton Raphson methods; Rate of convergence of these methods, general iterative methods. Simple and multiple roots of polynomials. Solutions of system of linear algebraic equations using Gauss elimination methods, Jacobi and Gauss-Seidel iterative methods and their rate of convergence; ill conditioned and well conditioned system. eigen values and eigen vectors using power methods. Numerical integration using trapezoidal, Simpson's rule and other quadrature formulas. Numerical Differentiation. Solution of boundary value problems. Solution of initial value problems of ordinary differential equations using Euler's method, predictor corrector and Runge Kutta method.

Programming : Elementary concepts and terminology of a computer system and system software, Fortran77 and C programming.

Fortran : Program organization, arithmetic statements, transfer of control, Do loops, subscripted variables, functions and subroutines.

C language : Basic data types and declarations, flow of control- iterative statement, conditional statement, unconditional branching, arrays, functions and procedures.

SECTION C. ELECTRICAL SCIENCES

Electric Circuits: Ideal voltage and current sources; RLC circuits, steady state and transient analysis of DC circuits, network theorems; alternating currents and voltages, single-phase AC circuits, resonance; three-phase circuits.

Magnetic circuits: Mmf and flux, and their relationship with voltage and current; transformer, equivalent circuit of a practical transformer, three-phase transformer connections.

Electrical machines: Principle of operation, characteristics, efficiency and regulation of DC and synchronous machines; equivalent circuit and performance of three-phase and single-phase induction motors.

Electronic Circuits: Characteristics of p-n junction diodes, zener diodes, bipolar junction transistors (BJT) and junction field effect transistors (JFET); MOSFET's structure, characteristics, and operations; rectifiers, filters, and regulated power supplies; biasing circuits, different configurations of transistor amplifiers, class A, B and C of power amplifiers; linear applications of operational amplifiers; oscillators; tuned and phase shift types.

Digital circuits: Number systems, Boolean algebra; logic gates, combinational circuits, flip-flops (RS, JK, D and T) counters.

Measuring instruments: Moving coil, moving iron, and dynamometer type instruments; shunts, instrument transformers, cathode ray oscilloscopes; D/A and A/D converters.

SECTION D. FLUID MECHANICS

Fluid Properties: Relation between stress and strain rate for Newtonian fluids

Hydrostatics, buoyancy, manometry

Concept of local and convective accelerations; control volume analysis for mass, momentum and energy conservation.

Differential equations of continuity and momentum (Euler's equation of motion); concept of fluid rotation, stream function, potential function; Bernoulli's equation and its applications.

Qualitative ideas of boundary layers and its separation; streamlined and bluff bodies; drag and lift forces.

Fully-developed pipe flow; laminar and turbulent flows; friction factor; Darcy Weisbach relation; Moody's friction chart; losses in pipe fittings; flow measurements using venturimeter and orifice plates.

Dimensional analysis; similitude and concept of dynamic similarity; importance of dimensionless numbers in model studies.

SECTION E. MATERIALS SCIENCE

Atomic structure and bonding in materials: metals, ceramics and polymers.

Structure of materials: Crystal systems, unit cells and space lattice; determination of structures of simple crystals by X-ray diffraction; Miller indices for planes and directions. Packing geometry in metallic, ionic and covalent solids.

Concept of amorphous, single and polycrystalline structures and their effects on properties of materials.

Imperfections in crystalline solids and their role in influencing various properties.

Fick´s laws of diffusion and applications of diffusion in sintering, doping of semiconductors and surface hardening of metals.

Alloys: solid solution and solubility limit. Binary phase diagram, intermediate phases and intermetallic compounds; iron-iron carbide phase diagram. Phase transformation in steels. Cold and hot working of metals, recovery, recrystallization and grain growth.

Properties and applications of ferrous and nonferrous alloys.

Structure, properties, processing and applications of traditional and advanced ceramics.

Polymers: classification, polymerization, structure and properties, additives for polymer products, processing and application.

Composites: properties and application of various composites.

Corrosion and environmental degradation of materials (metals, ceramics and polymers).

Mechanical properties of materials: Stress-strain diagrams of metallic, ceramic and polymeric materials, modulus of elasticity, yield strength, plastic deformation and toughness, tensile strength and elongation at break; viscoelasticity, hardness, impact strength. ductile and brittle fracture. creep and fatigue properties of materials.

Heat capacity, thermal conductivity, thermal expansion of materials.

Concept of energy band diagram for materials; conductors, semiconductors and insulators in terms of energy bands. Electrical conductivity, effect of temperature on conductivity in materials, intrinsic and extrinsic semiconductors, dielectric properties of materials.

Refraction, reflection, absorption and transmission of electromagnetic radiation in solids.

Origin of magnetism in metallic and ceramic materials, paramagnetism, diamagnetism, antiferromagnetism, ferromagnetism, ferrimagnetism in materials and magnetic hysteresis.

Advanced materials: Smart materials exhibiting ferroelectric, piezoelectric, optoelectronic, semiconducting behaviour; lasers and optical fibers; photoconductivity and superconductivity in materials.

SECTION F. SOLID MECHANICS

Equivalent force systems; free-body diagrams; equilibrium equations; analysis of determinate and indeterminate trusses and frames; friction.

Simple relative motion of particles; force as function of position, time and speed; force acting on a body in motion; laws of motion; law of conservation of energy; law of conservation of momentum

Stresses and strains; principal stresses and strains; Mohr's circle; generalized Hooke's Law; equilibrium equations; compatibility conditions; yield criteria.

Axial, shear and bending moment diagrams; axial, shear and bending stresses; deflection (for symmetric bending); torsion in circular shafts; thin cylinders; energy methods (Castigliano's Theorems); Euler buckling.

SECTION G. THERMODYNAMICS

Basic Concepts: Continuum, macroscopic approach, thermodynamic system (closed and open or control volume); thermodynamic properties and equilibrium; state of a system, state diagram, path and process; different modes of work; Zeroth law of thermodynamics; concept of temperature; heat.

First Law of Thermodynamics: Energy, enthalpy, specific heats, first law applied to systems and control volumes, steady and unsteady flow analysis.

Second Law of Thermodynamics: Kelvin-Planck and Clausius statements, reversible and irreversible processes, Carnot theorems, thermodynamic temperature scale, Clausius inequality and concept of entropy, principle of increase of entropy; availability and irreversibility.

Properties of Pure Substances: Thermodynamic properties of pure substances in solid, liquid and vapour phases, P-V-T behaviour of simple compressible substances, phase rule, thermodynamic property tables and charts, ideal and real gases, equations of state, compressibility chart.

Thermodynamic Relations: T-ds relations, Maxwell equations, Joule-Thomson coefficient, coefficient of volume expansion, adiabatic and isothermal compressibilities, Clapeyron equation.

Ideal Gas Mixtures: Dalton's and Amagat's laws, calculations of properties, air-water vapour mixtures.

XL - LIFE SCIENCES

The syllabi of the Sections of this paper are as follows:

SECTION H. CHEMISTRY (Compulsory)

Atomic structure and periodicity: Quantum chemistry; Planck's quantum theory, wave particle duality, uncertainty principle, quantum mechanical model of hydrogen atom; electronic configuration of atoms; periodic table and periodic properties; ionization energy, election affinity, electronegativity, atomic size.

Structure and bonding: Ionic and covalent bonding M.O. and V.B. approaches for diatomic molecules, VSEPR theory and shape of molecules, hybridisation, resonance, dipole moment, structure parameters such as bond length, bond angle and bond energy, hydrogen bonding, van der Waals interactions. Ionic solids; ionic radii, lattice energy (Born-Haber Cycle).

s.p. and d Block Elements: Oxides, halides and hydrides of alkali and alkaline earth metals, B, Al, S, N, P and S, silicones, general characteristics of 3d elements, coordination complexes: valence bond and crystal field theory, color, geometry and magnetic properties.

Chemical Equilibria: Colligative properties of solutions, ionic equilibria in solution, solubility product, common ion effect, hydrolysis of salts, pH, buffer and their applications in chemical analysis.

Electrochemistry: Conductance, Kohlrausch law, Half Cell potentials, emf, Nernst equation, galvanic cells, thermodynamic aspects and their applications.

Reaction Kinetics: Rate constant, order of reaction, molecularity, activation energy, zero, first and second order kinetics, equilibrium constants (Kc, Kp and Kx) for homogeneous reactions, catalysis and elementary enzyme reactions.

Thermodynamics: First law, reversible and irreversible processes, internal energy, enthalpy, Kirchoff's equation, heat of reaction, Hess law, heat of formation, Second law, entropy, free energy, and work function. Gibbs-Helmholtz equation, Clausius-Clapeyron equation, free energy change and equilibrium constant, Troutons rule, Third law of thermodynamics.

Mechanistic Basis of Organic Reactions: Elementary treatment of SN1, SN2, E1 and E2 reactions, Hoffmann and Saytzeff rules, Addition reactions, Markonikoff rule and Kharash effect, Diels-Alder reaction, aromatic electrophilic substitution, orientation effect as exemplified by various functional groups.

Structure-Reactivity Correlations: Acids and bases, electronic and steric effects, optical and geometrical isomerism, tautomerism, concept of aromaticity

SECTION I. BIOCHEMISTRY

Organization of life. Importance of water. Cell structure and organelles. Structure and function of biomolecules: Carbohydrates, Lipids, Proteins and Nucleic acids. Biochemical separation techniques. Spectroscopic methods; UV-visible and fluorescence. Protein structure, folding and function: Myoglobin, Hemoglobin, Lysozyme, ribonuclease A, Carboxypeptidase and Chymotrypsin. Enzyme kinetics and regulation, Coenzymes.

Metabolism and bioenergitics. Generation and utilization of ATP. Photosynthesis. Major metabolic pathways and their regulation. Biological membranes. Transport across membranes. Signal transduction; hormones and neurotransmitters.

DNA replication, transcription and translation. Biochemical regulation of gene expression. Recombinant DNA technology and applications. Genomics and Proteomics.

The immune system. Active and passive immunity. Complement system. Antobody structure, function and diversity. Cells of the immune system: T, B and macrophages. T and B cell activation. Major histocompatibilty complex. T cell receptor. Immunological techniques: Immunodiffusion, immunoelectrophoresis, RIA and ELISA.

SECTION J. BIOTECHNOLOGY

Recombinant DNA technology for the production of therapeutic proteins. Micro array technology. Heterologous protein expression systems in bacteria, yeast etc.

Architecture of plant genome; plant tissue culture techniques; methods of gene transfer into plant cells; manipulation of phenotypic traits in plants; plant cell fermentations and production of secondary metabolites using suspension/ immobilized cell culture; methods for plant micro propagation; crop improvement and development of transgenic plants. Expression of animal proteins in plants.

Animal cell metabolism and regulation; cell cycle; primary cell culture; nutritional requirements for animal cell culture; techniques for the mass culture of animal cell lines; production of vaccines; growth hormones and interferons using animal cell culture; cytokines-production and therapeutic uses; hybridoma technology; vectors for gene transfer and expression in animal cells. Transgenic animals and molecular pharming.

Microbial production of industrial enzymes; methods for immobilization of enzymes; kinetics of soluble and immobilized enzymes; application of soluble and immobilized enzymes; enzyme-based sensors.

Microbial growth kinetics; batch, fed batch and continuous culture of microbial cells; media for industrial fermentations; sterilization of air and media; design features and operation of stirred tank, air-lift and fluidized bed reactors; aeration and agitation in aerobic fermentations; recovery and purification of fermentation products- filtration, centrifugation, cell disintegration, solvent extraction and chromatographic separations; industrial fermentations for the production of ethanol, citric acid, lysine, penicillin and other biomolecules; simple calculations based on material and energy balance of fermentation processes; application of microbes in the management of domestic and industrial wastes.

SECTION K. BOTANY

Anatomy: Roots, stem and leaves of land plants, meristems, vascular system, their ontogeny, structure and functions. Plant cell structure, organisation, organelles, cytoskeleton, cell wall and membranes.

Development: Cell cycle, cell division, senescence, hormonal regulation of growth; life cycle of an angiosperm, pollination, fertilization, embryogenesis, seed formation, seed storage proteins, seed dormancy and germination. Concept of cellular totipotency, organogenesis and somatic embryogenesis, somaclonal variation, embryo culture, in vitro fertilization.

Physiology and Biochemistry: Plant water relations, transport of minerals and solutes, N2 metabolism, proteins and nucleic acid, respiration, photophysiology, photosynthesis, photorespiration; biosynthesis, mechanism of action and physiological effects of plant growth regulators.

Genetics: Principles of Mendelian inheritance, linkage, recombination and genetic mapping; extrachromosomal inheritance; eukaryotic genome organization (chromatin structure) and regulation of gene expression, gene mutation, chromosome aberrations (numerical and structural), transposons.

Plant Breeding: Principles, methods - selection, hybridization, heterosis; male sterility, self and inter-specific incompatibility; haploidy; somatic cell hybridization; molecular marker-assisted selection; gene transfer methods viz. direct and vector-mediated, transgenic plants and their applications in agriculture.

Economic Botany: Economically important plants - cereals, pulses, plants yielding fiber, timber, sugar, beverages, oils, rubber, dyes, gums, drugs and narcotics - a general account.

Systematics: Systems of classification (non-phylogenetic vs. phylogenetic - outline), plant groups, molecular systematics.

Plant Pathology: Nature and classification of plant diseases, diseases of important crops caused by fungi, bacteria and viruses, and their control measures, mechanism(s) of pathogenesis and resistance, molecular detection of pathogens; plant-microbe beneficial interactions.

Ecology and Plant Geography: Ecosystems - types, dynamics, degradation, ecological succession; food chains; vegetation types of the world; pollution and global warming; speciation and extinction, conservation strategies, cryopreservation.

SECTION L. MICROBIOLOGY

Historical perspective - Discovery of the microbial world; Controversy over spontaneous generation; Role of microorganisms in transformation of organic matter and in the causation of diseases.

Methods in microbiology - Pure culture techniques; Theory and practice of sterilization; Principles of microbial nutrition; Construction of culture media; Enrichment culture techniques for isolation of chemoautotrophs, chemoheterotrophs and photosynthetic microorganisms.

Microbial evolution, systematics and taxonomy - Evolution of earth and earliest life forms; Primitive organisms and their metabolic strategies; New approaches to bacterial taxonomic classification including ribotyping; Nomenclature.

Microbial diversity - Bacteria, archea and their broad classification; Eukaryotic microbes, yeast, fungi, slime mold and protozoa; Viruses and their classification.

Microbial growth -The definition of growth, mathematical expression of growth, growth curve, measurement of growth and growth yields; Synchronous growth; Continuous culture.

Nutrition and metabolism - Overview of metabolism; Microbial nutrition; Energy classes of microorganisms; Culture media; Energetics, modes of ATP generation; ATP generation by heterotrophs; Fermentation; Glycolysis; Respiration; The citric acid cycle; Electron transport systems; Alternate modes of energy generation; Pathways (anabolism) in the biosynthesis of amino acids, purines, pyrimidines and fatty acids.

Metabolic diversity among microorganisms - Photosynthesis in microorganisms; Role of chlorophylls, carotenoids and phycobilins; Calvin cycle; Chemolithotrophy; Hydrogen- iron- nitrite-oxidizing bacteria; Nitrate and sulfate reduction; Methanogenesis and acetogenesis.

Prokaryotic cells: structure-function - Cells walls of eubacteria (peptidoglycan) and related molecules; Outer-membrane of gram-negative bacteria; Cell wall and cell membrane synthesis; Flagella and motility; Cell inclusions like endospores, gas vesicles.

Microbial diseases and host parasite relationships - Normal microflora of skin; Oral cavity; Gastrointestinal tract; Entry of pathogens into the host; Infectious disease transmission; Respiratory infections caused by bacteria and viruses; Tuberculosis; Sexually transmitted diseases including AIDS; Diseases transmitted by animals (Rabies, plague), insects and ticks (rikettsias, Lyme disease, malaria); Food and water borne diseases; Public health and water quality; Pahtogenic fungi; Emerging and resurgent infectious diseases.

Chemotherapy/Antibiotics - Antimicrobial agents; Sulfa drugs; Antibiotics; Pencillins and cephalosporins; Broad-spectrum antibiotics; Antibiotics from prokaryotes; Antifungal antibiotics; Mode of action; Resistance to antibiotics.

Microbial genetics - Genes, mutation and mutagenesis - UV and chemical mutagnes; Types of mutations; Ames test for mutagenesis; Methods of genetic analysis. Bacterial genetic system - Transformation; Conjugation; Transduction; Recombination; Plasmids and Transposons; Bacterial genetic map with reference to E. coli. Viruses and their genetic system - Phage ? and its life cycle; RNA phages; RNA viruses; Retroviruses; Genetic systems of yeast and Neurospora; Extrachromosomal inheritance and mitochondrial genetics; Basic concept of genomics.

SECTION M. ZOOLOGY

Animal world: Animal diversity, distribution, systematic and classification of animals, the phylogenetic relationship.

Evolution: Origin of life, history of life on earth, evolutionary theories, natural selection, adaptation, speciation.

Genetics: Principles of inheritance, molecular basis of heredity, the genetic material, transmission of genetic material, mutations, cytoplasmic inheritance.

Biochemistry and Molecular Biology: Nucleic acids, proteins and other biological macromolecules. Replication, transcription and translation, regulation of gene expression, organization of genome, Kreb's cycle, glycolysis, enzyme catalysis, hormones and their action.

Cell Biology: Structure of cell, cellular organelles and their structure and function, cell cycle, cell division, cellular differentiation, chromosome and chromatin structure. Eukaryotic gene organisation and expression.

Animal Anatomy and Physiology: Comparative physiology, the respiratory system, circulatory system, digestive system, the nervous system, the excretory system, the endocrine system, the reproductive system, the skeletal system, osmoregulation.

Parasitology and Immunology: Nature of parasite, host-parasite relation, protozoan and helminthic parasites, the immune response, cellular and humoral immune response, evolution of the immune system.

Development Biology: Embryonic development, cellular differentiation, organogenesis, metamorphosis, genetic basis of development.

Ecology: The ecosystem, habitats the food chain, population dynamics, species diversity, zoogeography, biogeochemical cycles, conservation biology.

Animal Behaviour: Types of behaviours, courtship, mating and territoriality, instinct, learning and memory, social behaviour across the animal taxa, communication, pheromones, evolution of animal behaviour.

IT - INFORMATION TECHNOLOGY

ENGINEERING MATHEMATICS

Mathematical Logic: Propositional Logic; First Order Logic.

Probability: Conditional Probability; Mean, Median, Mode and Standard Deviation; Random Variables; Distributions; uniform, normal, exponential, Poisson, Binomial.

Set Theory & Algebra: Sets; Relations; Functions; Groups; Partial Orders; Lattice; Boolean Algebra.

Combinatorics: Permutations; Combinations; Counting; Summation; generating functions; recurrence relations; asymptotics.

Graph Theory: Connectivity; spanning trees; Cut vertices & edges; covering; matching; independent sets; Colouring; Planarity; Isomorphism.

Linear Algebra: Algebra of matrices, determinants, systems of linear equations, Eigen values and Eigen vectors.

Numerical Methods: LU decomposition for systems of linear equations; numerical solutions of non linear algebraic equations by Secant, Bisection and Newton-Raphson Methods; Numerical integration by trapezoidal and Simpson's rules.

Calculus: Limit, Continuity & differentiability, Mean value Theorems, Theorems of integral calculus, evaluation of definite & improper integrals, Partial derivatives, Total derivatives, maxima & minima.

FORMAL LANGUAGES AND AUTOMATA

Regular Languages: finite automata, regular expressions, regular grammar.

Context free languages: push down automata, context free grammars

COMPUTER HARDWARE

Digital Logic: Logic functions, minimization, design and synthesis of combinatorial and sequential circuits, number representation and computer arithmetic (fixed and floating point)

Computer organization: Machine instructions and addressing modes, ALU and data path, hardwired and microprogrammed control, memory interface, I/O interface (interrupt and DMA mode), serial communication interface, instruction pipelining, cache, main and secondary storage

SOFTWARE SYSTEMS

Data structures and Algorithms: the notion of abstract data types, stack, queue, list, set, string, tree, binary search tree, heap, graph, tree and graph traversals, connected components, spanning trees, shortest paths, hashing, sorting, searching, design techniques (greedy, dynamic, divide and conquer), asymptotic analysis (best, worst, average cases) of time and space, upper and lower bounds, intractability

Programming Methodology: C programming, program control (iteration, recursion, functions), scope, binding, parameter passing, elementary concepts of object oriented programming

Operating Systems (in the context of Unix): classical concepts (concurrency, synchronization, deadlock), processes, threads and interprocess communication, CPU scheduling, memory management, file systems, I/O systems, protection and security

Information Systems and Software Engineering: information gathering, requirement and feasibility analysis, data flow diagrams, process specifications, input/output design, process life cycle, planning and managing the project, design, coding, testing, implementation, maintenance.

Databases: relational model, database design, integrity constraints, normal forms, query languages (SQL), file structures (sequential, indexed), b-trees, transaction and concurrency control

Data Communication: data encoding and transmission, data link control, multiplexing, packet switching, LAN architecture, LAN systems (Ethernet, token ring), Network devices: switches, gateways, routers

Networks: ISO/OSI stack, sliding window protocols, routing protocols, TCP/UDP, application layer protocols & systems (http, smtp, dns, ftp), network security

Web technologies: three tier web based architecture; JSP, ASP, J2EE, .NET systems; html, XML

AG - AGRICULTURAL ENGINEERING

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

FARM MACHINERY AND POWER:

Sources of power on the farm-human, animal, mechanical, electrical, wind, solar and biomass; design and selection of machine elements - gears, pulleys, chains and sprockets and belts; overload safety devices used in farm machinery; measurement of force, torque, speed, displacement and acceleration on machine elements.

Soil tillage; forces acting on a tillage tool; hitch systems and hitching of tillage implements; functional requirements, principles of working, construction and operation of manual, animal and power operated equipment for tillage. sowing, planting, fertilizer application, inter-cultivation, spraying, mowing, chaff cutting, harvesting, threshing and transport; testing of agricultural machinery and equipment; calculation of performance parameters -field capacity, efficiency, application rate and losses; cost analysis of implements and tractors.

Thermodynamic principles of I.C. engines; I.C. engine cycles; engine components; fuels and combustion; lubricants and their properties; I.C. engine systems - fuel, cooling, lubrication, ignition, electrical, intake and exhaust; selection, operation, maintenance and repair of I.C. engines; power efficiencies and measurement; calculation of power, torque, fuel consumption, heat load and power losses.

Tractors and power tillers - type, selection, maintenance and repair; tractor clutches and brakes; power transmission systems - gear trains, differential, final drives and power take-off; mechanics of tractor chassis; traction theory; three point hitches- free link and restrained link operations; mechanical steering and hydraulic control systems used in tractors; human engineering and safety in tractor design; tractor tests and performance.

SOIL AND WATER CONSERVATION ENGINEERING:

Ideal and real fluids, properties of fluids; hydrostatic pressure and its measurement; hydrostatic forces on plane and curved surface; continuity equation; Bernoulli's theorem; laminar and turbulent flow in pipes, Darcy-Weisbach and Hazen-Williams equations, Moody's diagram; flow through orifices and notches; flow in open channels.

Engineering properties of soils, fundamental definitions and relationships; index properties of soils; permeability and seepage analysis; shear strength, Mohr's circle of stresses; active and passive earth pressures; stability of slopes.

Hydrological cycle; precipitation measurement, analysis of precipitation data; abstraction from precipitation; runoff; hydrograph analysis, unit hydrograph theory and application; stream flow measurement; flood routing, hydrological reservoir and channel routing.

Mechanics of soil erosion, factors affecting erosion; soil loss estimation; biological and engineering measures to control erosion, terraces and bunds; vegetative waterways; gully control structures, drop, drop inlet and chute spillways; farm ponds; earthen dams; principles of watershed management.

Water requirement of crops; consumptive use and evapo-transpiration; irrigation scheduling; irrigation efficiencies; design of prismatic and silt loaded channels; methods of irrigation water application; design and evaluation of irrigation methods; drainage coefficient; surface and subsurface drainage systems; leaching requirement and salinity control; irrigation and drainage water quality; classification of pumps; pump characteristics; pump selection; types of aquifer; evaluation of aquifer properties; well hydraulics; ground water recharge.

AGRICULTURAL PROCESSING AND FOOD ENGINEERING:

Steady state heat transfer in conduction, convection and radiation; transient heat transfer in simple geometry; condensation and boiling heat transfer; working principles of heat exchangers; diffusive and convective mass transfer; simultaneous heat and mass transfer in agricultural processing operations.

Material and energy balances in food processing systems; water activity, sorption and desorption isotherms; centrifugal separation of solids, liquids and gases; kinetics of microbial death - pasteurisation and sterilization of liquid foods; preservation of food by cooling and freezing; psychrometry - properties of air-vapour mixture; concentration and dehydration of liquid foods - evaporators, tray, drum and spray dryers.

Mechanics and energy requirement in size reduction of granular solids; particle size analysis for comminuted solids; size separation by screening; fluidisation of granular solids; cleaning and grading efficiency and effectiveness of grain cleaners; conditioning and hydrothermal treatments for grains; dehydration of food grains; processes and machines for processing of cereals, pulses and oilseeds; design considerations for grain silos.

AR - ARCHITECTURE AND PLANNING

City planning: Historical development of cities; principles of city planning; new towns; survey methods, site planning, planning regulations and building bye-laws.

Housing: Concept of shelter; housing policies and design; community planning; role of government agencies; finance and management.

Landscape Design: Principles of landscape design and site planning; history and landscape styles; landscape elements and materials; planting design.

Computer Aided Design: Application of computers in architecture and planning; understanding elements of hardware and software; computer graphics; programming languages - C and Visual Basic and usage of packages such as AutoCAD.

Environmental and Building Science: Elements of environmental science; ecological principles concerning environment; role of micro-climate in design; climatic control through design elements; thermal comfort; elements of solar architecture; principles of lighting and illumination; basic principles of architectural acoustics; air pollution, noise pollution and their control.

Visual and Urban Design: Principles of visual composition; proportion, scale, rhythm, symmetry, harmony, balance, form and colour; sense of place and space, division of space; focal point, vista, imageability, visual survey.

History of Architecture: Indian - Indus valley, Vedic, Buddhist, Indo-Aryan, Dravidian and Mughal periods; European - Egyptian, Greek, Roman, medieval and renaissance periods.

Development of Contemporary Architecture: Architectural developments and impacts on society since industrial revolution; influence of modern art on architecture; works of national and international architects; post modernism in architecture.

Building Services: Water supply, Sewerage and Drainage systems; Sanitary fittings and fixtures; principles of electrification of buildings; elevators, their standards and uses; air-conditioning systems; fire fighting systems.

Building Construction and Management: Building construction techniques, methods and details; building systems and prefabrication of building elements; principles of modular coordination; estimation, specification, valuation, professional practice; project management, PERT, CPM.

Materials and Structural Systems: Behavioural characteristics of all types of building materials e.g. mud, timber, bamboo, brick, concrete, steel, glass, FRP; principles of strength of materials; design of structural elements in wood, steel and RCC; elastic and limit state design; complex structural systems; principles of pre-stressing.

Planning Theory: Planning process; multilevel planning; comprehensive planning; central place theory; settlement pattern; land use and land utilization.

Techniques of Planning: Planning surveys; Preparation of urban and regional structure plans, development plans, action plans; site planning principles and design; statistical methods; application of remote sensing techniques in urban and regional planning.

Traffic and Transportation Planning: Principles of traffic engineering and transportation planning; methods of conducting surveys; design of roads, intersections and parking areas; hierarchy of roads and levels of services; traffic and transport management in urban areas; traffic safety and traffic laws; public transportation planning; modes of transportation.

Services and Amenities: Principles and design of water supply systems, sewerage systems, solid waste disposal systems, power supply and communication systems; Health, education, recreation and demography related standards at various levels of the settlements.

Development Administration and Management: Planning laws; development control and zoning regulations; laws relating to land acquisition; development enforcements, land ceiling; regional and urban plan preparations; planning and municipal administration; taxation, revenue resources and fiscal management; public participation and role of NGO.

CE - CIVIL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

STRUCTURAL ENGINEERING

Mechanics: Bending moments and shear forces in statically determinate beams; simple stress and strain: relationship; stress and strain in two dimensions, principal stresses, stress transformation, Mohr's circle; simple bending theory; flexural shear stress; thin-walled pressure vessels; uniform torsion.

Structural Analysis: Analysis of statically determinate trusses, arches and frames; displacements in statically determinate structures and analysis of statically indeterminate structures by force/energy methods; analysis by displacement methods (slope-deflection and moment-distribution methods); influence lines for determinate and indeterminate structures; basic concepts of matrix methods of structural analysis.

Concrete Structures: Basic working stress and limit states design concepts; analysis of ultimate load capacity and design of members subject to flexure, shear, compression and torsion (beams, columns and isolated footings); basic elements of prestressed concrete: analysis of beam sections at transfer and service loads.

Steel Structures: Analysis and design of tension and compression members, beams and beam-columns, column bases; connections - simple and eccentric, beam-column connections, plate girders and trusses; plastic analysis of beams and frames.

GEOTECHNICAL ENGINEERING

Soil Mechanics: Origin of soils; soil classification; three-phase system, fundamental definitions, relationship and inter-relationships; permeability and seepage; effective stress principle: consolidation, compaction; shear strength.

Foundation Engineering: Sub-surface investigation - scope, drilling bore holes, sampling, penetrometer tests, plate load test; earth pressure theories, effect of water table, layered soils; stability of slopes - infinite slopes, finite slopes; foundation types - foundation design requirements; shallow foundations; bearing capacity, effect of shape, water table and other factors, stress distribution, settlement analysis in sands and clays; deep foundations - pile types, dynamic and static formulae, load capacity of piles in sands and clays.

WATER RESOURCES ENGINEERING

Fluid Mechanics and Hydraulics: Hydrostatics, applications of Bernoulli equation, laminar and turbulent flow in pipes, pipe networks; concept of boundary layer and its growth; uniform flow, critical flow and gradually varied flow in channels, specific energy concept, hydraulic jump; forces on immersed bodies; flow measurement in channels; tanks and pipes; dimensional analysis and hydraulic modeling. Applications of momentum equation, potential flow, kinematics of flow; velocity triangles and specific speed of pumps and turbines.

Hydrology: Hydrologic cycle; rainfall; evaporation infiltration, unit hydrographs, flood estimation, reservoir design, reservoir and channel routing, well hydraulics.

Irrigation: Duty, delta, estimation of evapo-transpiration; crop water requirements; design of lined and unlined canals; waterways; head works, gravity dams and Ogee spillways. Designs of weirs on permeable foundation, irrigation methods.

ENVIRONMENTAL ENGINEERING

Water requirements; quality and standards, basic unit processes and operations for water treatment, distribution of water. Sewage and sewerage treatment: quantity and characteristic of waste water sewerage; primary and secondary treatment of waste water; sludge disposal; effluent discharge standards.

TRANSPORTATION ENGINEERING

Highway planning; geometric design of highways; testing and specifications of paving materials; design of flexible and rigid pavements.

CH - CHEMICAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

CHEMICAL ENGINEERING

Process Calculations and Thermodynamics: Laws of conservation of mass and energy; use of tie components; recycle, bypass and purge calculations; degree of freedom analysis.

First and Second laws of thermodynamics and their applications; equations of state and thermodynamic properties of real systems; phase equilibria; fugacity, excess properties and correlations of activity coefficients; chemical reaction equilibria.

Fluid Mechanics and Mechanical Operations: Fluid statics, Newtonian and non-Newtonian fluids, Bernoulli equation, Macroscopic friction factors, energy balance, dimensional analysis, shell balances, flow through pipeline systems, flow meters, pumps and compressors, packed and fluidized beds, elementary boundary layer theory, size reduction and size separation; free and hindered settling; centrifuge and cyclones; thickening and classification, filtration, mixing and agitation; conveying of solids.

Heat Transfer: Conduction, convection and radiation, heat transfer coefficients, steady and unsteady heat conduction, boiling, condensation and evaporation; types of heat exchangers and evaporators and their design.

Mass Transfer: Fick's law, molecular diffusion in fluids, mass transfer coefficients, film, penetration and surface renewal theories; momentum, heat and mass transfer analogies; stagewise and continuous contacting and stage efficiencies; HTU & NTU concepts design and operation of equipment for distillation, absorption, leaching, liquid-liquid extraction, crystallization, drying, humidification, dehumidification and adsorption.

Chemical Reaction Engineering: Theories of reaction rates; kinetics of homogeneous reactions, interpretation of kinetic data, single and multiple reactions in ideal reactors, non-ideal reactors; residence time; non-isothermal reactors; kinetics of heterogeneous catalytic reactions; diffusion effects in catalysis.

Instrumentation and Process Control: Measurement of process variables; sensors, transducers and their dynamics, dynamics of simple systems, dynamics such as CSTRs, transfer functions and responses of simple systems, process reaction curve, controller modes (P, PI, and PID); control valves; analysis of closed loop systems including stability, frequency response (including Bode plots) and controller tuning, cascade, feed forward control.

Plant Design and Economics: Design and sizing of chemical engineering equipment such as compressors, heat exchangers, multistage contactors; principles of process economics and cost estimation including total annualized cost, cost indexes, rate of return, payback period, discounted cash flow, optimization in Design.

Chemical Technology: Inorganic chemical industries; sulfuric acid, NaOH, fertilizers (Ammonia, Urea, SSP and TSP); natural products industries (Pulp and Paper, Sugar, Oil, and Fats); petroleum refining and petrochemicals; polymerization industries; polyethylene, polypropylene, PVC and polyester synthetic fibers.

CS - COMPUTER SCIENCE AND ENGINEERING

ENGINEERING MATHEMATICS

Mathematical Logic: Propositional Logic; First Order Logic.

Probability: Conditional Probability; Mean, Median, Mode and Standard Deviation; Random Variables; Distributions; uniform, normal, exponential, Poisson, Binomial.

Set Theory & Algebra: Sets; Relations; Functions; Groups; Partial Orders; Lattice; Boolean Algebra.

Combinatorics: Permutations; Combinations; Counting; Summation; generating functions; recurrence relations; asymptotics.

Graph Theory: Connectivity; spanning trees; Cut vertices & edges; covering; matching; independent sets; Colouring; Planarity; Isomorphism.

Linear Algebra: Algebra of matrices, determinants, systems of linear equations, Eigen values and Eigen vectors.

Numerical Methods: LU decomposition for systems of linear equations; numerical solutions of non linear algebraic equations by Secant, Bisection and Newton-Raphson Methods; Numerical integration by trapezoidal and Simpson's rules.

Calculus: Limit, Continuity & differentiability, Mean value Theorems, Theorems of integral calculus, evaluation of definite & improper integrals, Partial derivatives, Total derivatives, maxima & minima.

THEORY OF COMPUTATION

Formal Languages and Automata Theory: Regular languages and finite automata, Context free languages and Push-down automata, Recursively enumerable sets and Turing machines, Un-decidability;

Analysis of Algorithms and Computational Complexity: Asymptotic analysis (best, worst, average case) of time and space, Upper and lower bounds on the complexity of specific problems, NP-completeness.

COMPUTER HARDWARE

Digital Logic: Logic functions, Minimization, Design and synthesis of Combinational and Sequential circuits; Number representation and Computer Arithmetic (fixed and floating point);

Computer Organization: Machine instructions and addressing modes, ALU and Data-path, hardwired and micro-programmed control, Memory interface, I/O interface (Interrupt and DMA mode), Serial communication interface, Instruction pipelining, Cache, main and secondary storage.

SOFTWARE SYSTEMS

Data structures: Notion of abstract data types, Stack, Queue, List, Set, String, Tree, Binary search tree, Heap, Graph;

Programming Methodology: C programming, Program control (iteration, recursion, Functions), Scope, Binding, Parameter passing, Elementary concepts of Object oriented, Functional and Logic Programming;

Algorithms for problem solving: Tree and graph traversals, Connected components, Spanning trees, Shortest paths; Hashing, Sorting, Searching; Design techniques (Greedy, Dynamic Programming, Divide-and-conquer);

Compiler Design: Lexical analysis, Parsing, Syntax directed translation, Runtime environment, Code generation, Linking (static and dynamic); Operating Systems: Classical concepts (concurrency, synchronization, deadlock), Processes, threads and Inter-process communication, CPU scheduling, Memory management, File systems, I/O systems, Protection and security.

Databases: Relational model (ER-model, relational algebra, tuple calculus), Database design (integrity constraints, normal forms), Query languages (SQL), File structures (sequential files, indexing, B+ trees), Transactions and concurrency control;

Computer Networks: ISO/OSI stack, sliding window protocol, LAN Technologies (Ethernet, Token ring), TCP/UDP, IP, Basic concepts of switches, gateways, and routers.

CH - CHEMISTRY

PHYSICAL CHEMISTRY

Structure: Quantum theory - principles and techniques; applications to particle in a box, harmonic oscillator, rigid rotor and hydrogen atom; valence bond and molecular orbital theories and Huckel approximation, approximate techniques: variation and perturbation; symmetry, point groups; rotational, vibrational, electronic, NMR and ESR spectroscopy.

Equilibrium: First law of thermodynamics, heat, energy and work; second law of thermodynamics and entropy; third law and absolute entropy; free energy; partial molar quantities; ideal and non-ideal solutions; phase transformation: phase rule and phase diagrams- one, two, and three component systems; activity, activity coefficient, fugacity and fugacity coefficient ; chemical equilibrium, response of chemical equilibrium to temperature and pressure; colligative properties; kinetic theory of gases; thermodynamics of electrochemical cells; standard electrode potentials: applications - corrosion and energy conversion; molecular partition function (translational, rotational, vibrational and electronic).

Kinetics: Rates of chemical reactions, theories of reaction rates, collision and transition state theory; temperature dependence of chemical reactions; elementary reactions, consecutive elementary reactions; steady state approximation, kinetics of photochemical reactions and free radical polymerization, homogenous and heterogeneous catalysis.

INORGANIC CHEMISTRY

Non-Transition Elements: General characteristics, structure and reactions of simple and industrially important compounds, boranes, carboranes, silicates, silicones, diamond and graphite; hydrides, oxides and oxoacids of N, P, S and halogens; boron nitride, borazines and phosphazenes; xenon compounds. Shapes of molecules, hard-soft acid base concept.

Transition Elements: General characteristics of d and f block elements; coordination chemistry: structure and isomerism, stability, theories of metal-ligand bonding (CFT and LFT), electronic spectra and magnetic properties of transition metal complexes and lanthanides;

metal carbonyls, metal-metal bonds and metal atom clusters, metallocenes; transition metal complexes with bonds to hydrogen, alkyls, alkenes, and arenes; metal carbenes; use of organometallic compounds as catalysts in organic synthesis; mechanisms of substitution and electron transfer reactions of coordination complexes. Role of metals with special reference to Na, K, Mg, Ca, Fe, Co, Zn, and Mo in biological systems.

Solids: Crystal systems and lattices, Miller planes, crystal packing, crystal defects; Bragg's Law; ionic crystals, band theory, metals and semiconductors. Spinels.

Instrumental methods of analysis: atomic absorption, UV-visible spectrometry, chromatographic and electro-analytical methods.

ORGANIC CHEMISTRY

Synthesis, reactions and mechanisms involving the following: Alkenes, alkynes, arenes, alcohols, phenols, aldehydes, ketones, carboxylic acids and their derivatives; halides, nitro compounds and amines; stereochemical and conformational effects on reactivity and specificity; reactions with diborane and peracids. Michael reaction, Robinson annulation, reactivity umpolung, acyl anion equivalents; molecular rearrangements involving electron deficient atoms.

Photochemistry: Basic principles, photochemistry of olefins, carbonyl compounds, arenes, photo oxidation and reduction.

Pericyclic reactions: Cycloadditions, electrocyclic reactions, sigmatropic reactions; Woodward-Hoffmann rules.

Heterocycles: Structural properties and reactions of furan, pyrrole, thiophene, pyridine, indole.

Biomolecules: Structure, properties and reactions of mono- and di-saccharides, physico-chemical properties of amino acids, structural features of proteins and nucleic acids.

Spectroscopy: Principles and applications of IR, UV-visible, NMR and mass spectrometry in the determination of structures of organic compounds.

EC - ELECTRONICS AND COMMUNICATION ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix Algebra, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Mean value theorems, Theorems of integral calculus, Evaluation of definite and improper integrals, Partial Derivatives, Maxima and minima, Multiple integrals, Fourier series. Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equation (linear and nonlinear), Higher order linear differential equations with constant coefficients, Method of variation of parameters, Cauchy's and Euler's equations, Initial and boundary value problems, Partial Differential Equations and variable separable method.

Complex variables: Analytic functions, Cauchy's integral theorem and integral formula, Taylor's and Laurent' series, Residue theorem, solution integrals.

Probability and Statistics: Sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Discrete and continuous distributions, Poisson, Normal and Binomial distribution, Correlation and regression analysis.

Numerical Methods: Solutions of non-linear algebraic equations, single and multi-step

methods for differential equations.

Transform Theory: Fourier transform, Laplace transform, Z-transform.

ELECTRONICS & COMMUNICATION ENGINEERING

Networks: Network graphs: matrices associated with graphs; incidence, fundamental cut set and fundamental circuit matrices. Solution methods: nodal and mesh analysis. Network theorems: superposition, Thevenin and Norton's maximum power transfer, Wye-Delta transformation. Steady state sinusoidal analysis using phasors. Linear constant coefficient differential equations; time domain analysis of simple RLC circuits, Solution of network equations using Laplace transform: frequency domain analysis of RLC circuits. 2-port network parameters: driving point and transfer functions. State equations for networks.

Electronic Devices: Energy bands in silicon, intrinsic and extrinsic silicon. Carrier transport in silicon: diffusion current, drift current, mobility, resistivity. Generation and recombination of carriers. p-n junction diode, Zener diode, tunnel diode, BJT, JFET, MOS capacitor, MOSFET, LED, p-I-n and avalanche photo diode, LASERs. Device technology: integrated circuits fabrication process, oxidation, diffusion, ion implantation, photolithography, n-tub, p-tub and twin-tub CMOS process.

Analog Circuits: Equivalent circuits (large and small-signal) of diodes, BJTs, JFETs, and MOSFETs. Simple diode circuits, clipping, clamping, rectifier. Biasing and bias stability of transistor and FET amplifiers. Amplifiers: single-and multi-stage, differential, operational, feedback and power. Analysis of amplifiers; frequency response of amplifiers. Simple op-amp circuits. Filters. Sinusoidal oscillators; criterion for oscillation; single-transistor and op-amp configurations. Function generators and wave-shaping circuits. Power supplies.

Digital circuits: Boolean algebra, minimization of Boolean functions; logic gates digital IC families (DTL, TTL, ECL, MOS, CMOS). Combinational circuits: arithmetic circuits, code converters, multiplexers and decoders. Sequential circuits: latches and flip-flops, counters and shift-registers. Sample and hold circuits, ADCs, DACs. Semiconductor memories. Microprocessor(8085): architecture, programming, memory and I/O interfacing.

Signals and Systems: Definitions and properties of Laplace transform, continuous-time and discrete-time Fourier series, continuous-time and discrete-time Fourier Transform, z-transform. Sampling theorems. Linear Time-Invariant (LTI) Systems: definitions and properties; casuality, stability, impulse response, convolution, poles and zeros frequency response, group delay, phase delay. Signal transmission through LTI systems. Random signals and noise: probability, random variables, probability density function, autocorrelation, power spectral density.

Controls Systems: Basic control system components; block diagrammatic description, reduction of block diagrams. Open loop and closed loop (feedback) systems and stability analysis of these systems. Signal flow graphs and their use in determining transfer functions of systems; transient and steady state analysis of LTI control systems and frequency response. Tools and techniques for LTI control system analysis: root loci, Routh-Hurwitz criterion, Bode and Nyquist plots. Control system compensators: elements of lead and lag compensation, elements of Proportional-Integral-Derivative(PID) control. State variable representation and solution of state equation of LTI control systems.

Communications: Analog communication systems: amplitude and angle modulation and demodulation systems, spectral analysis of these operations, superheterodyne receivers; elements of hardware, realizations of analog communication systems; signal-to-noise ratio (SNR) calculations for amplitude modulation (AM) and frequency modulation (FM) for low noise conditions. Digital communication systems: pulse code modulation (PCM), differential pulse code modulation (DPCM), delta modulation (DM); digital modulation schemes-amplitude, phase and frequency shift keying schemes (ASK, PSK, FSK), matched filter receivers, bandwith consideration and probability of error calculations for these schemes.

Electromagnetics: Elements of vector calculus: divergence and curl; Gauss' and Stokes' theorems, Maxwell's equations: differential and integral forms. Wave equation, Poynting vector. Plane waves: propagation through various media; reflection and refraction; phase and group velocity; skin depth. Transmission lines: characteristic impedance; impedance transformation; Smith chart; impedance matching; pulse excitation. Waveguides: modes in rectangular waveguides; boundary conditions; cut-off frequencies; dispersion relations. Antennas: Dipole antennas; antenna arrays; radiation pattern; reciprocity theorem, antenna gain.

EE - ELECTRICAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix Algebra, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Mean value theorems, Theorems of integral calculus, Evaluation of definite and improper integrals, Partial Derivatives, Maxima and minima, Multiple integrals, Fourier series. Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equation (linear and nonlinear), Higher order linear differential equations with constant coefficients, Method of variation of parameters, Cauchy's and Euler's equations, Initial and boundary value problems, Partial Differential Equations and variable separable method.

Complex variables: Analytic functions, Cauchy's integral theorem and integral formula, Taylor's and Laurent' series, Residue theorem, solution integrals.

Probability and Statistics: Sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Discrete and continuous distributions, Poisson, Normal and Binomial distribution, Correlation and regression analysis.

Numerical Methods: Solutions of non-linear algebraic equations, single and multi-step methods for differential equations.

Transform Theory: Fourier transform, Laplace transform, Z-transform.

ELECTRICAL ENGINEERING

Electrical Circuits and Fields: Network graph, KCL, KVL, node/ cut set, mesh/ tie set analysis, transient response of d.c. and a.c. networks; sinusoidal steady-state analysis; resonance in electrical circuits; concepts of ideal voltage and current sources, network theorems, driving point, immittance and transfer functions of two port networks, elementary concepts of filters; three phase circuits; Fourier series and its application; Gauss theorem, electric field intensity and potential due to point, line, plane and spherical charge distribution, dielectrics, capacitance calculations for simple configurations; Ampere's and Biot-Savart's law, inductance calculations for simple configurations.

Electrical Machines: Single phase transformer - equivalent circuit, phasor diagram, tests, regulation and efficiency; three phase transformers - connections, parallel operation; auto transformer and three-winding transformer; principles of energy conversion, windings of rotating machines: D. C. generators and motors - characteristics, starting and speed control, armature reaction and commutation; three phase induction motors-performance characteristics, starting and speed control; single-phase induction motors; synchronous generators-performance, regulation, parallel operation; synchronous motors - starting, characteristics, applications, synchronous condensers; fractional horse power motors; permanent magnet and stepper motors.

Power Systems: Electric power generation - thermal, hydro, nuclear; transmission line parameters; steady-state performance of overhead transmission lines and cables and surge propagation; distribution systems, insulators, bundle conductors, corona and radio interference effects; per-unit quantities; bus admittance and impedance matrices; load flow; voltage control and power factor correction; economic operation; symmetrical components, analysis of symmetrical and unsymmetrical faults; principles of over current, differential and distance protections; concept of solid state relays and digital protection; circuit breakers; concept of system stability-swing curves and equal area criterion; basic concepts of HVDC transmission.

Control Systems: Principles of feedback; transfer function; block diagrams: steady-state errors; stability-Routh and Nyquist criteria; Bode plots; compensation; root loci; elementary state variable formulation; state transition matrix and response for Linear Time Invariant systems.

Electrical and Electronic Measurements: Bridges and potentiometers, PMMC, moving iron, dynamometer and induction type instruments; measurement of voltage, current, power, energy and power factor; instrument transformers; digital voltmeters and multimeters; phase, time and frequency measurement; Q-meter, oscilloscopes, potentiometric recorders, error analysis.

Analog and Digital Electronics: Characteristics of diodes, BJT, FET, SCR; amplifiers-biasing, equivalent circuit and frequency response; oscillators and feedback amplifiers, operational amplifiers- characteristics and applications; simple active filters; VCOs and timers; combinational and sequential logic circuits, multiplexer, Schmitt trigger, multivibrators, sample and hold circuits, A/D and D/A converters; microprocessors and their applications.

Power Electronics and Electric Drives: Semiconductor power devices-diodes, transistors, thyristors, triacs, GTOs, MOSFETs and IGBTs - static characteristics and principles of operation; triggering circuits; phase control rectifiers; bridge converters-fully controlled and half controlled; principles of choppers and inverters, basic concepts of adjustable speed dc and ac drives.

GG - GEOLOGY AND GEOPHYSICS

PART - I

Earth and planetary system; size, shape, internal structure and composition of the earth; atmosphere and greenhouse effect; isostasy; elements of seismology; continents and continental processes; physical oceanography; palaeomagnetism, continental drift plate tectonics, geothermal energy.

Weathering; soil formation; action of river, wind and glacier; oceans and oceanic features; earthquakes, volcanoes, orogeny and mountain building; elements of structural geology; crystallography; classification, composition and properties of minerals and rocks; engineering properties of rocks and soils, role of geology in the construction of engineering structures.

Processes of ore formation, occurrence and distribution of ores on land and on ocean floor; coal and petroleum resources in India; ground water geology including well hydraulics, geological time scale and geochronology; stratigraphic principles and stratigraphy of India; basics concepts of gravity, magnetic and electrical prospecting for ores and ground water.

PART - IIA: GEOLOGY

Crystal symmetry, forms, twinning; crystal chemistry; optical mineralogy, classification of minerals, diagnostic properties of rock minerals.

Mineralogy, structure, texture and classification of igneous, sedimentary and metamorphic rock, their origin and evolution; application of thermodynamics; structure and petrology of sedimentary rocks; sedimentary processes and environments, sedimentary facies, basin studies; basement cover relationship;

Primary and secondary structures; geometry and genesis of folds, faults, joints, unconformities, cleavage, schistosity and lineation; methods of projection. Tectonites and their significance; shear zone; superposed folding.

Morphology, classification and geological significance of important invertebrates, vertebrates, microfossils and palaeoflora; stratigraphic principles and Indian stratigraphy; geomorphic processes and agents; development and evolution of landforms; slope and drainage; processes on deep oceanic and near-shore regions; quantitative and applied geomorphology; air photo interpretation and remote sensing; chemical and optical properties of ore minerals; formation and localization of ore deposits; prospecting and exploration of economic minerals; coal and petroleum geology; origin and distribution of mineral and fuel deposits in India; ore dressing and mineral economics.

Cosmic abundance; meteorites; geochemical evolution of the earth; geochemical cycles; distribution of major, minor and trace elements; isotope geochemistry; geochemistry of waters including solution equilibria and water rock interaction.

Engineering properties of rocks and soils; rocks as construction material; geology of dams, tunnels and excavation sites; natural hazards; the fly ash problem; ground water geology and exploration; water quality; impact of human activity; Remote sensing techniques for the interpretation of landforms and resource management.

PART - II B: GEOPHYSICS

The earth as a planet; different motions of the earth; gravity filed of the earth and its shape; geochronology; isostasy, seismology and interior of the earth; variation of density, velocity, pressure, temperature, electrical and magnetic properties inside the earth; earthquakes-causes and measurements; zonation and seismic hazards; geomagnetic field, palaeomagnetism; oceanic and continental lithosphere; plate tectonics; heat flow; upper and lower atmospheric phenomena.

Theories of scalar and vector potential fields; Laplace, Maxwell and Helmholtz equations for solution of different types of boundary value problems for Cartesian, cylindrical and spherical polar coordinates; Green's theorem; Image theory; integral equations and conformal transformations in potential theory; Eikonal equation and ray theory.

'G' and 'g' units of measurement, density of rocks, gravimeters, preparation, analysis and interpretation of gravity maps; derivative maps, analytical continuation; gravity anomaly type curves; calculation of mass.

Earth's magnetic field, units of measurement, magnetic susceptibility of rocks, magnetometers, corrections, preparation of magnetic maps, magnetic anomaly type curve, analytical continuation, interpretation and application; magnetic well logging.

Conduction of electricity through rocks, electrical conductivities of metals, metallic, non-metallic and rock forming minerals, D.C. resistivity units and methods of measurement, electrode configuration for sounding and profiling, application of filter theory, interpretation of resistivity field data, application; self potential origin, classification, field measurement, interpretation of induced polarization time frequency, phase domain; IP units and methods of measurement, interpretation and application; ground-water exploration.

Origin of electromagnetic field elliptic polarization, methods of measurement for different source-receiver configuration components in EM measurements, interpretation and applications; earth's natural electromagnetic field, tellurics, magneto-tellurics; geomagnetic depth sounding principles, methods of measurement, processing of data and interpretation.

Seismic methods of prospecting: Reflection, refraction and CDP surveys; land and marine seismic sources, generation and propagation of elastic waves, velocity increasing with depth, geophones, hydrophones, recording instruments (DFS), digital formats, field layouts, seismic noises and noise profile analysis, optimum geophone grouping, noise cancellation by shot and geophone arrays, 2D and 3D seismic data acquisition and processing, CDP stacking charts, binning, filtering, dip-moveout, static and dynamic corrections, deconvolution, migration, signal processing, Fourier and Hilbert transforms, attribute analysis, bright and dim spots, seismic stratigraphy, high resolution seismics, VSP.

Principles and techniques of geophysical well-logging, SP, resistivity, induction, micro gamma ray, neutron, density, sonic, temperature, dip meter, caliper, nuclear magnetic, cement bond logging. Quantitative evaluation of formations from well logs; well hydraulics and application of geophysical methods for groundwater study; application of bore hole geophysics in ground water, mineral and oil exploration. Remote sensing techniques and application of remote sensing methods in geophysics.

IN - INSTRUMENTATION ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix Algebra, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Mean value theorems, Theorems of integral calculus, Evaluation of definite and improper integrals, Partial Derivatives, Maxima and minima, Multiple integrals, Fourier series. Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equation (linear and nonlinear), Higher order linear differential equations with constant coefficients, Method of variation of parameters, Cauchy's and Euler's equations, Initial and boundary value problems, Partial Differential Equations and variable separable method.

Complex variables: Analytic functions, Cauchy's integral theorem and integral formula, Taylor's and Laurent' series, Residue theorem, solution integrals.

Probability and Statistics: Sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Discrete and continuous distributions, Poisson, Normal and Binomial distribution, Correlation and regression analysis.

Numerical Methods: Solutions of non-linear algebraic equations, single and multi-step methods for differential equations.

Transform Theory: Fourier transform, Laplace transform, Z-transform.

INSTRUMENTATION ENGINEERING

Measurement Basics and Metrology: Static and dynamic characteristics of measurement systems. Standards and calibration. Error and uncertainty analysis, statistical analysis of data, and curve fitting. Linear and angular measurements; Measurement of straightness, flatness, roundness and roughness.

Transducers, Mechanical Measurements and Industrial Instrumentation: Transducers - elastic, resistive, inductive, capacitive, thermo-electric, piezoelectric, photoelectric, electro-mechanical, electro-chemical, and ultrasonic. Measurement of displacement, velocity (linear and rotational), acceleration, shock, vibration, force, torque, power, strain, stress, pressure, flow, temperature, humidity, viscosity, and density. energy storing elements, suspension systems and dampers.

Analog Electronics: Characteristics of diodes, BJTs, JFETs and MOSFETs; Diode circuits;

Amplifiers: single and multi-stage, feedback; Frequency response; Operational amplifiers - design, characteristic, linear and non-linear applications: difference amplifiers; instrumentation amplifiers; precision rectifiers, I-to-V converters, active filters, oscillators, comparators, signal generators, wave shaping circuits.

Digital Electronics: Combinational logic circuits, minimization of Boolean functions; IC families (TTL, MOS, CMOS), arithmetic circuits, multiplexer and decoders. Sequential circuits: flip-flops, counters, shift registers. Schmitt trigger, timers, and multivibrators. Analog switches, multiplexers, S/H circuits. Analog-to-digital and digital-to-analog converters. Basics of computer organization and architecture. 8-bit microprocessor (8085), applications, memory, I/O interfacing, and microcontrollers.

Signals and Systems: Vectors and matrices; Fourier series; Fourier transforms; Ordinary differential equations. Impulse and frequency responses of first and second order systems. Laplace transform and transfer function, convolution and correlation. Amplitude and frequency modulations and demodulations. Discrete time systems, difference equations, impulse and frequency responses; Z-transforms and transfer functions; IIR and FIR filters.

Electrical and Electronic Measurements: Measurement of R, L and C; bridges and potentiometers. Measurement of voltage, current, power, power factor, and energy; Instrument transformers; Q meter, waveform analyzers. Digital volt-meters and multi-meters. Time, phase and frequency measurements; Oscilloscope. Noise and interference in instrumentation.

Control Systems & Process Control: Principles of feedback; transfer function, signal flow graphs. Stability criteria, Bode plots, root-loci, Routh and Nyquist criteria. Compensation techniques; State space analysis. System components: mechanical, hydraulic, pneumatic, electrical and electronic; Servos and synchros; Stepper motors. On-off, cascade, P, PI, PID and feed-forward controls. Controller tuning and general frequency response.

Analytical, Optical and Biomedical Instrumentation: Principles of spectrometry, UV, visible, IR mass spectrometry, X-ray methods; nuclear radiation measurements, gas, solid and semi conductor lasers and their characteristics, interferometers, basics of fibre optics, transducers in biomedical applications, cardiovascular system measurements, instrumentation for clinical laboratory.

MA - MATHEMATICS

Linear Algebra: Finite dimensional vector spaces. Linear transformations and their matrix representations, rank; systems of linear equations, eigenvalues and eigenvectors, minimal polynomial, Cayley-Hamilton theorem, diagonalisation, Hermitian, Skew-Hermitian and unitary matrices. Finite dimensional inner product spaces, self-adjoint and Normal linear operators, spectral theorem, Quadratic forms.

Complex Analysis: Analytic functions, conformal mappings, bilinear transformations, complex integration: Cauchy's integral theorem and formula, Liouville's theorem, maximum modulus principle, Taylor and Laurent's series, residue theorem and applications for evaluating real integrals.

Real Analysis: Sequences and series of functions, uniform convergence, power series, Fourier series, functions of several variables, maxima, minima, multiple integrals, line, surface and volume integrals, theorems of Green, Stokes and Gauss; metric spaces, completeness, Weierstrass approximation theorem, compactness. Lebesgue measure, measurable functions; Lebesgue integral, Fatou's lemma, dominated convergence theorem.

Ordinary Differential Equations: First order ordinary differential equations, existence and uniqueness theorems, systems of linear first order ordinary differential equations, linear ordinary differential equations of higher order with constant coefficients; linear second order ordinary differential equations with variable coefficients, method of Laplace transforms for solving ordinary differential equations, series solutions; Legendre and Bessel functions and their orthogonality, Sturm Liouville system, Greeen's functions.

Algebra: Normal subgroups and homomorphisms theorems, automorphisms. Group actions, sylow's theorems and their applications groups of order less than or equal to 20, Finite p-groups. Euclidean domains, Principal ideal domains and unique factorizations domains. Prime ideals and maximal ideals in commutative rings.

Functional Analysis: Banach spaces, Hahn-Banach theorems, open mapping and closed graph theorems, principle of uniform boundedness; Hilbert spaces, orthonormal sets, Riesz representation theorem, self-adjoint, unitary and normal linear operators on Hilbert Spaces.

Numerical Analysis: Numerical solution of algebraic and transcendental equations; bisection, secant method, Newton-Raphson method, fixed point iteration, interpolation: existence and error of polynomial interpolation, Lagrange, Newton, Hermite(osculatory)interpolations; numerical differentiation and integration, Trapezoidal and Simpson rules; Gaussian quadrature; (Gauss-Legendre and Gauss-Chebyshev), method of undetermined parameters, least square and orthonormal polynomial approximation; numerical solution of systems of linear equations: direct and iterative methods, (Jacobi Gauss-Seidel and SOR) with convergence; matrix eigenvalue problems: Jacobi and Given's methods, numerical solution of ordinary differential equations: initial value problems, Taylor series method, Runge-Kutta methods, predictor-corrector methods; convergence and stability.

Partial Differential Equations: Linear and quasilinear first order partial differential equations, method of characteristics; second order linear equations in two variables and their classification; Cauchy, Dirichlet and Neumann problems, Green's functions; solutions of Laplace, wave and diffusion equations in two variables Fourier series and transform methods of solutions of the above equations and applications to physical problems.

Mechanics: Forces in three dimensions, Poinsot central axis, virtual work, Lagrange's equations for holonomic systems, theory of small oscillations, Hamiltonian equations;

Topology: Basic concepts of topology, product topology, connectedness, compactness, countability and separation axioms, Urysohn's Lemma, Tietze extension theorem, metrization theorems, Tychonoff theorem on compactness of product spaces.

Probability and Statistics: Probability space, conditional probability, Bayes' theorem, independence, Random variables, joint and conditional distributions, standard probability distributions and their properties, expectation, conditional expectation, moments. Weak and strong law of large numbers, central limit theorem. Sampling distributions, UMVU estimators, sufficiency and consistency, maximum likelihood estimators. Testing of hypotheses, Neyman-Pearson tests, monotone likelihood ratio, likelihood ratio tests, standard parametric tests based on normal, X2 ,t, F-distributions. Linear regression and test for linearity of regression. Interval estimation.

Linear Programming: Linear programming problem and its formulation, convex sets their properties, graphical method, basic feasible solution, simplex method, big-M and two phase methods, infeasible and unbounded LPP's, alternate optima. Dual problem and duality theorems, dual simplex method and its application in post optimality analysis, interpretation of dual variables. Balanced and unbalanced transportation problems, unimodular property and u-v method for solving transportation problems. Hungarian method for solving assignment problems.

Calculus of Variations and Integral Equations: Variational problems with fixed boundaries; sufficient conditions for extremum, Linear integral equations of Fredholm and Volterra type, their iterative solutions. Fredholm alternative.

ME - MECHANICAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

APPLIED MECHANICS AND DESIGN

Engineering Mechanics: Equivalent force systems, free-body concepts, equations of equilibrium, trusses and frames, virtual work and minimum potential energy. Kinematics and dynamics of particles and rigid bodies, impulse and momentum (linear and angular), energy methods, central force motion.

Strength of Materials: Stress and strain, stress-strain relationship and elastic constants, Mohr's circle for plane stress and plane strain, shear force and bending moment diagrams, bending and shear stresses, deflection of beams, torsion of circular shafts, thin and thick cylinders, Euler's theory of columns, strain energy methods, thermal stresses.

Theory of Machines: Displacement, velocity and acceleration, analysis of plane mechanisms, dynamic analysis of slider-crank mechanism, planar cams and followers, gear tooth profiles, kinematics of gears, governors and flywheels, balancing of reciprocating and rotating masses.

Vibrations: Free and forced vibration of single degree freedom systems, effect of damping, vibration isolation, resonance, critical speed of rotors.

Design of Machine Elements: Design for static and dynamic loading, failure theories, fatigue strength; design of bolted, riveted and welded joints; design of shafts and keys; design of spur gears, rolling and sliding contact bearings; brakes and clutches; belt, rope and chain drives.

FLUID MECHANICS AND THERMAL SCIENCES

Fluid Mechanics: Fluid properties, fluid statics, manometry, buoyancy; control-volume analysis of mass, momentum and energy; fluid acceleration; differential equations of continuity and momentum; Bernoulli's equation; viscous flow of incompressible fluids; boundary layer; elementary turbulent flow; flow through pipes, head losses in pipes, bends etc.

Heat-Transfer: Modes of heat transfer; one dimensional heat conduction, resistance concept, electrical analogy, unsteady heat conduction, fins; dimensionless parameters in free and forced convective heat transfer, various correlations for heat transfer in flow over flat plates and through pipes; thermal boundary layer; effect of turbulence; radiative heat transfer, black and grey surfaces, shape factors, network analysis; heat exchanger performance, LMTD and NTU methods.

Thermodynamics: Zeroth, First and Second laws of thermodynamics; thermodynamic system and processes; irreversibility and availability; behaviour of ideal and real gases, properties of pure substances, calculation of work and heat in ideal processes; analysis of thermodynamic cycles related to energy conversion; Carnot, Rankine, Otto, Diesel, Brayton and vapour compression cycles.

Power Plant Engineering: Steam generators; steam power cycles; steam turbines; impulse and reaction principles, velocity diagrams, pressure and velocity compounding; reheating and reheat factor; condensers and feed heaters.

I.C. Engines: Requirements and suitability of fuels in IC engines, fuel ratings, fuel-air mixture requirements; normal combustion in SI and CI engines; engine performance calculations.

Refrigeration and air-conditioning: Refrigerant compressors, expansion devices, condensers and evaporators; properties of moist air, psychrometric chart, basic psychometric processes.

Turbomachinery: Components of gas turbines; compression processes, centrifugal and axial flow compressors; axial flow turbines, elementary theory; hydraulic turbines; Euler-turbine equation; specific speed, Pelton-wheel, Francis and Kaplan turbines; centrifugal pumps.

MANUFACTURING AND INDUSTRIAL ENGINEERING

Engineering Materials: Structure and properties of engineering materials and their applications, heat treatment.

Metal Casting: Casting processes (expendable and non-expendable) -pattern, moulds and cores, heating and pouring, solidification and cooling, gating design, design considerations, defects.

Forming Processes: Stress-strain diagrams for ductile and brittle material, Plastic deformation and yield criteria, fundamentals of hot and cold working processes, Bulk metal forming processes (forging, rolling, extrusion, drawing), sheet metal working processes (punching, blanking, bending, deep drawing, coining, spinning, load estimation using homogeneous deformation methods, defects). processing of powder metals- atomization, compaction, sintering, secondary and finishing operations. forming and shaping of plastics- extrusion, injection moulding.

Joining Processes: Physics of welding, fusion and non-fusion welding processes, brazing and soldering, adhesive bonding, design considerations in welding, weld quality defects.

Machining and Machine Tool Operations: Mechanics of machining, single and multi-point cutting tools, tool geometry and materials, tool life and wear, cutting fluids, machinability, economics of machining, non-traditional machining processes.

Metrology and Inspection: Limits, fits and tolerances, linear and angular measurements, comparators, gauge design, interferometry, form and finish measurement, measurement of screw threads, alignment and testing methods.

Tool Engineering: Principles of work holding, design of jigs and fixtures.

Computer Integrated Manufacturing: Basic concepts of CAD, CAM and their integration tools.

Manufacturing Analysis: Part-print analysis, tolerance analysis in manufacturing and assembly, time and cost analysis.

Work-Study: Method study, work measurement, time study, work sampling, job evaluation, merit rating.

Production Planning and Control: Forecasting models, aggregate production planning, master scheduling, materials requirements planning.

Inventory Control: Deterministic and probabilistic models, safety stock inventory control systems.

Operations Research: Linear programming, simplex and duplex method, transportation, assignment, network flow models, simple queuing models, PERT and CPM

MN - MINING ENGINEERING

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

MINING ENGINEERING

Mechanics: Equivalent force systems, equations of equilibrium, two dimensional frames and trusses, free body diagrams, friction forces, particle kinematics and dynamics.

Mine Development, Geomechanics and Strata Control: Drivages for underground mine development, drilling methods and machines, explosives, blasting devices and practices, shaft sinking. Physico-mechanical properties of rocks, rock mass classification, ground control instrumentation and stress measurement techniques, theories of rock failure, ground vibrations, stress distribution around mine openings, subsidence, design of supports in roadways and workings, stability of open pits, slopes.

Mining Methods and Machinery: Surface mining - layout, development, loading, transportation and mechanization, continuous surface mining systems. Underground coal mining - bord and pillar system, longwall mining, thick seam mining methods. Underground metal mining: different stoping methods, stope mechanization, ore handling systems, mine filling. Generation and transmission of mechanical, hydraulic, and pneumatic power. Materials handling - haulages, conveyors, ropeways, face and development machinery, hoisting systems, and pumps.

Ventilation, Underground Hazards and Surface Environment: Underground atmosphere, heat load sources and thermal environment, air cooling, mechanics of air flow distribution, natural and mechanical ventilation, mine fans and their usage, auxiliary ventilation. Subsurface hazards from fires, explosions, gases, dust, and inundation, rescue apparatus and practices, safety in mines, accident analysis, noise, mine lighting. Air and water pollution: causes, dispersion, quality standards, and control.

Surveying, Mine Planning and Systems Engineering: Fundamentals of engineering surveying, Levels and levelling, Theodolite, tacheometry, triangulation, contouring, errors and adjustments, correlation, underground surveying, curves, photogrammetry, field astronomy, GPS fundamentals. Principles of planning - Sampling methods and practices, reserve estimation techniques, basics of geostatistics, optimization of facility location, cash flow concepts and mine valuation, open pit design. Work study, concepts of reliability, reliability of series and parallel systems. Linear programming, transportation and assignment problems, queueing, network analysis, inventory control.

MT - METALLURGICAL ENGINEERING

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

METALLURGICAL ENGINEERING

Thermodynamics and Rate Processes: Laws of thermodynamics, activity, equilibrium constant, applications to metallurgical systems, solutions, phase equilibria, basic kinetic laws, order of reactions, rate constants and rate limiting steps principles of electro chemistry, aqueous, corrosion and protection of metals, oxidation and high temperature corrosion - characterization and control; momentum transfer - concepts of viscosity, shell balances, Bernoulli's equation; heat transfer - conduction, convection and heat transfer coefficient relations, radiation, mass transfer - diffusion and Fick's laws.

Extractive Metallurgy: Flotation, gravity and other methods of mineral processing; agglomeration, pyro-hydro-and electro-metallurgical processes; material and energy balances; principles and processes for the extraction of non-ferrous metals - aluminium, copper, zinc, lead, magnesium, nickel, titanium and other rare metals; iron and steel making - principles, blast furnace, direct reduction processes, primary and secondary steel making, deoxidation and inclusion in steel; ingot and continuous casting; stainless steel making, design of furnaces; fuels and refractories.

Physical Metallurgy: Crystal structure and bonding characteristics of metals, alloys, ceramics and polymers; solid solutions; solidification; phase transformation and binary phase diagrams; principles of heat treatment of steels, aluminum alloys and cast irons; recovery, recrystallization and grain growth; industrially important ferrous and non-ferrous alloys; elements of X-ray and electron diffraction; principles of scanning and transmission electron microscopy; elements of ceramics, composites and electronic materials; electronic basis of thermal, optical, electrical and magnetic properties of materials.

Mechanical Metallurgy: Elements of elasticity and plasticity; defects in crystals; elements of dislocation theory - types of dislocations, slip and twinning, stress fields of dislocations, dislocation interactions and reactions, methods of seeing dislocations; strengthening mechanisms; tensile, fatigue and creep behaviour; superplasticity; fracture - Griffith theory, ductile to brittle transition, fracture toughness; failure analysis; mechanical testing - tension, compression, torsion, hardness, impact, creep, fatigue, fracture toughness and formability tests.

Manufacturing Processes: Metal casting - patterns, moulds, melting, gating, feeding and casting processes, defects and castings, hot and cold working of metals; Metal forming - fundamentals of metal forming, rolling wire drawing, extrusion, forming, sheet metal forming processes, defects in forming; Metal joining - soldering, brazing and welding, common welding processes, welding metallurgy, problems associated with welding of steels and aluminium alloys, defects in welding, powder metallurgy; NDT methods - ultrasonic, radiography, eddy current, acoustic emission and magnetic.

PH - PHYSICS

Mathematical Physics: Linear vector space, matrices; vector calculus; linear differential equations; elements of complex analysis; Laplace transforms, Fourier analysis, elementary ideas about tensors.

Classical Mechanics: Conservation laws; central forces; collisions and scattering in laboratory and centre of mass reference frames; mechanics of system of particles; rigid body dynamics; moment of inertia tensor; noninertial frames and pseudo forces; variational principle; Lagrange's and Hamilton's formalisms; equation of motion, cyclic coordinates, Poisson bracket; periodic motion, small oscillations, normal modes; wave equation and wave propagation; special theory of relativity - Lorentz transformations, relativistic kinematics, mass-energy equivalence.

Electromagnetic Theory: Laplace and Poisson equations; conductors and dielectrics; boundary value problems; Ampere's and Biot-Savart's laws; Faraday's law; Maxwell's equations; scalar and vector potentials; Coulomb and Lorentz gauges; boundary conditions at interfaces; electromagnetic waves; interference, diffraction and polarization; radiation from moving charges.

Quantum Mechanics: Physical basis of quantum mechanics; uncertainty principle; Schrodinger equation; one and three dimensional potential problems; Particle in a box, harmonic oscillator, hydrogen atom; linear vectors and operators in Hilbert space; angular momentum and spin; addition of angular momentum; time independent perturbation theory; elementary scattering theory.

Atomic and Molecular Physics: Spectra of one-and many-electron atoms; LS and jj coupling; hyperfine structure; Zeeman and Stark effects; electric dipole transitions and selection rules; X-ray spectra; rotational and vibrational spectra of diatomic molecules; electronic transition in diatomic molecules, Franck-Condon principle; Raman effect; NMR and ESR; lasers.

Thermodynamics and Statistical Physics: Laws of thermodynamics; macrostates, phase space; probability ensembles; partition function, free energy, calculation of thermodynamic quantities; classical and quantum statistics; degenerate Fermi gas; black body radiation and Planck's distribution law; Bose-Einstein condensation; first and second order phase transitions, critical point.

Solid State Physics: Elements of crystallography; diffraction methods for structure determination; bonding in solids; elastic properties of solids; defects in crystals; lattice vibrations and thermal properties of solids; free electron theory; band theory of solids;

metals, semiconductors and insulators; transport properties; optical, dielectric and magnetic properties of solids; elements of superconductivity.

Nuclear and Particle Physics: Rutheford scattering; basic properties of nuclei; radioactive decay; nuclear forces; two nucleon problem; nuclear reactions; conservation laws; fission and fusion; nuclear models; particle accelerators, detectors; elementary particles; photons, baryons, mesons and leptons; Quark model.

Electronics: Network analysis; semiconductor devices; bipolar transistors; FETs; power supplies, amplifier, oscillators; operational amplifiers; elements of digital electronics; logic circuits.

PI - PRODUCTION AND INDUSTRIAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

GENERAL ENGINEERING:

Engineering Materials: Structure and properties of engineering materials and their applications; effect of strain, strain rate and temperature on mechanical properties of metals and alloys; heat treatment of metals and alloys.

Applied Mechanics: Engineering mechanics - equivalent force systems, free body concepts, equations of equilibrium, virtual work and minimum potential energy; strength of materials-stress, strain and their relationship, Mohr's circle, deflection of beams, bending and shear stress, Euler's theory of columns.

Theory of Machines and Design: Analysis of planar mechanisms, plane cams and followers; governers and fly wheels; design of elements-failure theories; design of bolted, riveted and welded joints; design of shafts, keys, belt drives, brakes and clutches.

Thermal Engineering: Fluid machines - fluid statics, Bernoulli's equation, flow through pipes, equations of continuity and momentum; Thermodynamics - zeroth, First and Second laws of thermodynamics, thermodynamic system and processes, calculation of work and heat for systems and control volumes; Heat transfer - fundamentals of conduction, convection and radiation.

PRODUCTION ENGINEERING

Metal Casting: Casting processes; patterns-materials; allowances; moulds and cores - materials, making and testing; melting and founding of cast iron, steels and nonferrous metals and alloys; solidification; design of casting, gating and risering; casting defects and inspection.

Metal working: Stress-strain in elastic and plastic deformation; deformation mechanisms; hot and cold working-forging, rolling, extrusion, wire and tube drawing; sheet metal working; analysis of rolling, forging, extrusion and wire /rod drawing; metal working defects, high energy rate forming processes-explosive, magnetic, electro and electrohydraulic.

Metal Joining Processes: Welding processes - gas shielded metal arc, TIG, MIG, submerged arc, electroslag, thermit, resistance, pressure and forge welding; thermal cutting; other joining processes - soldering, brazing, braze welding; welding codes, welding symbols, design of welded joints, defects and inspection; introduction to modern welding processes - friction, ultrasonic, explosive, electron beam, laser and plasma.

Machining and Machine Tool Operations: Machining processes-turning, drilling, boring, milling, shaping, planing, sawing, gear cutting, thread production, broaching, grinding, lapping, honing super finishing; mechanics of cutting- Merchant's analysis, geometry of cutting tools, cutting forces, power requirements; selection of process parameters; tool materials, tool wear and tool life, cutting fluids, machinability; nontraditional machining processes and hybrid processes- EDM, CHM, ECM, USM, LBM, EBM, AJM, PAM AND WJM; economics of machining.

Metrology and Inspection: Limits and fits, linear and angular measurements by mechanical and optical methods, comparators; design of limit gauges; interferometry; measurement of straightness, flatness, roundness, squareness and symmetry; surface finish measurement; inspection of screw threads and gears; alignment testing.

Powder Metallurgy and Processing of Plastics: Production of powders, compaction, sintering; Polymers and composites; injection, compression and blow molding, extrusion, calendaring and thermoforming; molding of composites.

Tool Engineering: Work-holding-location and clamping; principles and methods; design of jigs and fixtures; design of press working tools, forging dies.

Manufacturing Analysis: Sources of errors in manufacturing; process capability; part-print analysis; tolerance analysis in manufacturing and assembly; process planning; parameter selection and comparison of production alternatives; time and cost analysis; Issues in choosing manufacturing technologies and strategies.

Computer Integrated Manufacturing: Basic concepts of CAD, CAM, CAPP, group technology, NC, CNC, DNC, FMS, Robotics and CIM.

INDUSTRIAL ENGINEERING

Product Design and Development: Principles of good product design, component and tolerance design; efficiency, quality and cost considerations; product life cycle; standardization, simplification, diversification, value analysis, concurrent engineering.

Engineering Economy and Costing: Financial statements; elementary cost accounting, methods of depreciation; break-even analysis, techniques for evaluation of capital investments.

Work System Design: Taylor's scientific management, Gilbreths's contributions; productivity concepts and measurements; method study, micro-motion study, principles of motion economy; human factors engineering, ergonomics; work measurement - time study, PMTS, work sampling; job evaluation, merit rating, wage administration, incentive systems; business process reengineering.

Logistics and Facility Design: Facility location factors, evaluation of alternatives, types of plant layout, evaluation; computer aided layout; assembly line balancing; material handling systems; supply chain management.

Production Planning and Inventory Control: Inventory Function costs, classifications - deterministic and probabilistic models; quantity discount; safety stock; inventory control system; Forecasting techniques - causal and time series models, moving average, exponential smoothing; trend and seasonality; aggregate production planning; master scheduling; bill of materials and material requirement planning; order control and flow control, routing, scheduling and priority dispatching; JIT; Kanban PULL systems; bottleneck scheduling and theory of constraints.

Operation Research: Linear programming - problem formulation, simplex method, duality and sensitivity analysis; transportation; assignment; network flow models, constrained optimization and Lagrange multipliers; simple queuing models; dynamic programming; simulation; PERT and CPM, time-cost trade-off, resource leveling.

Quality Control: Taguchi method; design of experiments; quality costs, statistical quality assurance, process control charts, acceptance sampling, zero defects; quality circles, total quality management.

Reliability and Maintenance: Reliability, availability and maintainability; probabilistic failure and repair times; system reliability; preventive maintenance and replacement, TPM.

Management Information System: Value of information; information storage and retrieval system - database and data structures; interactive systems; knowledge based systems.

Intellectual Property System: Definition of intellectual property, importance of IPR; TRIPS, and its implications, WIPO and Global IP structure, and IPS in India; patent, copyright, industrial design and trademark; meanings, rules and procedures, terms, infringements and remedies.

PY - PHARMACEUTICAL SCIENCES

Natural Products: Pharmacognosy & Phytochemistry - Chemistry, tests, isolation, characterization and estimation of phytopharmaceuticals belonging to the group of Alkaloids, Glycosides, Terpenoids, Steroids, Bioflavanoids, Purines, Guggul lipids. Pharmacognosy of crude drugs which contain the above constituents. Standardisation of raw materials and herbal products. WHO guide lines. Quantitative microscopy including modern techniques used for evaluation. Biotechnological principles and techniques for plant development Tissue culture.

Pharmacology: General pharmacological principles including Toxicology. Drug interaction. Pharmacology of drugs acting on Central nervous system, Cardiovascular system, Autonomic nervous system, Gastro intestinal system and Respiratory system. Pharmacology of Autocoids, Hormones, Chemotherapeutic agents including anticancer drugs. Bioassays. Immuno Pharmacology.

Medicinal Chemistry: Structure, nomenclature, classification, synthesis, SAR and metabolism of the following category of drugs which are official in Indian Pharmacopoeia and British Pharmacopoeia Hypnotics and Sedatives, Analgesics, NSAIDS, Neuroleptics, Antidepressants, Anxiolytics, Anticonvulsants, Antihistaminics, Local anaesthetics, Cardio Vascular drugs - Antianginal agents Vasodilators, Adrenergic & cholinergic drugs, Cardiotonic agents, Diuretics, Antihypertensive drugs, Hypoglycemic agents, Antilipedmic agents, Coagulants, Anticoagulants, Antiplatelet agents. Chemotherapeutic agents - Antibiotics, Antibacterials, Sulphadrugs. Antiproliozoal drugs, Antiviral, Antitubercular, Antimalarial, Anticancer, Antiamoebic drugs. Diagnostic agents. Preparation and storage and uses of official Radiopharmaceuticals. Vitamins and Hormones.

Pharmaceutics: Development, manufacturing standards, labeling, packing as per the pharmacopoeal requirements, Storage of different dosage forms and new drug delivery systems. Biopharmaceutics and Pharmacokinetics and their importance in formulation. Formulation and preparation of cosmetics - lipstick, shampoo, creams, nail preparations and dentifrices. Pharmaceutical calculations.

Pharmaceutical Jurisprudence: Legal aspects of manufacture, storage, sale of drugs. D and C act and rules. Pharmacy act.

Pharmaceutical Analysis: Principles, instrumentation and applications of the following. Absorption spectroscopy (UV, visible & IR), Fluorimetry, Flame photometry, Potentiometry, Conductometry and Plarography. Pharmacopoeial assays. Principles of NMR, ESR, Mass spectroscopy, X-ray diffraction analysis and different chromatographic methods.

Biochemistry and Clinical Pharmacy: Biochemical role of hormones, Vitamins, Enzymes, Nucleic acids. Bioenergetics. General principles of immunology. Immunological techniques. Adverse drug interaction.

Microbiology: Principles and methods of microbiological assays of the Pharmacopoeia. Methods of preparation of official sera and vaccines. Serological and diagnostic tests. Applications of microorganisms in Bio Conversions and in Pharmaceutical industry.

TF - TEXTILE ENGINEERING AND FIBRE SCIENCE

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

TEXTILE ENGINEERING & FIBRE SCIENCE

Textile Fibres: Classification of textile fibres according to their nature and origin; general characteristics of textile fibres-their chemical and physical structures and their properties; essential characteristics of fibre forming polymers; uses of natural and man-made fibres; physical and chemical methods of fibre and blend identification and blend analysis.

Melt Spinning processes with special reference to polyamide and polyester fibres; wet and dry spinning of viscose and acrylic fibres; post spinning operations-drawing, heat setting, texturing- false twist and air-jet, tow-to-top conversion. Methods of investigating fibre structure e.g. X-ray diffraction, birefringence, optical and electron microscopy, I.R. absorption, thermal methods; structure and morphology and principal natural and man-made fibres, mechanical properties of fibres, moisture sorption in fibres; fibre structure and property correlation.

Textile Testing: Sampling techniques, sample size and sampling errors; measurement of fibre length, fineness, crimp, strength and reflectance; measurement of cotton fibre maturity ad trash content; HVI and AFIS for fibre testing. Measurement of yarn count, twist and hairiness; tensile testing of fibres, yarn and fabrics; evenness testing of slivers, rovings and yarns; testing equipment for measurement test methods of fabric properties like thickness, compressibility, air permeability, drape, crease recovery, tear strength bursting strength and abrasion resistance. Correlation analysis, significance tests and analysis of variance; frequency distributions and control charts.

Yarn Manufacture and Yarn Structure: Modern methods of opening, cleaning and blending of fibrous materials; the technology of carding with particular reference to modern developments; causes of irregularity introduced by drafting, the development of modern drafting systems; principles and techniques of preparing material for combing; recent development in combers; functions and synchronization of various mechanisms concerned with roving production; forces acting on yarn and traveller, ring and traveller designs; causes of end breakages; properties of doubles yarns; new methods of yarn production such as rotor spinning, air jet spinning and friction spinning.

Yarn diameter; specific volume, packing coefficient; twist-strength relationship; fibre orientation in yarn; fibre migration.

Fabric Manufacture and Fabric Structure: Principles of cheese and cone winding processes and machines; random and precision winding; package faults and their remedies; yarn clearers and tensioners; different systems of yarn splicing; features of modern cone winding machines; different types of warping creels; features of modern beam and sectional warping machines; different sizing systems, sizing of spun and filament yarns, modern sizing machines; principles of pirn winding processes and machines; primary and secondary motions of loom, effect of their settings and timings on fabric formation, fabric appearance and weaving performance; dobby and jacquard shedding; mechanics of weft insertion with shuttle; warp and weft stop motions, warp protection, weft replenishment; functional principles of weft insertion systems of shuttleless weaving machines, principles of multiphase and circular looms. Principles of weft and warp knitting; basic weft and warp knitted structures; classification, production and areas of application of nonwoven fabrics.

Basic woven fabric constructions and their derivatives; crepe, cord, terry, gauze, lino and double cloth constructions.

Peirce's equations for fabric geometry; thickness, cover and maximum sett of woven fabrics

Textile Chemical Processing: Preparatory processes for natural-and and their blends; mercerization of cotton; machines for yarn and fabric mercerization.

Dyeing and printing of natural- and synthetic- fibre fabrics and their blends with different dye classes; dyeing and printing machines; styles of printing; fastness properties of dyed and printed textile materials.

Finishing of textile materials, wash and wear, durable press, soil release, water repellent, flame retardant and antistatic finishes; shrink-resistance finish for wool; heat setting of synthetic-fibre fabrics, finishing machines; energy efficient processes; pollution control.

XE - ENGINERING SCIENCES

The syllabi of the sections of this paper are as follows:

SECTION A. ENGINEERING MATHEMATICS (Compulsory)

Linear Algebra : Determinates, algebra of matrices, rank, inverse, system of linear equations, symmetric, skew-symmetric and orthogonal matrices. Hermitian, skew-hermitian and unitary matrices. eigenvalues and eigenvectors, diagonalisation of matrices, Cayley-Hamiltonian, quadratic forms.

Calculus : Functions of single variables, limit, continuity and differentiability, Mean value theorems, Intermediate forms and L'Hospital rule, Maxima and minima, Taylor's series, Fundamental and mean value-theorems of integral calculus. Evaluation of definite and improper integrals, Beta and Gamma functions, Functions of two variables, limit, continuity, partial derivatives, Euler's theorem for homogeneous functions, total derivatives, maxima and minima, Lagrange method of multipliers, double and triple integrals and their applications, sequence and series, tests for convergence, power series, Fourier Series, Fourier integrals.

Complex variable: Analytic functions, Cauchy's integral theorem and integral formula without proof. Taylor's and Laurent' series, Residue theorem (without proof) with application to the evaluation of real integarls.

Vector Calculus: Gradient, divergence and curl, vector identities, directional derivatives, line, surface and volume integrals, Stokes, Gauss and Green's theorems (without proofs) with applications.

Ordinary Differential Equations: First order equation (linear and nonlinear), higher order linear differential equations with constant coefficients, method of variation of paramaters, Cauchy's and Euler's equations, initial and boundary value problems, power series solutions, Legendre polynomials and Bessel's functions of the first kind.

Partial Differential Equations: Variables separable method, solutions of one dimensional heat, wave and Laplace equations.

Probability and Statistics: Definitions of probability and simple theorems, conditional probability, mean, mode and standard deviation, random variables, discrete and continuous distributions, Poisson, normal and Binomial distribution, correlation and regression

Numerical Methods: L-U decomposition for systems of linear equations,Newton-Raphson method, numerical integration(trapezoidal and Simpson's rule), numerical methods for first order differential equation (Euler method)

SECTION B. COMPUTATIONAL SCIENCE

Numerical Methods: Truncation errors, round off errors and their propagation; Interpolation; Lagrange, Newton's forward, backward and divided difference formulas, least square curve fitting, solution of non-linear equations of one variables using bisection, false position, secant and Newton Raphson methods; Rate of convergence of these methods, general iterative methods. Simple and multiple roots of polynomials. Solutions of system of linear algebraic equations using Gauss elimination methods, Jacobi and Gauss-Seidel iterative methods and their rate of convergence; ill conditioned and well conditioned system. eigen values and eigen vectors using power methods. Numerical integration using trapezoidal, Simpson's rule and other quadrature formulas. Numerical Differentiation. Solution of boundary value problems. Solution of initial value problems of ordinary differential equations using Euler's method, predictor corrector and Runge Kutta method.

Programming : Elementary concepts and terminology of a computer system and system software, Fortran77 and C programming.

Fortran : Program organization, arithmetic statements, transfer of control, Do loops, subscripted variables, functions and subroutines.

C language : Basic data types and declarations, flow of control- iterative statement, conditional statement, unconditional branching, arrays, functions and procedures.

SECTION C. ELECTRICAL SCIENCES

Electric Circuits: Ideal voltage and current sources; RLC circuits, steady state and transient analysis of DC circuits, network theorems; alternating currents and voltages, single-phase AC circuits, resonance; three-phase circuits.

Magnetic circuits: Mmf and flux, and their relationship with voltage and current; transformer, equivalent circuit of a practical transformer, three-phase transformer connections.

Electrical machines: Principle of operation, characteristics, efficiency and regulation of DC and synchronous machines; equivalent circuit and performance of three-phase and single-phase induction motors.

Electronic Circuits: Characteristics of p-n junction diodes, zener diodes, bipolar junction transistors (BJT) and junction field effect transistors (JFET); MOSFET's structure, characteristics, and operations; rectifiers, filters, and regulated power supplies; biasing circuits, different configurations of transistor amplifiers, class A, B and C of power amplifiers; linear applications of operational amplifiers; oscillators; tuned and phase shift types.

Digital circuits: Number systems, Boolean algebra; logic gates, combinational circuits, flip-flops (RS, JK, D and T) counters.

Measuring instruments: Moving coil, moving iron, and dynamometer type instruments; shunts, instrument transformers, cathode ray oscilloscopes; D/A and A/D converters.

SECTION D. FLUID MECHANICS

Fluid Properties: Relation between stress and strain rate for Newtonian fluids

Hydrostatics, buoyancy, manometry

Concept of local and convective accelerations; control volume analysis for mass, momentum and energy conservation.

Differential equations of continuity and momentum (Euler's equation of motion); concept of fluid rotation, stream function, potential function; Bernoulli's equation and its applications.

Qualitative ideas of boundary layers and its separation; streamlined and bluff bodies; drag and lift forces.

Fully-developed pipe flow; laminar and turbulent flows; friction factor; Darcy Weisbach relation; Moody's friction chart; losses in pipe fittings; flow measurements using venturimeter and orifice plates.

Dimensional analysis; similitude and concept of dynamic similarity; importance of dimensionless numbers in model studies.

SECTION E. MATERIALS SCIENCE

Atomic structure and bonding in materials: metals, ceramics and polymers.

Structure of materials: Crystal systems, unit cells and space lattice; determination of structures of simple crystals by X-ray diffraction; Miller indices for planes and directions. Packing geometry in metallic, ionic and covalent solids.

Concept of amorphous, single and polycrystalline structures and their effects on properties of materials.

Imperfections in crystalline solids and their role in influencing various properties.

Fick´s laws of diffusion and applications of diffusion in sintering, doping of semiconductors and surface hardening of metals.

Alloys: solid solution and solubility limit. Binary phase diagram, intermediate phases and intermetallic compounds; iron-iron carbide phase diagram. Phase transformation in steels. Cold and hot working of metals, recovery, recrystallization and grain growth.

Properties and applications of ferrous and nonferrous alloys.

Structure, properties, processing and applications of traditional and advanced ceramics.

Polymers: classification, polymerization, structure and properties, additives for polymer products, processing and application.

Composites: properties and application of various composites.

Corrosion and environmental degradation of materials (metals, ceramics and polymers).

Mechanical properties of materials: Stress-strain diagrams of metallic, ceramic and polymeric materials, modulus of elasticity, yield strength, plastic deformation and toughness, tensile strength and elongation at break; viscoelasticity, hardness, impact strength. ductile and brittle fracture. creep and fatigue properties of materials.

Heat capacity, thermal conductivity, thermal expansion of materials.

Concept of energy band diagram for materials; conductors, semiconductors and insulators in terms of energy bands. Electrical conductivity, effect of temperature on conductivity in materials, intrinsic and extrinsic semiconductors, dielectric properties of materials.

Refraction, reflection, absorption and transmission of electromagnetic radiation in solids.

Origin of magnetism in metallic and ceramic materials, paramagnetism, diamagnetism, antiferromagnetism, ferromagnetism, ferrimagnetism in materials and magnetic hysteresis.

Advanced materials: Smart materials exhibiting ferroelectric, piezoelectric, optoelectronic, semiconducting behaviour; lasers and optical fibers; photoconductivity and superconductivity in materials.

SECTION F. SOLID MECHANICS

Equivalent force systems; free-body diagrams; equilibrium equations; analysis of determinate and indeterminate trusses and frames; friction.

Simple relative motion of particles; force as function of position, time and speed; force acting on a body in motion; laws of motion; law of conservation of energy; law of conservation of momentum

Stresses and strains; principal stresses and strains; Mohr's circle; generalized Hooke's Law; equilibrium equations; compatibility conditions; yield criteria.

Axial, shear and bending moment diagrams; axial, shear and bending stresses; deflection (for symmetric bending); torsion in circular shafts; thin cylinders; energy methods (Castigliano's Theorems); Euler buckling.

SECTION G. THERMODYNAMICS

Basic Concepts: Continuum, macroscopic approach, thermodynamic system (closed and open or control volume); thermodynamic properties and equilibrium; state of a system, state diagram, path and process; different modes of work; Zeroth law of thermodynamics; concept of temperature; heat.

First Law of Thermodynamics: Energy, enthalpy, specific heats, first law applied to systems and control volumes, steady and unsteady flow analysis.

Second Law of Thermodynamics: Kelvin-Planck and Clausius statements, reversible and irreversible processes, Carnot theorems, thermodynamic temperature scale, Clausius inequality and concept of entropy, principle of increase of entropy; availability and irreversibility.

Properties of Pure Substances: Thermodynamic properties of pure substances in solid, liquid and vapour phases, P-V-T behaviour of simple compressible substances, phase rule, thermodynamic property tables and charts, ideal and real gases, equations of state, compressibility chart.

Thermodynamic Relations: T-ds relations, Maxwell equations, Joule-Thomson coefficient, coefficient of volume expansion, adiabatic and isothermal compressibilities, Clapeyron equation.

Ideal Gas Mixtures: Dalton's and Amagat's laws, calculations of properties, air-water vapour mixtures.

XL - LIFE SCIENCES

The syllabi of the Sections of this paper are as follows:

SECTION H. CHEMISTRY (Compulsory)

Atomic structure and periodicity: Quantum chemistry; Planck's quantum theory, wave particle duality, uncertainty principle, quantum mechanical model of hydrogen atom; electronic configuration of atoms; periodic table and periodic properties; ionization energy, election affinity, electronegativity, atomic size.

Structure and bonding: Ionic and covalent bonding M.O. and V.B. approaches for diatomic molecules, VSEPR theory and shape of molecules, hybridisation, resonance, dipole moment, structure parameters such as bond length, bond angle and bond energy, hydrogen bonding, van der Waals interactions. Ionic solids; ionic radii, lattice energy (Born-Haber Cycle).

s.p. and d Block Elements: Oxides, halides and hydrides of alkali and alkaline earth metals, B, Al, S, N, P and S, silicones, general characteristics of 3d elements, coordination complexes: valence bond and crystal field theory, color, geometry and magnetic properties.

Chemical Equilibria: Colligative properties of solutions, ionic equilibria in solution, solubility product, common ion effect, hydrolysis of salts, pH, buffer and their applications in chemical analysis.

Electrochemistry: Conductance, Kohlrausch law, Half Cell potentials, emf, Nernst equation, galvanic cells, thermodynamic aspects and their applications.

Reaction Kinetics: Rate constant, order of reaction, molecularity, activation energy, zero, first and second order kinetics, equilibrium constants (Kc, Kp and Kx) for homogeneous reactions, catalysis and elementary enzyme reactions.

Thermodynamics: First law, reversible and irreversible processes, internal energy, enthalpy, Kirchoff's equation, heat of reaction, Hess law, heat of formation, Second law, entropy, free energy, and work function. Gibbs-Helmholtz equation, Clausius-Clapeyron equation, free energy change and equilibrium constant, Troutons rule, Third law of thermodynamics.

Mechanistic Basis of Organic Reactions: Elementary treatment of SN1, SN2, E1 and E2 reactions, Hoffmann and Saytzeff rules, Addition reactions, Markonikoff rule and Kharash effect, Diels-Alder reaction, aromatic electrophilic substitution, orientation effect as exemplified by various functional groups.

Structure-Reactivity Correlations: Acids and bases, electronic and steric effects, optical and geometrical isomerism, tautomerism, concept of aromaticity

SECTION I. BIOCHEMISTRY

Organization of life. Importance of water. Cell structure and organelles. Structure and function of biomolecules: Carbohydrates, Lipids, Proteins and Nucleic acids. Biochemical separation techniques. Spectroscopic methods; UV-visible and fluorescence. Protein structure, folding and function: Myoglobin, Hemoglobin, Lysozyme, ribonuclease A, Carboxypeptidase and Chymotrypsin. Enzyme kinetics and regulation, Coenzymes.

Metabolism and bioenergitics. Generation and utilization of ATP. Photosynthesis. Major metabolic pathways and their regulation. Biological membranes. Transport across membranes. Signal transduction; hormones and neurotransmitters.

DNA replication, transcription and translation. Biochemical regulation of gene expression. Recombinant DNA technology and applications. Genomics and Proteomics.

The immune system. Active and passive immunity. Complement system. Antobody structure, function and diversity. Cells of the immune system: T, B and macrophages. T and B cell activation. Major histocompatibilty complex. T cell receptor. Immunological techniques: Immunodiffusion, immunoelectrophoresis, RIA and ELISA.

SECTION J. BIOTECHNOLOGY

Recombinant DNA technology for the production of therapeutic proteins. Micro array technology. Heterologous protein expression systems in bacteria, yeast etc.

Architecture of plant genome; plant tissue culture techniques; methods of gene transfer into plant cells; manipulation of phenotypic traits in plants; plant cell fermentations and production of secondary metabolites using suspension/ immobilized cell culture; methods for plant micro propagation; crop improvement and development of transgenic plants. Expression of animal proteins in plants.

Animal cell metabolism and regulation; cell cycle; primary cell culture; nutritional requirements for animal cell culture; techniques for the mass culture of animal cell lines; production of vaccines; growth hormones and interferons using animal cell culture; cytokines-production and therapeutic uses; hybridoma technology; vectors for gene transfer and expression in animal cells. Transgenic animals and molecular pharming.

Microbial production of industrial enzymes; methods for immobilization of enzymes; kinetics of soluble and immobilized enzymes; application of soluble and immobilized enzymes; enzyme-based sensors.

Microbial growth kinetics; batch, fed batch and continuous culture of microbial cells; media for industrial fermentations; sterilization of air and media; design features and operation of stirred tank, air-lift and fluidized bed reactors; aeration and agitation in aerobic fermentations; recovery and purification of fermentation products- filtration, centrifugation, cell disintegration, solvent extraction and chromatographic separations; industrial fermentations for the production of ethanol, citric acid, lysine, penicillin and other biomolecules; simple calculations based on material and energy balance of fermentation processes; application of microbes in the management of domestic and industrial wastes.

SECTION K. BOTANY

Anatomy: Roots, stem and leaves of land plants, meristems, vascular system, their ontogeny, structure and functions. Plant cell structure, organisation, organelles, cytoskeleton, cell wall and membranes.

Development: Cell cycle, cell division, senescence, hormonal regulation of growth; life cycle of an angiosperm, pollination, fertilization, embryogenesis, seed formation, seed storage proteins, seed dormancy and germination. Concept of cellular totipotency, organogenesis and somatic embryogenesis, somaclonal variation, embryo culture, in vitro fertilization.

Physiology and Biochemistry: Plant water relations, transport of minerals and solutes, N2 metabolism, proteins and nucleic acid, respiration, photophysiology, photosynthesis, photorespiration; biosynthesis, mechanism of action and physiological effects of plant growth regulators.

Genetics: Principles of Mendelian inheritance, linkage, recombination and genetic mapping; extrachromosomal inheritance; eukaryotic genome organization (chromatin structure) and regulation of gene expression, gene mutation, chromosome aberrations (numerical and structural), transposons.

Plant Breeding: Principles, methods - selection, hybridization, heterosis; male sterility, self and inter-specific incompatibility; haploidy; somatic cell hybridization; molecular marker-assisted selection; gene transfer methods viz. direct and vector-mediated, transgenic plants and their applications in agriculture.

Economic Botany: Economically important plants - cereals, pulses, plants yielding fiber, timber, sugar, beverages, oils, rubber, dyes, gums, drugs and narcotics - a general account.

Systematics: Systems of classification (non-phylogenetic vs. phylogenetic - outline), plant groups, molecular systematics.

Plant Pathology: Nature and classification of plant diseases, diseases of important crops caused by fungi, bacteria and viruses, and their control measures, mechanism(s) of pathogenesis and resistance, molecular detection of pathogens; plant-microbe beneficial interactions.

Ecology and Plant Geography: Ecosystems - types, dynamics, degradation, ecological succession; food chains; vegetation types of the world; pollution and global warming; speciation and extinction, conservation strategies, cryopreservation.

SECTION L. MICROBIOLOGY

Historical perspective - Discovery of the microbial world; Controversy over spontaneous generation; Role of microorganisms in transformation of organic matter and in the causation of diseases.

Methods in microbiology - Pure culture techniques; Theory and practice of sterilization; Principles of microbial nutrition; Construction of culture media; Enrichment culture techniques for isolation of chemoautotrophs, chemoheterotrophs and photosynthetic microorganisms.

Microbial evolution, systematics and taxonomy - Evolution of earth and earliest life forms; Primitive organisms and their metabolic strategies; New approaches to bacterial taxonomic classification including ribotyping; Nomenclature.

Microbial diversity - Bacteria, archea and their broad classification; Eukaryotic microbes, yeast, fungi, slime mold and protozoa; Viruses and their classification.

Microbial growth -The definition of growth, mathematical expression of growth, growth curve, measurement of growth and growth yields; Synchronous growth; Continuous culture.

Nutrition and metabolism - Overview of metabolism; Microbial nutrition; Energy classes of microorganisms; Culture media; Energetics, modes of ATP generation; ATP generation by heterotrophs; Fermentation; Glycolysis; Respiration; The citric acid cycle; Electron transport systems; Alternate modes of energy generation; Pathways (anabolism) in the biosynthesis of amino acids, purines, pyrimidines and fatty acids.

Metabolic diversity among microorganisms - Photosynthesis in microorganisms; Role of chlorophylls, carotenoids and phycobilins; Calvin cycle; Chemolithotrophy; Hydrogen- iron-nitrite-oxidizing bacteria; Nitrate and sulfate reduction; Methanogenesis and acetogenesis.

Prokaryotic cells: structure-function - Cells walls of eubacteria (peptidoglycan) and related molecules; Outer-membrane of gram-negative bacteria; Cell wall and cell membrane synthesis; Flagella and motility; Cell inclusions like endospores, gas vesicles.

Microbial diseases and host parasite relationships - Normal microflora of skin; Oral cavity; Gastrointestinal tract; Entry of pathogens into the host; Infectious disease transmission; Respiratory infections caused by bacteria and viruses; Tuberculosis; Sexually transmitted diseases including AIDS; Diseases transmitted by animals (Rabies, plague), insects and ticks (rikettsias, Lyme disease, malaria); Food and water borne diseases; Public health and water quality; Pahtogenic fungi; Emerging and resurgent infectious diseases.

Chemotherapy/Antibiotics - Antimicrobial agents; Sulfa drugs; Antibiotics; Pencillins and cephalosporins; Broad-spectrum antibiotics; Antibiotics from prokaryotes; Antifungal antibiotics; Mode of action; Resistance to antibiotics.

Microbial genetics - Genes, mutation and mutagenesis - UV and chemical mutagnes; Types of mutations; Ames test for mutagenesis; Methods of genetic analysis. Bacterial genetic system - Transformation; Conjugation; Transduction; Recombination; Plasmids and Transposons; Bacterial genetic map with reference to E. coli. Viruses and their genetic system - Phage ? and its life cycle; RNA phages; RNA viruses; Retroviruses; Genetic systems of yeast and Neurospora; Extrachromosomal inheritance and mitochondrial genetics; Basic concept of genomics.

SECTION M. ZOOLOGY

Animal world: Animal diversity, distribution, systematic and classification of animals, the phylogenetic relationship.

Evolution: Origin of life, history of life on earth, evolutionary theories, natural selection, adaptation, speciation.

Genetics: Principles of inheritance, molecular basis of heredity, the genetic material, transmission of genetic material, mutations, cytoplasmic inheritance.

Biochemistry and Molecular Biology: Nucleic acids, proteins and other biological macromolecules. Replication, transcription and translation, regulation of gene expression, organization of genome, Kreb's cycle, glycolysis, enzyme catalysis, hormones and their action.

Cell Biology: Structure of cell, cellular organelles and their structure and function, cell cycle, cell division, cellular differentiation, chromosome and chromatin structure. Eukaryotic gene organisation and expression.

Animal Anatomy and Physiology: Comparative physiology, the respiratory system, circulatory system, digestive system, the nervous system, the excretory system, the endocrine system, the reproductive system, the skeletal system, osmoregulation.

Parasitology and Immunology: Nature of parasite, host-parasite relation, protozoan and helminthic parasites, the immune response, cellular and humoral immune response, evolution of the immune system.

Development Biology: Embryonic development, cellular differentiation, organogenesis, metamorphosis, genetic basis of development.

Ecology: The ecosystem, habitats the food chain, population dynamics, species diversity, zoogeography, biogeochemical cycles, conservation biology.

Animal Behaviour: Types of behaviours, courtship, mating and territoriality, instinct, learning and memory, social behaviour across the animal taxa, communication, pheromones, evolution of animal behaviour.

IT - INFORMATION TECHNOLOGY

ENGINEERING MATHEMATICS

Mathematical Logic: Propositional Logic; First Order Logic.

Probability: Conditional Probability; Mean, Median, Mode and Standard Deviation; Random Variables; Distributions; uniform, normal, exponential, Poisson, Binomial.

Set Theory & Algebra: Sets; Relations; Functions; Groups; Partial Orders; Lattice; Boolean Algebra.

Combinatorics: Permutations; Combinations; Counting; Summation; generating functions; recurrence relations; asymptotics.

Graph Theory: Connectivity; spanning trees; Cut vertices & edges; covering; matching; independent sets; Colouring; Planarity; Isomorphism.

Linear Algebra: Algebra of matrices, determinants, systems of linear equations, Eigen values and Eigen vectors.

Numerical Methods: LU decomposition for systems of linear equations; numerical solutions of non linear algebraic equations by Secant, Bisection and Newton-Raphson Methods; Numerical integration by trapezoidal and Simpson's rules.

Calculus: Limit, Continuity & differentiability, Mean value Theorems, Theorems of integral calculus, evaluation of definite & improper integrals, Partial derivatives, Total derivatives, maxima & minima.

FORMAL LANGUAGES AND AUTOMATA

Regular Languages: finite automata, regular expressions, regular grammar.

Context free languages: push down automata, context free grammars

COMPUTER HARDWARE

Digital Logic: Logic functions, minimization, design and synthesis of combinatorial and sequential circuits, number representation and computer arithmetic (fixed and floating point)

Computer organization: Machine instructions and addressing modes, ALU and data path, hardwired and microprogrammed control, memory interface, I/O interface (interrupt and DMA mode), serial communication interface, instruction pipelining, cache, main and secondary storage

SOFTWARE SYSTEMS

Data structures and Algorithms: the notion of abstract data types, stack, queue, list, set, string, tree, binary search tree, heap, graph, tree and graph traversals, connected components, spanning trees, shortest paths, hashing, sorting, searching, design techniques (greedy, dynamic, divide and conquer), asymptotic analysis (best, worst, average cases) of time and space, upper and lower bounds, intractability

Programming Methodology: C programming, program control (iteration, recursion, functions), scope, binding, parameter passing, elementary concepts of object oriented programming

Operating Systems (in the context of Unix): classical concepts (concurrency, synchronization, deadlock), processes, threads and interprocess communication, CPU scheduling, memory management, file systems, I/O systems, protection and security

Information Systems and Software Engineering: information gathering, requirement and feasibility analysis, data flow diagrams, process specifications, input/output design, process life cycle, planning and managing the project, design, coding, testing, implementation, maintenance.

Databases: relational model, database design, integrity constraints, normal forms, query languages (SQL), file structures (sequential, indexed), b-trees, transaction and concurrency control

Data Communication: data encoding and transmission, data link control, multiplexing, packet switching, LAN architecture, LAN systems (Ethernet, token ring), Network devices: switches, gateways, routers

Networks: ISO/OSI stack, sliding window protocols, routing protocols, TCP/UDP, application layer protocols & systems (http, smtp, dns, ftp), network security

Web technologies: three tier web based architecture; JSP, ASP, J2EE, .NET systems; html, XML

AG - AGRICULTURAL ENGINEERING

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

FARM MACHINERY AND POWER:

Sources of power on the farm-human, animal, mechanical, electrical, wind, solar and biomass; design and selection of machine elements - gears, pulleys, chains and sprockets and belts; overload safety devices used in farm machinery; measurement of force, torque, speed, displacement and acceleration on machine elements.

Soil tillage; forces acting on a tillage tool; hitch systems and hitching of tillage implements; functional requirements, principles of working, construction and operation of manual, animal and power operated equipment for tillage. sowing, planting, fertilizer application, inter-cultivation, spraying, mowing, chaff cutting, harvesting, threshing and transport; testing of agricultural machinery and equipment; calculation of performance parameters -field capacity, efficiency, application rate and losses; cost analysis of implements and tractors.

Thermodynamic principles of I.C. engines; I.C. engine cycles; engine components; fuels and combustion; lubricants and their properties; I.C. engine systems - fuel, cooling, lubrication, ignition, electrical, intake and exhaust; selection, operation, maintenance and repair of I.C. engines; power efficiencies and measurement; calculation of power, torque, fuel consumption, heat load and power losses.

Tractors and power tillers - type, selection, maintenance and repair; tractor clutches and brakes; power transmission systems - gear trains, differential, final drives and power take-off; mechanics of tractor chassis; traction theory; three point hitches- free link and restrained link operations; mechanical steering and hydraulic control systems used in tractors; human engineering and safety in tractor design; tractor tests and performance.

SOIL AND WATER CONSERVATION ENGINEERING:

Ideal and real fluids, properties of fluids; hydrostatic pressure and its measurement; hydrostatic forces on plane and curved surface; continuity equation; Bernoulli's theorem; laminar and turbulent flow in pipes, Darcy-Weisbach and Hazen-Williams equations, Moody's diagram; flow through orifices and notches; flow in open channels.

Engineering properties of soils, fundamental definitions and relationships; index properties of soils; permeability and seepage analysis; shear strength, Mohr's circle of stresses; active and passive earth pressures; stability of slopes.

Hydrological cycle; precipitation measurement, analysis of precipitation data; abstraction from precipitation; runoff; hydrograph analysis, unit hydrograph theory and application; stream flow measurement; flood routing, hydrological reservoir and channel routing.

Mechanics of soil erosion, factors affecting erosion; soil loss estimation; biological and engineering measures to control erosion, terraces and bunds; vegetative waterways; gully control structures, drop, drop inlet and chute spillways; farm ponds; earthen dams; principles of watershed management.

Water requirement of crops; consumptive use and evapo-transpiration; irrigation scheduling; irrigation efficiencies; design of prismatic and silt loaded channels; methods of irrigation water application; design and evaluation of irrigation methods; drainage coefficient; surface and subsurface drainage systems; leaching requirement and salinity control; irrigation and drainage water quality; classification of pumps; pump characteristics; pump selection; types of aquifer; evaluation of aquifer properties; well hydraulics; ground water recharge.

AGRICULTURAL PROCESSING AND FOOD ENGINEERING:

Steady state heat transfer in conduction, convection and radiation; transient heat transfer in simple geometry; condensation and boiling heat transfer; working principles of heat exchangers; diffusive and convective mass transfer; simultaneous heat and mass transfer in agricultural processing operations.

Material and energy balances in food processing systems; water activity, sorption and desorption isotherms; centrifugal separation of solids, liquids and gases; kinetics of microbial death - pasteurisation and sterilization of liquid foods; preservation of food by cooling and freezing; psychrometry - properties of air-vapour mixture; concentration and dehydration of liquid foods - evaporators, tray, drum and spray dryers.

Mechanics and energy requirement in size reduction of granular solids; particle size analysis for comminuted solids; size separation by screening; fluidisation of granular solids; cleaning and grading efficiency and effectiveness of grain cleaners; conditioning and hydrothermal treatments for grains; dehydration of food grains; processes and machines for processing of cereals, pulses and oilseeds; design considerations for grain silos.

AR - ARCHITECTURE AND PLANNING

City planning: Historical development of cities; principles of city planning; new towns; survey methods, site planning, planning regulations and building bye-laws.

Housing: Concept of shelter; housing policies and design; community planning; role of government agencies; finance and management.

Landscape Design: Principles of landscape design and site planning; history and landscape styles; landscape elements and materials; planting design.

Computer Aided Design: Application of computers in architecture and planning; understanding elements of hardware and software; computer graphics; programming languages - C and Visual Basic and usage of packages such as AutoCAD.

Environmental and Building Science: Elements of environmental science; ecological principles concerning environment; role of micro-climate in design; climatic control through design elements; thermal comfort; elements of solar architecture; principles of lighting and illumination; basic principles of architectural acoustics; air pollution, noise pollution and their control.

Visual and Urban Design: Principles of visual composition; proportion, scale, rhythm, symmetry, harmony, balance, form and colour; sense of place and space, division of space; focal point, vista, imageability, visual survey.

History of Architecture: Indian - Indus valley, Vedic, Buddhist, Indo-Aryan, Dravidian and Mughal periods; European - Egyptian, Greek, Roman, medieval and renaissance periods.

Development of Contemporary Architecture: Architectural developments and impacts on society since industrial revolution; influence of modern art on architecture; works of national and international architects; post modernism in architecture.

Building Services: Water supply, Sewerage and Drainage systems; Sanitary fittings and fixtures; principles of electrification of buildings; elevators, their standards and uses; air-conditioning systems; fire fighting systems.

Building Construction and Management: Building construction techniques, methods and details; building systems and prefabrication of building elements; principles of modular coordination; estimation, specification, valuation, professional practice; project management, PERT, CPM.

Materials and Structural Systems: Behavioural characteristics of all types of building materials e.g. mud, timber, bamboo, brick, concrete, steel, glass, FRP; principles of strength of materials; design of structural elements in wood, steel and RCC; elastic and limit state design; complex structural systems; principles of pre-stressing.

Planning Theory: Planning process; multilevel planning; comprehensive planning; central place theory; settlement pattern; land use and land utilization.

Techniques of Planning: Planning surveys; Preparation of urban and regional structure plans, development plans, action plans; site planning principles and design; statistical methods; application of remote sensing techniques in urban and regional planning.

Traffic and Transportation Planning: Principles of traffic engineering and transportation planning; methods of conducting surveys; design of roads, intersections and parking areas; hierarchy of roads and levels of services; traffic and transport management in urban areas; traffic safety and traffic laws; public transportation planning; modes of transportation.

Services and Amenities: Principles and design of water supply systems, sewerage systems, solid waste disposal systems, power supply and communication systems; Health, education, recreation and demography related standards at various levels of the settlements.

Development Administration and Management: Planning laws; development control and zoning regulations; laws relating to land acquisition; development enforcements, land ceiling; regional and urban plan preparations; planning and municipal administration; taxation, revenue resources and fiscal management; public participation and role of NGO.

CE - CIVIL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

STRUCTURAL ENGINEERING

Mechanics: Bending moments and shear forces in statically determinate beams; simple stress and strain: relationship; stress and strain in two dimensions, principal stresses, stress transformation, Mohr's circle; simple bending theory; flexural shear stress; thin-walled pressure vessels; uniform torsion.

Structural Analysis: Analysis of statically determinate trusses, arches and frames; displacements in statically determinate structures and analysis of statically indeterminate structures by force/energy methods; analysis by displacement methods (slope-deflection and moment-distribution methods); influence lines for determinate and indeterminate structures; basic concepts of matrix methods of structural analysis.

Concrete Structures: Basic working stress and limit states design concepts; analysis of ultimate load capacity and design of members subject to flexure, shear, compression and torsion (beams, columns and isolated footings); basic elements of prestressed concrete: analysis of beam sections at transfer and service loads.

Steel Structures: Analysis and design of tension and compression members, beams and beam-columns, column bases; connections - simple and eccentric, beam-column connections, plate girders and trusses; plastic analysis of beams and frames.

GEOTECHNICAL ENGINEERING

Soil Mechanics: Origin of soils; soil classification; three-phase system, fundamental definitions, relationship and inter-relationships; permeability and seepage; effective stress principle: consolidation, compaction; shear strength.

Foundation Engineering: Sub-surface investigation - scope, drilling bore holes, sampling, penetrometer tests, plate load test; earth pressure theories, effect of water table, layered soils; stability of slopes - infinite slopes, finite slopes; foundation types - foundation design requirements; shallow foundations; bearing capacity, effect of shape, water table and other factors, stress distribution, settlement analysis in sands and clays; deep foundations - pile types, dynamic and static formulae, load capacity of piles in sands and clays.

WATER RESOURCES ENGINEERING

Fluid Mechanics and Hydraulics: Hydrostatics, applications of Bernoulli equation, laminar and turbulent flow in pipes, pipe networks; concept of boundary layer and its growth; uniform flow, critical flow and gradually varied flow in channels, specific energy concept, hydraulic jump; forces on immersed bodies; flow measurement in channels; tanks and pipes; dimensional analysis and hydraulic modeling. Applications of momentum equation, potential flow, kinematics of flow; velocity triangles and specific speed of pumps and turbines.

Hydrology: Hydrologic cycle; rainfall; evaporation infiltration, unit hydrographs, flood estimation, reservoir design, reservoir and channel routing, well hydraulics.

Irrigation: Duty, delta, estimation of evapo-transpiration; crop water requirements; design of lined and unlined canals; waterways; head works, gravity dams and Ogee spillways. Designs of weirs on permeable foundation, irrigation methods.

ENVIRONMENTAL ENGINEERING

Water requirements; quality and standards, basic unit processes and operations for water treatment, distribution of water. Sewage and sewerage treatment: quantity and characteristic of waste water sewerage; primary and secondary treatment of waste water; sludge disposal; effluent discharge standards.

TRANSPORTATION ENGINEERING

Highway planning; geometric design of highways; testing and specifications of paving materials; design of flexible and rigid pavements.

CH - CHEMICAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear

differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

CHEMICAL ENGINEERING

Process Calculations and Thermodynamics: Laws of conservation of mass and energy; use of tie components; recycle, bypass and purge calculations; degree of freedom analysis.

First and Second laws of thermodynamics and their applications; equations of state and thermodynamic properties of real systems; phase equilibria; fugacity, excess properties and correlations of activity coefficients; chemical reaction equilibria.

Fluid Mechanics and Mechanical Operations: Fluid statics, Newtonian and non-Newtonian fluids, Bernoulli equation, Macroscopic friction factors, energy balance, dimensional analysis, shell balances, flow through pipeline systems, flow meters, pumps and compressors, packed and fluidized beds, elementary boundary layer theory, size reduction and size separation; free and hindered settling; centrifuge and cyclones; thickening and classification, filtration, mixing and agitation; conveying of solids.

Heat Transfer: Conduction, convection and radiation, heat transfer coefficients, steady and unsteady heat conduction, boiling, condensation and evaporation; types of heat exchangers and evaporators and their design.

Mass Transfer: Fick's law, molecular diffusion in fluids, mass transfer coefficients, film, penetration and surface renewal theories; momentum, heat and mass transfer analogies; stagewise and continuous contacting and stage efficiencies; HTU & NTU concepts design and operation of equipment for distillation, absorption, leaching, liquid-liquid extraction, crystallization, drying, humidification, dehumidification and adsorption.

Chemical Reaction Engineering: Theories of reaction rates; kinetics of homogeneous reactions, interpretation of kinetic data, single and multiple reactions in ideal reactors, non-ideal reactors; residence time; non-isothermal reactors; kinetics of heterogeneous catalytic reactions; diffusion effects in catalysis.

Instrumentation and Process Control: Measurement of process variables; sensors, transducers and their dynamics, dynamics of simple systems, dynamics such as CSTRs, transfer functions and responses of simple systems, process reaction curve, controller modes (P, PI, and PID); control valves; analysis of closed loop systems including stability, frequency response (including Bode plots) and controller tuning, cascade, feed forward control.

Plant Design and Economics: Design and sizing of chemical engineering equipment such as compressors, heat exchangers, multistage contactors; principles of process economics and cost estimation including total annualized cost, cost indexes, rate of return, payback period, discounted cash flow, optimization in Design.

Chemical Technology: Inorganic chemical industries; sulfuric acid, NaOH, fertilizers (Ammonia, Urea, SSP and TSP); natural products industries (Pulp and Paper, Sugar, Oil, and Fats); petroleum refining and petrochemicals; polymerization industries; polyethylene, polypropylene, PVC and polyester synthetic fibers.

CS - COMPUTER SCIENCE AND ENGINEERING

ENGINEERING MATHEMATICS

Mathematical Logic: Propositional Logic; First Order Logic.

Probability: Conditional Probability; Mean, Median, Mode and Standard Deviation; Random Variables; Distributions; uniform, normal, exponential, Poisson, Binomial.

Set Theory & Algebra: Sets; Relations; Functions; Groups; Partial Orders; Lattice; Boolean Algebra.

Combinatorics: Permutations; Combinations; Counting; Summation; generating functions; recurrence relations; asymptotics.

Graph Theory: Connectivity; spanning trees; Cut vertices & edges; covering; matching; independent sets; Colouring; Planarity; Isomorphism.

Linear Algebra: Algebra of matrices, determinants, systems of linear equations, Eigen values and Eigen vectors.

Numerical Methods: LU decomposition for systems of linear equations; numerical solutions of non linear algebraic equations by Secant, Bisection and Newton-Raphson Methods; Numerical integration by trapezoidal and Simpson's rules.

Calculus: Limit, Continuity & differentiability, Mean value Theorems, Theorems of integral calculus, evaluation of definite & improper integrals, Partial derivatives, Total derivatives, maxima & minima.

THEORY OF COMPUTATION

Formal Languages and Automata Theory: Regular languages and finite automata, Context free languages and Push-down automata, Recursively enumerable sets and Turing machines, Un-decidability;

Analysis of Algorithms and Computational Complexity: Asymptotic analysis (best, worst, average case) of time and space, Upper and lower bounds on the complexity of specific problems, NP-completeness.

COMPUTER HARDWARE

Digital Logic: Logic functions, Minimization, Design and synthesis of Combinational and Sequential circuits; Number representation and Computer Arithmetic (fixed and floating point);

Computer Organization: Machine instructions and addressing modes, ALU and Data-path, hardwired and micro-programmed control, Memory interface, I/O interface (Interrupt and DMA mode), Serial communication interface, Instruction pipelining, Cache, main and secondary storage.

SOFTWARE SYSTEMS

Data structures: Notion of abstract data types, Stack, Queue, List, Set, String, Tree, Binary search tree, Heap, Graph;

Programming Methodology: C programming, Program control (iteration, recursion, Functions), Scope, Binding, Parameter passing, Elementary concepts of Object oriented, Functional and

Logic Programming;

Algorithms for problem solving: Tree and graph traversals, Connected components, Spanning trees, Shortest paths; Hashing, Sorting, Searching; Design techniques (Greedy, Dynamic Programming, Divide-and-conquer);

Compiler Design: Lexical analysis, Parsing, Syntax directed translation, Runtime environment, Code generation, Linking (static and dynamic); Operating Systems: Classical concepts (concurrency, synchronization, deadlock), Processes, threads and Inter-process communication, CPU scheduling, Memory management, File systems, I/O systems, Protection and security.

Databases: Relational model (ER-model, relational algebra, tuple calculus), Database design (integrity constraints, normal forms), Query languages (SQL), File structures (sequential files, indexing, B+ trees), Transactions and concurrency control;

Computer Networks: ISO/OSI stack, sliding window protocol, LAN Technologies (Ethernet, Token ring), TCP/UDP, IP, Basic concepts of switches, gateways, and routers.

CH - CHEMISTRY

PHYSICAL CHEMISTRY

Structure: Quantum theory - principles and techniques; applications to particle in a box, harmonic oscillator, rigid rotor and hydrogen atom; valence bond and molecular orbital theories and Huckel approximation, approximate techniques: variation and perturbation; symmetry, point groups; rotational, vibrational, electronic, NMR and ESR spectroscopy.

Equilibrium: First law of thermodynamics, heat, energy and work; second law of thermodynamics and entropy; third law and absolute entropy; free energy; partial molar quantities; ideal and non-ideal solutions; phase transformation: phase rule and phase diagrams- one, two, and three component systems; activity, activity coefficient, fugacity and fugacity coefficient ; chemical equilibrium, response of chemical equilibrium to temperature and pressure; colligative properties; kinetic theory of gases; thermodynamics of electrochemical cells; standard electrode potentials: applications - corrosion and energy conversion; molecular partition function (translational, rotational, vibrational and electronic).

Kinetics: Rates of chemical reactions, theories of reaction rates, collision and transition state theory; temperature dependence of chemical reactions; elementary reactions, consecutive elementary reactions; steady state approximation, kinetics of photochemical reactions and free radical polymerization, homogenous and heterogeneous catalysis.

INORGANIC CHEMISTRY

Non-Transition Elements: General characteristics, structure and reactions of simple and industrially important compounds, boranes, carboranes, silicates, silicones, diamond and graphite; hydrides, oxides and oxoacids of N, P, S and halogens; boron nitride, borazines and phosphazenes; xenon compounds. Shapes of molecules, hard-soft acid base concept.

Transition Elements: General characteristics of d and f block elements; coordination chemistry: structure and isomerism, stability, theories of metal-ligand bonding (CFT and LFT), electronic spectra and magnetic properties of transition metal complexes and lanthanides; metal carbonyls, metal-metal bonds and metal atom clusters, metallocenes; transition metal complexes with bonds to hydrogen, alkyls, alkenes, and arenes; metal carbenes; use of organometallic compounds as catalysts in organic synthesis; mechanisms of substitution and electron transfer reactions of coordination complexes. Role of metals with special reference to Na, K, Mg, Ca, Fe, Co, Zn, and Mo in biological systems.

Solids: Crystal systems and lattices, Miller planes, crystal packing, crystal defects; Bragg's

Law; ionic crystals, band theory, metals and semiconductors. Spinels.

Instrumental methods of analysis: atomic absorption, UV-visible spectrometry, chromatographic and electro-analytical methods.

ORGANIC CHEMISTRY

Synthesis, reactions and mechanisms involving the following: Alkenes, alkynes, arenes, alcohols, phenols, aldehydes, ketones, carboxylic acids and their derivatives; halides, nitro compounds and amines; stereochemical and conformational effects on reactivity and specificity; reactions with diborane and peracids. Michael reaction, Robinson annulation, reactivity umpolung, acyl anion equivalents; molecular rearrangements involving electron deficient atoms.

Photochemistry: Basic principles, photochemistry of olefins, carbonyl compounds, arenes, photo oxidation and reduction.

Pericyclic reactions: Cycloadditions, electrocyclic reactions, sigmatropic reactions; Woodward-Hoffmann rules.

Heterocycles: Structural properties and reactions of furan, pyrrole, thiophene, pyridine, indole.

Biomolecules: Structure, properties and reactions of mono- and di-saccharides, physico-chemical properties of amino acids, structural features of proteins and nucleic acids.

Spectroscopy: Principles and applications of IR, UV-visible, NMR and mass spectrometry in the determination of structures of organic compounds.

EC - ELECTRONICS AND COMMUNICATION ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix Algebra, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Mean value theorems, Theorems of integral calculus, Evaluation of definite and improper integrals, Partial Derivatives, Maxima and minima, Multiple integrals, Fourier series. Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equation (linear and nonlinear), Higher order linear differential equations with constant coefficients, Method of variation of parameters, Cauchy's and Euler's equations, Initial and boundary value problems, Partial Differential Equations and variable separable method.

Complex variables: Analytic functions, Cauchy's integral theorem and integral formula, Taylor's and Laurent' series, Residue theorem, solution integrals.

Probability and Statistics: Sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Discrete and continuous distributions, Poisson, Normal and Binomial distribution, Correlation and regression analysis.

Numerical Methods: Solutions of non-linear algebraic equations, single and multi-step methods for differential equations.

Transform Theory: Fourier transform, Laplace transform, Z-transform.

ELECTRONICS & COMMUNICATION ENGINEERING

Networks: Network graphs: matrices associated with graphs; incidence, fundamental cut set and fundamental circuit matrices. Solution methods: nodal and mesh analysis. Network theorems: superposition, Thevenin and Norton's maximum power transfer, Wye-Delta transformation. Steady state sinusoidal analysis using phasors. Linear constant coefficient differential equations; time domain analysis of simple RLC circuits, Solution of network equations using Laplace transform: frequency domain analysis of RLC circuits. 2-port network parameters: driving point and transfer functions. State equations for networks.

Electronic Devices: Energy bands in silicon, intrinsic and extrinsic silicon. Carrier transport in silicon: diffusion current, drift current, mobility, resistivity. Generation and recombination of carriers. p-n junction diode, Zener diode, tunnel diode, BJT, JFET, MOS capacitor, MOSFET, LED, p-I-n and avalanche photo diode, LASERs. Device technology: integrated circuits fabrication process, oxidation, diffusion, ion implantation, photolithography, n-tub, p-tub and twin-tub CMOS process.

Analog Circuits: Equivalent circuits (large and small-signal) of diodes, BJTs, JFETs, and MOSFETs. Simple diode circuits, clipping, clamping, rectifier. Biasing and bias stability of transistor and FET amplifiers. Amplifiers: single-and multi-stage, differential, operational, feedback and power. Analysis of amplifiers; frequency response of amplifiers. Simple op-amp circuits. Filters. Sinusoidal oscillators; criterion for oscillation; single-transistor and op-amp configurations. Function generators and wave-shaping circuits. Power supplies.

Digital circuits: Boolean algebra, minimization of Boolean functions; logic gates digital IC families (DTL, TTL, ECL, MOS, CMOS). Combinational circuits: arithmetic circuits, code converters, multiplexers and decoders. Sequential circuits: latches and flip-flops, counters and shift-registers. Sample and hold circuits, ADCs, DACs. Semiconductor memories. Microprocessor(8085): architecture, programming, memory and I/O interfacing.

Signals and Systems: Definitions and properties of Laplace transform, continuous-time and discrete-time Fourier series, continuous-time and discrete-time Fourier Transform, z-transform. Sampling theorems. Linear Time-Invariant (LTI) Systems: definitions and properties; casuality, stability, impulse response, convolution, poles and zeros frequency response, group delay, phase delay. Signal transmission through LTI systems. Random signals and noise: probability, random variables, probability density function, autocorrelation, power spectral density.

Controls Systems: Basic control system components; block diagrammatic description, reduction of block diagrams. Open loop and closed loop (feedback) systems and stability analysis of these systems. Signal flow graphs and their use in determining transfer functions of systems; transient and steady state analysis of LTI control systems and frequency response. Tools and techniques for LTI control system analysis: root loci, Routh-Hurwitz criterion, Bode and Nyquist plots. Control system compensators: elements of lead and lag compensation, elements of Proportional-Integral-Derivative(PID) control. State variable representation and solution of state equation of LTI control systems.

Communications: Analog communication systems: amplitude and angle modulation and demodulation systems, spectral analysis of these operations, superheterodyne receivers; elements of hardware, realizations of analog communication systems; signal-to-noise ratio (SNR) calculations for amplitude modulation (AM) and frequency modulation (FM) for low noise conditions. Digital communication systems: pulse code modulation (PCM), differential pulse code modulation (DPCM), delta modulation (DM); digital modulation schemes-amplitude, phase and frequency shift keying schemes (ASK, PSK, FSK), matched filter receivers, bandwith consideration and probability of error calculations for these schemes.

Electromagnetics: Elements of vector calculus: divergence and curl; Gauss' and Stokes' theorems, Maxwell's equations: differential and integral forms. Wave equation, Poynting vector. Plane waves: propagation through various media; reflection and refraction; phase and group velocity; skin depth. Transmission lines: characteristic impedance; impedance transformation; Smith chart; impedance matching; pulse excitation. Waveguides: modes in rectangular waveguides; boundary conditions; cut-off frequencies; dispersion relations.

Antennas: Dipole antennas; antenna arrays; radiation pattern; reciprocity theorem, antenna gain.

EE - ELECTRICAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix Algebra, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Mean value theorems, Theorems of integral calculus, Evaluation of definite and improper integrals, Partial Derivatives, Maxima and minima, Multiple integrals, Fourier series. Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equation (linear and nonlinear), Higher order linear differential equations with constant coefficients, Method of variation of parameters, Cauchy's and Euler's equations, Initial and boundary value problems, Partial Differential Equations and variable separable method.

Complex variables: Analytic functions, Cauchy's integral theorem and integral formula, Taylor's and Laurent' series, Residue theorem, solution integrals.

Probability and Statistics: Sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Discrete and continuous distributions, Poisson, Normal and Binomial distribution, Correlation and regression analysis.

Numerical Methods: Solutions of non-linear algebraic equations, single and multi-step methods for differential equations.

Transform Theory: Fourier transform, Laplace transform, Z-transform.

ELECTRICAL ENGINEERING

Electrical Circuits and Fields: Network graph, KCL, KVL, node/ cut set, mesh/ tie set analysis, transient response of d.c. and a.c. networks; sinusoidal steady-state analysis; resonance in electrical circuits; concepts of ideal voltage and current sources, network theorems, driving point, immittance and transfer functions of two port networks, elementary concepts of filters; three phase circuits; Fourier series and its application; Gauss theorem, electric field intensity and potential due to point, line, plane and spherical charge distribution, dielectrics, capacitance calculations for simple configurations; Ampere's and Biot-Savart's law, inductance calculations for simple configurations.

Electrical Machines: Single phase transformer - equivalent circuit, phasor diagram, tests, regulation and efficiency; three phase transformers - connections, parallel operation; auto transformer and three-winding transformer; principles of energy conversion, windings of rotating machines: D. C. generators and motors - characteristics, starting and speed control, armature reaction and commutation; three phase induction motors-performance characteristics, starting and speed control; single-phase induction motors; synchronous generators-performance, regulation, parallel operation; synchronous motors - starting, characteristics, applications, synchronous condensers; fractional horse power motors; permanent magnet and stepper motors.

Power Systems: Electric power generation - thermal, hydro, nuclear; transmission line parameters; steady-state performance of overhead transmission lines and cables and surge propagation; distribution systems, insulators, bundle conductors, corona and radio interference effects; per-unit quantities; bus admittance and impedance matrices; load flow; voltage control and power factor correction; economic operation; symmetrical components, analysis of symmetrical and unsymmetrical faults; principles of over current, differential and distance protections; concept of solid state relays and digital protection; circuit breakers;

concept of system stability-swing curves and equal area criterion; basic concepts of HVDC transmission.

Control Systems: Principles of feedback; transfer function; block diagrams: steady-state errors; stability-Routh and Nyquist criteria; Bode plots; compensation; root loci; elementary state variable formulation; state transition matrix and response for Linear Time Invariant systems.

Electrical and Electronic Measurements: Bridges and potentiometers, PMMC, moving iron, dynamometer and induction type instruments; measurement of voltage, current, power, energy and power factor; instrument transformers; digital voltmeters and multimeters; phase, time and frequency measurement; Q-meter, oscilloscopes, potentiometric recorders, error analysis.

Analog and Digital Electronics: Characteristics of diodes, BJT, FET, SCR; amplifiers-biasing, equivalent circuit and frequency response; oscillators and feedback amplifiers, operational amplifiers- characteristics and applications; simple active filters; VCOs and timers; combinational and sequential logic circuits, multiplexer, Schmitt trigger, multivibrators, sample and hold circuits, A/D and D/A converters; microprocessors and their applications.

Power Electronics and Electric Drives: Semiconductor power devices-diodes, transistors, thyristors, triacs, GTOs, MOSFETs and IGBTs - static characteristics and principles of operation; triggering circuits; phase control rectifiers; bridge converters-fully controlled and half controlled; principles of choppers and inverters, basic concepts of adjustable speed dc and ac drives.

GG - GEOLOGY AND GEOPHYSICS

PART - I

Earth and planetary system; size, shape, internal structure and composition of the earth; atmosphere and greenhouse effect; isostasy; elements of seismology; continents and continental processes; physical oceanography; palaeomagnetism, continental drift plate tectonics, geothermal energy.

Weathering; soil formation; action of river, wind and glacier; oceans and oceanic features; earthquakes, volcanoes, orogeny and mountain building; elements of structural geology; crystallography; classification, composition and properties of minerals and rocks; engineering properties of rocks and soils, role of geology in the construction of engineering structures.

Processes of ore formation, occurrence and distribution of ores on land and on ocean floor; coal and petroleum resources in India; ground water geology including well hydraulics, geological time scale and geochronology; stratigraphic principles and stratigraphy of India; basics concepts of gravity, magnetic and electrical prospecting for ores and ground water.

PART - IIA: GEOLOGY

Crystal symmetry, forms, twinning; crystal chemistry; optical mineralogy, classification of minerals, diagnostic properties of rock minerals.

Mineralogy, structure, texture and classification of igneous, sedimentary and metamorphic rock, their origin and evolution; application of thermodynamics; structure and petrology of sedimentary rocks; sedimentary processes and environments, sedimentary facies, basin studies; basement cover relationship;

Primary and secondary structures; geometry and genesis of folds, faults, joints, unconformities, cleavage, schistosity and lineation; methods of projection. Tectonites and their significance; shear zone; superposed folding.

Morphology, classification and geological significance of important invertebrates, vertebrates, microfossils and palaeoflora; stratigraphic principles and Indian stratigraphy; geomorphic processes and agents; development and evolution of landforms; slope and drainage; processes on deep oceanic and near-shore regions; quantitative and applied geomorphology; air photo interpretation and remote sensing; chemical and optical properties of ore minerals; formation and localization of ore deposits; prospecting and exploration of economic minerals; coal and petroleum geology; origin and distribution of mineral and fuel deposits in India; ore dressing and mineral economics.

Cosmic abundance; meteorites; geochemical evolution of the earth; geochemical cycles; distribution of major, minor and trace elements; isotope geochemistry; geochemistry of waters including solution equilibria and water rock interaction.

Engineering properties of rocks and soils; rocks as construction material; geology of dams, tunnels and excavation sites; natural hazards; the fly ash problem; ground water geology and exploration; water quality; impact of human activity; Remote sensing techniques for the interpretation of landforms and resource management.

PART - II B: GEOPHYSICS

The earth as a planet; different motions of the earth; gravity filed of the earth and its shape; geochronology; isostasy, seismology and interior of the earth; variation of density, velocity, pressure, temperature, electrical and magnetic properties inside the earth; earthquakes-causes and measurements; zonation and seismic hazards; geomagnetic field, palaeomagnetism; oceanic and continental lithosphere; plate tectonics; heat flow; upper and lower atmospheric phenomena.

Theories of scalar and vector potential fields; Laplace, Maxwell and Helmholtz equations for solution of different types of boundary value problems for Cartesian, cylindrical and spherical polar coordinates; Green's theorem; Image theory; integral equations and conformal transformations in potential theory; Eikonal equation and ray theory.

'G' and 'g' units of measurement, density of rocks, gravimeters, preparation, analysis and interpretation of gravity maps; derivative maps, analytical continuation; gravity anomaly type curves; calculation of mass.

Earth's magnetic field, units of measurement, magnetic susceptibility of rocks, magnetometers, corrections, preparation of magnetic maps, magnetic anomaly type curve, analytical continuation, interpretation and application; magnetic well logging.

Conduction of electricity through rocks, electrical conductivities of metals, metallic, non-metallic and rock forming minerals, D.C. resistivity units and methods of measurement, electrode configuration for sounding and profiling, application of filter theory, interpretation of resistivity field data, application; self potential origin, classification, field measurement, interpretation of induced polarization time frequency, phase domain; IP units and methods of measurement, interpretation and application; ground-water exploration.

Origin of electromagnetic field elliptic polarization, methods of measurement for different source-receiver configuration components in EM measurements, interpretation and applications; earth's natural electromagnetic field, tellurics, magneto-tellurics; geomagnetic depth sounding principles, methods of measurement, processing of data and interpretation.

Seismic methods of prospecting: Reflection, refraction and CDP surveys; land and marine seismic sources, generation and propagation of elastic waves, velocity increasing with depth, geophones, hydrophones, recording instruments (DFS), digital formats, field layouts, seismic noises and noise profile analysis, optimum geophone grouping, noise cancellation by shot and geophone arrays, 2D and 3D seismic data acquisition and processing, CDP stacking charts, binning, filtering, dip-moveout, static and dynamic corrections, deconvolution, migration, signal processing, Fourier and Hilbert transforms, attribute analysis, bright and dim spots, seismic stratigraphy, high resolution seismics, VSP.

Principles and techniques of geophysical well-logging, SP, resistivity, induction, micro gamma ray, neutron, density, sonic, temperature, dip meter, caliper, nuclear magnetic, cement bond logging. Quantitative evaluation of formations from well logs; well hydraulics and application of geophysical methods for groundwater study; application of bore hole geophysics in ground water, mineral and oil exploration. Remote sensing techniques and application of remote sensing methods in geophysics.

IN - INSTRUMENTATION ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix Algebra, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Mean value theorems, Theorems of integral calculus, Evaluation of definite and improper integrals, Partial Derivatives, Maxima and minima, Multiple integrals, Fourier series. Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equation (linear and nonlinear), Higher order linear differential equations with constant coefficients, Method of variation of parameters, Cauchy's and Euler's equations, Initial and boundary value problems, Partial Differential Equations and variable separable method.

Complex variables: Analytic functions, Cauchy's integral theorem and integral formula, Taylor's and Laurent' series, Residue theorem, solution integrals.

Probability and Statistics: Sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Discrete and continuous distributions, Poisson, Normal and Binomial distribution, Correlation and regression analysis.

Numerical Methods: Solutions of non-linear algebraic equations, single and multi-step methods for differential equations.

Transform Theory: Fourier transform, Laplace transform, Z-transform.

INSTRUMENTATION ENGINEERING

Measurement Basics and Metrology: Static and dynamic characteristics of measurement systems. Standards and calibration. Error and uncertainty analysis, statistical analysis of data, and curve fitting. Linear and angular measurements; Measurement of straightness, flatness, roundness and roughness.

Transducers, Mechanical Measurements and Industrial Instrumentation: Transducers - elastic, resistive, inductive, capacitive, thermo-electric, piezoelectric, photoelectric, electro-mechanical, electro-chemical, and ultrasonic. Measurement of displacement, velocity (linear and rotational), acceleration, shock, vibration, force, torque, power, strain, stress, pressure, flow, temperature, humidity, viscosity, and density. energy storing elements, suspension systems and dampers.

Analog Electronics: Characteristics of diodes, BJTs, JFETs and MOSFETs; Diode circuits; Amplifiers: single and multi-stage, feedback; Frequency response; Operational amplifiers - design, characteristic, linear and non-linear applications: difference amplifiers; instrumentation amplifiers; precision rectifiers, I-to-V converters, active filters, oscillators, comparators, signal generators, wave shaping circuits.

Digital Electronics: Combinational logic circuits, minimization of Boolean functions; IC families (TTL, MOS, CMOS), arithmetic circuits, multiplexer and decoders. Sequential circuits: flip-flops, counters, shift registers. Schmitt trigger, timers, and multivibrators. Analog switches, multiplexers, S/H circuits. Analog-to-digital and digital-to-analog converters. Basics of computer organization and architecture. 8-bit microprocessor (8085), applications, memory, I/O interfacing, and microcontrollers.

Signals and Systems: Vectors and matrices; Fourier series; Fourier transforms; Ordinary differential equations. Impulse and frequency responses of first and second order systems. Laplace transform and transfer function, convolution and correlation. Amplitude and frequency modulations and demodulations. Discrete time systems, difference equations, impulse and frequency responses; Z-transforms and transfer functions; IIR and FIR filters.

Electrical and Electronic Measurements: Measurement of R, L and C; bridges and potentiometers. Measurement of voltage, current, power, power factor, and energy; Instrument transformers; Q meter, waveform analyzers. Digital volt-meters and multi-meters. Time, phase and frequency measurements; Oscilloscope. Noise and interference in instrumentation.

Control Systems & Process Control: Principles of feedback; transfer function, signal flow graphs. Stability criteria, Bode plots, root-loci, Routh and Nyquist criteria. Compensation techniques; State space analysis. System components: mechanical, hydraulic, pneumatic, electrical and electronic; Servos and synchros; Stepper motors. On-off, cascade, P, PI, PID and feed-forward controls. Controller tuning and general frequency response.

Analytical, Optical and Biomedical Instrumentation: Principles of spectrometry, UV, visible, IR mass spectrometry, X-ray methods; nuclear radiation measurements, gas, solid and semi conductor lasers and their characteristics, interferometers, basics of fibre optics, transducers in biomedical applications, cardiovascular system measurements, instrumentation for clinical laboratory.

MA - MATHEMATICS

Linear Algebra: Finite dimensional vector spaces. Linear transformations and their matrix representations, rank; systems of linear equations, eigenvalues and eigenvectors, minimal polynomial, Cayley-Hamilton theorem, diagonalisation, Hermitian, Skew-Hermitian and unitary matrices. Finite dimensional inner product spaces, self-adjoint and Normal linear operators, spectral theorem, Quadratic forms.

Complex Analysis: Analytic functions, conformal mappings, bilinear transformations, complex integration: Cauchy's integral theorem and formula, Liouville's theorem, maximum modulus principle, Taylor and Laurent's series, residue theorem and applications for evaluating real integrals.

Real Analysis: Sequences and series of functions, uniform convergence, power series, Fourier series, functions of several variables, maxima, minima, multiple integrals, line, surface and volume integrals, theorems of Green, Stokes and Gauss; metric spaces, completeness, Weierstrass approximation theorem, compactness. Lebesgue measure, measurable functions; Lebesgue integral, Fatou's lemma, dominated convergence theorem.

Ordinary Differential Equations: First order ordinary differential equations, existence and uniqueness theorems, systems of linear first order ordinary differential equations, linear ordinary differential equations of higher order with constant coefficients; linear second order ordinary differential equations with variable coefficients, method of Laplace transforms for solving ordinary differential equations, series solutions; Legendre and Bessel functions and their orthogonality, Sturm Liouville system, Greeen's functions.

Algebra: Normal subgroups and homomorphisms theorems, automorphisms. Group actions, sylow's theorems and their applications groups of order less than or equal to 20, Finite p-groups. Euclidean domains, Principal ideal domains and unique factorizations domains. Prime ideals and maximal ideals in commutative rings.

Functional Analysis: Banach spaces, Hahn-Banach theorems, open mapping and closed graph theorems, principle of uniform boundedness; Hilbert spaces, orthonormal sets, Riesz representation theorem, self-adjoint, unitary and normal linear operators on Hilbert Spaces.

Numerical Analysis: Numerical solution of algebraic and transcendental equations; bisection, secant method, Newton-Raphson method, fixed point iteration, interpolation: existence and error of polynomial interpolation, Lagrange, Newton, Hermite(osculatory)interpolations; numerical differentiation and integration, Trapezoidal and Simpson rules; Gaussian quadrature; (Gauss-Legendre and Gauss-Chebyshev), method of undetermined parameters, least square and orthonormal polynomial approximation; numerical solution of systems of linear equations: direct and iterative methods, (Jacobi Gauss-Seidel and SOR) with convergence; matrix eigenvalue problems: Jacobi and Given's methods, numerical solution of ordinary differential equations: initial value problems, Taylor series method, Runge-Kutta methods, predictor-corrector methods; convergence and stability.

Partial Differential Equations: Linear and quasilinear first order partial differential equations, method of characteristics; second order linear equations in two variables and their classification; Cauchy, Dirichlet and Neumann problems, Green's functions; solutions of Laplace, wave and diffusion equations in two variables Fourier series and transform methods of solutions of the above equations and applications to physical problems.

Mechanics: Forces in three dimensions, Poinsot central axis, virtual work, Lagrange's equations for holonomic systems, theory of small oscillations, Hamiltonian equations;

Topology: Basic concepts of topology, product topology, connectedness, compactness, countability and separation axioms, Urysohn's Lemma, Tietze extension theorem, metrization theorems, Tychonoff theorem on compactness of product spaces.

Probability and Statistics: Probability space, conditional probability, Bayes' theorem, independence, Random variables, joint and conditional distributions, standard probability distributions and their properties, expectation, conditional expectation, moments. Weak and strong law of large numbers, central limit theorem. Sampling distributions, UMVU estimators, sufficiency and consistency, maximum likelihood estimators. Testing of hypotheses, Neyman-Pearson tests, monotone likelihood ratio, likelihood ratio tests, standard parametric tests based on normal, X2 ,t, F-distributions. Linear regression and test for linearity of regression. Interval estimation.

Linear Programming: Linear programming problem and its formulation, convex sets their properties, graphical method, basic feasible solution, simplex method, big-M and two phase methods, infeasible and unbounded LPP's, alternate optima. Dual problem and duality theorems, dual simplex method and its application in post optimality analysis, interpretation of dual variables. Balanced and unbalanced transportation problems, unimodular property and u-v method for solving transportation problems. Hungarian method for solving assignment problems.

Calculus of Variations and Integral Equations: Variational problems with fixed boundaries; sufficient conditions for extremum, Linear integral equations of Fredholm and Volterra type, their iterative solutions. Fredholm alternative.

ME - MECHANICAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative,

Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

APPLIED MECHANICS AND DESIGN

Engineering Mechanics: Equivalent force systems, free-body concepts, equations of equilibrium, trusses and frames, virtual work and minimum potential energy. Kinematics and dynamics of particles and rigid bodies, impulse and momentum (linear and angular), energy methods, central force motion.

Strength of Materials: Stress and strain, stress-strain relationship and elastic constants, Mohr's circle for plane stress and plane strain, shear force and bending moment diagrams, bending and shear stresses, deflection of beams, torsion of circular shafts, thin and thick cylinders, Euler's theory of columns, strain energy methods, thermal stresses.

Theory of Machines: Displacement, velocity and acceleration, analysis of plane mechanisms, dynamic analysis of slider-crank mechanism, planar cams and followers, gear tooth profiles, kinematics of gears, governors and flywheels, balancing of reciprocating and rotating masses.

Vibrations: Free and forced vibration of single degree freedom systems, effect of damping, vibration isolation, resonance, critical speed of rotors.

Design of Machine Elements: Design for static and dynamic loading, failure theories, fatigue strength; design of bolted, riveted and welded joints; design of shafts and keys; design of spur gears, rolling and sliding contact bearings; brakes and clutches; belt, rope and chain drives.

FLUID MECHANICS AND THERMAL SCIENCES

Fluid Mechanics: Fluid properties, fluid statics, manometry, buoyancy; control-volume analysis of mass, momentum and energy; fluid acceleration; differential equations of continuity and momentum; Bernoulli's equation; viscous flow of incompressible fluids; boundary layer; elementary turbulent flow; flow through pipes, head losses in pipes, bends etc.

Heat-Transfer: Modes of heat transfer; one dimensional heat conduction, resistance concept, electrical analogy, unsteady heat conduction, fins; dimensionless parameters in free and forced convective heat transfer, various correlations for heat transfer in flow over flat plates and through pipes; thermal boundary layer; effect of turbulence; radiative heat transfer, black and grey surfaces, shape factors, network analysis; heat exchanger performance, LMTD and NTU methods.

Thermodynamics: Zeroth, First and Second laws of thermodynamics; thermodynamic system and processes; irreversibility and availability; behaviour of ideal and real gases, properties of pure substances, calculation of work and heat in ideal processes; analysis of thermodynamic cycles related to energy conversion; Carnot, Rankine, Otto, Diesel, Brayton and vapour compression cycles.

Power Plant Engineering: Steam generators; steam power cycles; steam turbines; impulse and reaction principles, velocity diagrams, pressure and velocity compounding; reheating and reheat factor; condensers and feed heaters.

I.C. Engines: Requirements and suitability of fuels in IC engines, fuel ratings, fuel-air mixture requirements; normal combustion in SI and CI engines; engine performance calculations.

Refrigeration and air-conditioning: Refrigerant compressors, expansion devices, condensers and evaporators; properties of moist air, psychrometric chart, basic psychometric processes.

Turbomachinery: Components of gas turbines; compression processes, centrifugal and axial flow compressors; axial flow turbines, elementary theory; hydraulic turbines; Euler-turbine equation; specific speed, Pelton-wheel, Francis and Kaplan turbines; centrifugal pumps.

MANUFACTURING AND INDUSTRIAL ENGINEERING

Engineering Materials: Structure and properties of engineering materials and their applications, heat treatment.

Metal Casting: Casting processes (expendable and non-expendable) -pattern, moulds and cores, heating and pouring, solidification and cooling, gating design, design considerations, defects.

Forming Processes: Stress-strain diagrams for ductile and brittle material, Plastic deformation and yield criteria, fundamentals of hot and cold working processes, Bulk metal forming processes (forging, rolling, extrusion, drawing), sheet metal working processes (punching, blanking, bending, deep drawing, coining, spinning, load estimation using homogeneous deformation methods, defects). processing of powder metals- atomization, compaction, sintering, secondary and finishing operations. forming and shaping of plastics- extrusion, injection moulding.

Joining Processes: Physics of welding, fusion and non-fusion welding processes, brazing and soldering, adhesive bonding, design considerations in welding, weld quality defects.

Machining and Machine Tool Operations: Mechanics of machining, single and multi-point cutting tools, tool geometry and materials, tool life and wear, cutting fluids, machinability, economics of machining, non-traditional machining processes.

Metrology and Inspection: Limits, fits and tolerances, linear and angular measurements, comparators, gauge design, interferometry, form and finish measurement, measurement of screw threads, alignment and testing methods.

Tool Engineering: Principles of work holding, design of jigs and fixtures.

Computer Integrated Manufacturing: Basic concepts of CAD, CAM and their integration tools.

Manufacturing Analysis: Part-print analysis, tolerance analysis in manufacturing and assembly, time and cost analysis.

Work-Study: Method study, work measurement, time study, work sampling, job evaluation, merit rating.

Production Planning and Control: Forecasting models, aggregate production planning, master scheduling, materials requirements planning.

Inventory Control: Deterministic and probabilistic models, safety stock inventory control systems.

Operations Research: Linear programming, simplex and duplex method, transportation, assignment, network flow models, simple queuing models, PERT and CPM

MN - MINING ENGINEERING

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

MINING ENGINEERING

Mechanics: Equivalent force systems, equations of equilibrium, two dimensional frames and trusses, free body diagrams, friction forces, particle kinematics and dynamics.

Mine Development, Geomechanics and Strata Control: Drivages for underground mine development, drilling methods and machines, explosives, blasting devices and practices, shaft sinking. Physico-mechanical properties of rocks, rock mass classification, ground control instrumentation and stress measurement techniques, theories of rock failure, ground vibrations, stress distribution around mine openings, subsidence, design of supports in roadways and workings, stability of open pits, slopes.

Mining Methods and Machinery: Surface mining - layout, development, loading, transportation and mechanization, continuous surface mining systems. Underground coal mining - bord and pillar system, longwall mining, thick seam mining methods. Underground metal mining: different stoping methods, stope mechanization, ore handling systems, mine filling. Generation and transmission of mechanical, hydraulic, and pneumatic power. Materials handling - haulages, conveyors, ropeways, face and development machinery, hoisting systems, and pumps.

Ventilation, Underground Hazards and Surface Environment: Underground atmosphere, heat load sources and thermal environment, air cooling, mechanics of air flow distribution, natural and mechanical ventilation, mine fans and their usage, auxiliary ventilation. Subsurface hazards from fires, explosions, gases, dust, and inundation, rescue apparatus and practices, safety in mines, accident analysis, noise, mine lighting. Air and water pollution: causes, dispersion, quality standards, and control.

Surveying, Mine Planning and Systems Engineering: Fundamentals of engineering surveying, Levels and levelling, Theodolite, tacheometry, triangulation, contouring, errors and adjustments, correlation, underground surveying, curves, photogrammetry, field astronomy, GPS fundamentals. Principles of planning - Sampling methods and practices, reserve estimation techniques, basics of geostatistics, optimization of facility location, cash flow concepts and mine valuation, open pit design. Work study, concepts of reliability, reliability of series and parallel systems. Linear programming, transportation and assignment problems, queueing, network analysis, inventory control.

MT - METALLURGICAL ENGINEERING

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

METALLURGICAL ENGINEERING

Thermodynamics and Rate Processes: Laws of thermodynamics, activity, equilibrium constant, applications to metallurgical systems, solutions, phase equilibria, basic kinetic laws, order of reactions, rate constants and rate limiting steps principles of electro chemistry, aqueous, corrosion and protection of metals, oxidation and high temperature corrosion - characterization and control; momentum transfer - concepts of viscosity, shell balances, Bernoulli's equation; heat transfer - conduction, convection and heat transfer coefficient relations, radiation, mass transfer - diffusion and Fick's laws.

Extractive Metallurgy: Flotation, gravity and other methods of mineral processing; agglomeration, pyro-hydro-and electro-metallurgical processes; material and energy balances; principles and processes for the extraction of non-ferrous metals - aluminium, copper, zinc, lead, magnesium, nickel, titanium and other rare metals; iron and steel making - principles, blast furnace, direct reduction processes, primary and secondary steel making, deoxidation and inclusion in steel; ingot and continuous casting; stainless steel making, design of furnaces; fuels and refractories.

Physical Metallurgy: Crystal structure and bonding characteristics of metals, alloys, ceramics and polymers; solid solutions; solidification; phase transformation and binary phase diagrams; principles of heat treatment of steels, aluminum alloys and cast irons; recovery, recrystallization and grain growth; industrially important ferrous and non-ferrous alloys; elements of X-ray and electron diffraction; principles of scanning and transmission electron microscopy; elements of ceramics, composites and electronic materials; electronic basis of thermal, optical, electrical and magnetic properties of materials.

Mechanical Metallurgy: Elements of elasticity and plasticity; defects in crystals; elements of dislocation theory - types of dislocations, slip and twinning, stress fields of dislocations, dislocation interactions and reactions, methods of seeing dislocations; strengthening mechanisms; tensile, fatigue and creep behaviour; superplasticity; fracture - Griffith theory, ductile to brittle transition, fracture toughness; failure analysis; mechanical testing - tension, compression, torsion, hardness, impact, creep, fatigue, fracture toughness and formability tests.

Manufacturing Processes: Metal casting - patterns, moulds, melting, gating, feeding and casting processes, defects and castings, hot and cold working of metals; Metal forming - fundamentals of metal forming, rolling wire drawing, extrusion, forming, sheet metal forming processes, defects in forming; Metal joining - soldering, brazing and welding, common welding processes, welding metallurgy, problems associated with welding of steels and aluminium alloys, defects in welding, powder metallurgy; NDT methods - ultrasonic, radiography, eddy current, acoustic emission and magnetic.

PH - PHYSICS

Mathematical Physics: Linear vector space, matrices; vector calculus; linear differential equations; elements of complex analysis; Laplace transforms, Fourier analysis, elementary ideas about tensors.

Classical Mechanics: Conservation laws; central forces; collisions and scattering in laboratory and centre of mass reference frames; mechanics of system of particles; rigid body dynamics; moment of inertia tensor; noninertial frames and pseudo forces; variational principle; Lagrange's and Hamilton's formalisms; equation of motion, cyclic coordinates, Poisson bracket; periodic motion, small oscillations, normal modes; wave equation and wave propagation; special theory of relativity - Lorentz transformations, relativistic kinematics, mass-energy equivalence.

Electromagnetic Theory: Laplace and Poisson equations; conductors and dielectrics; boundary value problems; Ampere's and Biot-Savart's laws; Faraday's law; Maxwell's equations; scalar and vector potentials; Coulomb and Lorentz gauges; boundary conditions at interfaces; electromagnetic waves; interference, diffraction and polarization; radiation from moving charges.

Quantum Mechanics: Physical basis of quantum mechanics; uncertainty principle; Schrodinger equation; one and three dimensional potential problems; Particle in a box, harmonic oscillator, hydrogen atom; linear vectors and operators in Hilbert space; angular momentum and spin; addition of angular momentum; time independent perturbation theory; elementary scattering theory.

Atomic and Molecular Physics: Spectra of one-and many-electron atoms; LS and jj coupling; hyperfine structure; Zeeman and Stark effects; electric dipole transitions and selection rules; X-ray spectra; rotational and vibrational spectra of diatomic molecules; electronic transition in diatomic molecules, Franck-Condon principle; Raman effect; NMR and ESR; lasers.

Thermodynamics and Statistical Physics: Laws of thermodynamics; macrostates, phase space; probability ensembles; partition function, free energy, calculation of thermodynamic quantities; classical and quantum statistics; degenerate Fermi gas; black body radiation and Planck's distribution law; Bose-Einstein condensation; first and second order phase transitions, critical point.

Solid State Physics: Elements of crystallography; diffraction methods for structure determination; bonding in solids; elastic properties of solids; defects in crystals; lattice vibrations and thermal properties of solids; free electron theory; band theory of solids; metals, semiconductors and insulators; transport properties; optical, dielectric and magnetic properties of solids; elements of superconductivity.

Nuclear and Particle Physics: Rutheford scattering; basic properties of nuclei; radioactive decay; nuclear forces; two nucleon problem; nuclear reactions; conservation laws; fission and fusion; nuclear models; particle accelerators, detectors; elementary particles; photons, baryons, mesons and leptons; Quark model.

Electronics: Network analysis; semiconductor devices; bipolar transistors; FETs; power supplies, amplifier, oscillators; operational amplifiers; elements of digital electronics; logic circuits.

PI - PRODUCTION AND INDUSTRIAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

GENERAL ENGINEERING:

Engineering Materials: Structure and properties of engineering materials and their applications; effect of strain, strain rate and temperature on mechanical properties of metals and alloys; heat treatment of metals and alloys.

Applied Mechanics: Engineering mechanics - equivalent force systems, free body concepts, equations of equilibrium, virtual work and minimum potential energy; strength of materials-stress, strain and their relationship, Mohr's circle, deflection of beams, bending and shear stress, Euler's theory of columns.

Theory of Machines and Design: Analysis of planar mechanisms, plane cams and followers; governers and fly wheels; design of elements-failure theories; design of bolted, riveted and welded joints; design of shafts, keys, belt drives, brakes and clutches.

Thermal Engineering: Fluid machines - fluid statics, Bernoulli's equation, flow through pipes, equations of continuity and momentum; Thermodynamics - zeroth, First and Second laws of thermodynamics, thermodynamic system and processes, calculation of work and heat for systems and control volumes; Heat transfer - fundamentals of conduction, convection and radiation.

PRODUCTION ENGINEERING

Metal Casting: Casting processes; patterns-materials; allowances; moulds and cores - materials, making and testing; melting and founding of cast iron, steels and nonferrous metals and alloys; solidification; design of casting, gating and risering; casting defects and inspection.

Metal working: Stress-strain in elastic and plastic deformation; deformation mechanisms; hot and cold working-forging, rolling, extrusion, wire and tube drawing; sheet metal working; analysis of rolling, forging, extrusion and wire /rod drawing; metal working defects, high energy rate forming processes-explosive, magnetic, electro and electrohydraulic.

Metal Joining Processes: Welding processes - gas shielded metal arc, TIG, MIG, submerged arc, electroslag, thermit, resistance, pressure and forge welding; thermal cutting; other joining processes - soldering, brazing, braze welding; welding codes, welding symbols, design of welded joints, defects and inspection; introduction to modern welding processes - friction, ultrasonic, explosive, electron beam, laser and plasma.

Machining and Machine Tool Operations: Machining processes-turning, drilling, boring, milling, shaping, planing, sawing, gear cutting, thread production, broaching, grinding, lapping, honing super finishing; mechanics of cutting- Merchant's analysis, geometry of cutting tools, cutting forces, power requirements; selection of process parameters; tool materials, tool wear and tool life, cutting fluids, machinability; nontraditional machining processes and hybrid processes- EDM, CHM, ECM, USM, LBM, EBM, AJM, PAM AND WJM; economics of machining.

Metrology and Inspection: Limits and fits, linear and angular measurements by mechanical and optical methods, comparators; design of limit gauges; interferometry; measurement of straightness, flatness, roundness, squareness and symmetry; surface finish measurement; inspection of screw threads and gears; alignment testing.

Powder Metallurgy and Processing of Plastics: Production of powders, compaction, sintering; Polymers and composites; injection, compression and blow molding, extrusion, calendaring and thermoforming; molding of composites.

Tool Engineering: Work-holding-location and clamping; principles and methods; design of jigs and fixtures; design of press working tools, forging dies.

Manufacturing Analysis: Sources of errors in manufacturing; process capability; part-print analysis; tolerance analysis in manufacturing and assembly; process planning; parameter selection and comparison of production alternatives; time and cost analysis; Issues in choosing manufacturing technologies and strategies.

Computer Integrated Manufacturing: Basic concepts of CAD, CAM, CAPP, group technology, NC, CNC, DNC, FMS, Robotics and CIM.

INDUSTRIAL ENGINEERING

Product Design and Development: Principles of good product design, component and tolerance design; efficiency, quality and cost considerations; product life cycle; standardization, simplification, diversification, value analysis, concurrent engineering.

Engineering Economy and Costing: Financial statements; elementary cost accounting, methods of depreciation; break-even analysis, techniques for evaluation of capital investments.

Work System Design: Taylor's scientific management, Gilbreths's contributions; productivity concepts and measurements; method study, micro-motion study, principles of motion economy; human factors engineering, ergonomics; work measurement - time study, PMTS, work sampling; job evaluation, merit rating, wage administration, incentive systems; business process reengineering.

Logistics and Facility Design: Facility location factors, evaluation of alternatives, types of plant layout, evaluation; computer aided layout; assembly line balancing; material handling systems; supply chain management.

Production Planning and Inventory Control: Inventory Function costs, classifications - deterministic and probabilistic models; quantity discount; safety stock; inventory control system; Forecasting techniques - causal and time series models, moving average, exponential smoothing; trend and seasonality; aggregate production planning; master scheduling; bill of materials and material requirement planning; order control and flow control, routing, scheduling and priority dispatching; JIT; Kanban PULL systems; bottleneck scheduling and theory of constraints.

Operation Research: Linear programming - problem formulation, simplex method, duality and sensitivity analysis; transportation; assignment; network flow models, constrained optimization and Lagrange multipliers; simple queuing models; dynamic programming; simulation; PERT and CPM, time-cost trade-off, resource leveling.

Quality Control: Taguchi method; design of experiments; quality costs, statistical quality assurance, process control charts, acceptance sampling, zero defects; quality circles, total quality management.

Reliability and Maintenance: Reliability, availability and maintainability; probabilistic failure and repair times; system reliability; preventive maintenance and replacement, TPM.

Management Information System: Value of information; information storage and retrieval system - database and data structures; interactive systems; knowledge based systems.

Intellectual Property System: Definition of intellectual property, importance of IPR; TRIPS, and its implications, WIPO and Global IP structure, and IPS in India; patent, copyright, industrial design and trademark; meanings, rules and procedures, terms, infringements and remedies.

PY - PHARMACEUTICAL SCIENCES

Natural Products: Pharmacognosy & Phytochemistry - Chemistry, tests, isolation, characterization and estimation of phytopharmaceuticals belonging to the group of Alkaloids, Glycosides, Terpenoids, Steroids, Bioflavanoids, Purines, Guggul lipids. Pharmacognosy of crude drugs which contain the above constituents. Standardisation of raw materials and herbal products. WHO guide lines. Quantitative microscopy including modern techniques used for evaluation. Biotechnological principles and techniques for plant development Tissue culture.

Pharmacology: General pharmacological principles including Toxicology. Drug interaction. Pharmacology of drugs acting on Central nervous system, Cardiovascular system, Autonomic nervous system, Gastro intestinal system and Respiratory system. Pharmacology of Autocoids, Hormones, Chemotherapeutic agents including anticancer drugs. Bioassays. Immuno Pharmacology.

Medicinal Chemistry: Structure, nomenclature, classification, synthesis, SAR and metabolism of the following category of drugs which are official in Indian Pharmacopoeia and British Pharmacopoeia Hypnotics and Sedatives, Analgesics, NSAIDS, Neuroleptics, Antidepressants, Anxiolytics, Anticonvulsants, Antihistaminics, Local anaesthetics, Cardio Vascular drugs - Antianginal agents Vasodilators, Adrenergic & cholinergic drugs, Cardiotonic agents, Diuretics, Antihypertensive drugs, Hypoglycemic agents, Antilipedmic agents, Coagulants, Anticoagulants, Antiplatelet agents. Chemotherapeutic agents - Antibiotics, Antibacterials, Sulphadrugs. Antiproliozoal drugs, Antiviral, Antitubercular, Antimalarial, Anticancer, Antiamoebic drugs. Diagnostic agents. Preparation and storage and uses of official Radiopharmaceuticals. Vitamins and Hormones.

Pharmaceutics: Development, manufacturing standards, labeling, packing as per the pharmacopoeal requirements, Storage of different dosage forms and new drug delivery systems. Biopharmaceutics and Pharmacokinetics and their importance in formulation. Formulation and preparation of cosmetics - lipstick, shampoo, creams, nail preparations and dentifrices. Pharmaceutical calculations.

Pharmaceutical Jurisprudence: Legal aspects of manufacture, storage, sale of drugs. D and C act and rules. Pharmacy act.

Pharmaceutical Analysis: Principles, instrumentation and applications of the following. Absorption spectroscopy (UV, visible & IR), Fluorimetry, Flame photometry, Potentiometry, Conductometry and Plarography. Pharmacopoeial assays. Principles of NMR, ESR, Mass spectroscopy, X-ray diffraction analysis and different chromatographic methods.

Biochemistry and Clinical Pharmacy: Biochemical role of hormones, Vitamins, Enzymes, Nucleic acids. Bioenergetics. General principles of immunology. Immunological techniques. Adverse drug interaction.

Microbiology: Principles and methods of microbiological assays of the Pharmacopoeia. Methods of preparation of official sera and vaccines. Serological and diagnostic tests. Applications of microorganisms in Bio Conversions and in Pharmaceutical industry.

TF - TEXTILE ENGINEERING AND FIBRE SCIENCE

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

TEXTILE ENGINEERING & FIBRE SCIENCE

Textile Fibres: Classification of textile fibres according to their nature and origin; general characteristics of textile fibres-their chemical and physical structures and their properties; essential characteristics of fibre forming polymers; uses of natural and man-made fibres; physical and chemical methods of fibre and blend identification and blend analysis.

Melt Spinning processes with special reference to polyamide and polyester fibres; wet and dry spinning of viscose and acrylic fibres; post spinning operations-drawing, heat setting, texturing- false twist and air-jet, tow-to-top conversion. Methods of investigating fibre structure e.g. X-ray diffraction, birefringence, optical and electron microscopy, I.R. absorption, thermal methods; structure and morphology and principal natural and man-made fibres, mechanical properties of fibres, moisture sorption in fibres; fibre structure and property correlation.

Textile Testing: Sampling techniques, sample size and sampling errors; measurement of fibre length, fineness, crimp, strength and reflectance; measurement of cotton fibre maturity ad trash content; HVI and AFIS for fibre testing. Measurement of yarn count, twist and hairiness; tensile testing of fibres, yarn and fabrics; evenness testing of slivers, rovings and yarns; testing equipment for measurement test methods of fabric properties like thickness, compressibility, air permeability, drape, crease recovery, tear strength bursting strength and abrasion resistance. Correlation analysis, significance tests and analysis of variance; frequency distributions and control charts.

Yarn Manufacture and Yarn Structure: Modern methods of opening, cleaning and blending of fibrous materials; the technology of carding with particular reference to modern developments; causes of irregularity introduced by drafting, the development of modern drafting systems; principles and techniques of preparing material for combing; recent development in combers; functions and synchronization of various mechanisms concerned with roving production; forces acting on yarn and traveller, ring and traveller designs; causes of end breakages; properties of doubles yarns; new methods of yarn production such as rotor spinning, air jet spinning and friction spinning.

Yarn diameter; specific volume, packing coefficient; twist-strength relationship; fibre orientation in yarn; fibre migration.

Fabric Manufacture and Fabric Structure: Principles of cheese and cone winding processes and machines; random and precision winding; package faults and their remedies; yarn clearers and tensioners; different systems of yarn splicing; features of modern cone winding machines; different types of warping creels; features of modern beam and sectional warping machines; different sizing systems, sizing of spun and filament yarns, modern sizing machines; principles of pirn winding processes and machines; primary and secondary motions of loom, effect of their settings and timings on fabric formation, fabric appearance and weaving performance; dobby and jacquard shedding; mechanics of weft insertion with shuttle; warp and weft stop motions, warp protection, weft replenishment; functional principles of weft insertion systems of shuttleless weaving machines, principles of multiphase and circular looms. Principles of weft and warp knitting; basic weft and warp knitted structures; classification, production and areas of application of nonwoven fabrics.

Basic woven fabric constructions and their derivatives; crepe, cord, terry, gauze, lino and double cloth constructions.

Peirce's equations for fabric geometry; thickness, cover and maximum sett of woven fabrics

Textile Chemical Processing: Preparatory processes for natural-and and their blends; mercerization of cotton; machines for yarn and fabric mercerization.

Dyeing and printing of natural- and synthetic- fibre fabrics and their blends with different dye classes; dyeing and printing machines; styles of printing; fastness properties of dyed and printed textile materials.

Finishing of textile materials, wash and wear, durable press, soil release, water repellent, flame retardant and antistatic finishes; shrink-resistance finish for wool; heat setting of synthetic-fibre fabrics, finishing machines; energy efficient processes; pollution control.

XE - ENGINERING SCIENCES

The syllabi of the sections of this paper are as follows:

SECTION A. ENGINEERING MATHEMATICS (Compulsory)

Linear Algebra : Determinates, algebra of matrices, rank, inverse, system of linear equations, symmetric, skew-symmetric and orthogonal matrices. Hermitian, skew-hermitian and unitary matrices. eigenvalues and eigenvectors, diagonalisation of matrices, Cayley-Hamiltonian, quadratic forms.

Calculus : Functions of single variables, limit, continuity and differentiability, Mean value theorems, Intermediate forms and L'Hospital rule, Maxima and minima, Taylor's series, Fundamental and mean value-theorems of integral calculus. Evaluation of definite and improper integrals, Beta and Gamma functions, Functions of two variables, limit, continuity, partial derivatives, Euler's theorem for homogeneous functions, total derivatives, maxima and minima, Lagrange method of multipliers, double and triple integrals and their applications, sequence and series, tests for convergence, power series, Fourier Series, Fourier integrals.

Complex variable: Analytic functions, Cauchy's integral theorem and integral formula without proof. Taylor's and Laurent' series, Residue theorem (without proof) with application to the evaluation of real integarls.

Vector Calculus: Gradient, divergence and curl, vector identities, directional derivatives, line, surface and volume integrals, Stokes, Gauss and Green's theorems (without proofs) with applications.

Ordinary Differential Equations: First order equation (linear and nonlinear), higher order linear differential equations with constant coefficients, method of variation of paramaters, Cauchy's and Euler's equations, initial and boundary value problems, power series solutions, Legendre polynomials and Bessel's functions of the first kind.

Partial Differential Equations: Variables separable method, solutions of one dimensional heat, wave and Laplace equations.

Probability and Statistics: Definitions of probability and simple theorems, conditional probability, mean, mode and standard deviation, random variables, discrete and continuous distributions, Poisson, normal and Binomial distribution, correlation and regression

Numerical Methods: L-U decomposition for systems of linear equations,Newton-Raphson method, numerical integration(trapezoidal and Simpson's rule), numerical methods for first order differential equation (Euler method)

SECTION B. COMPUTATIONAL SCIENCE

Numerical Methods: Truncation errors, round off errors and their propagation; Interpolation; Lagrange, Newton's forward, backward and divided difference formulas, least square curve fitting, solution of non-linear equations of one variables using bisection, false position, secant and Newton Raphson methods; Rate of convergence of these methods, general iterative methods. Simple and multiple roots of polynomials. Solutions of system of linear algebraic equations using Gauss elimination methods, Jacobi and Gauss-Seidel iterative methods and their rate of convergence; ill conditioned and well conditioned system. eigen values and eigen vectors using power methods. Numerical integration using trapezoidal, Simpson's rule and other quadrature formulas. Numerical Differentiation. Solution of boundary value problems. Solution of initial value problems of ordinary differential equations using Euler's method, predictor corrector and Runge Kutta method.

Programming : Elementary concepts and terminology of a computer system and system software, Fortran77 and C programming.

Fortran : Program organization, arithmetic statements, transfer of control, Do loops, subscripted variables, functions and subroutines.

C language : Basic data types and declarations, flow of control- iterative statement, conditional statement, unconditional branching, arrays, functions and procedures.

SECTION C. ELECTRICAL SCIENCES

Electric Circuits: Ideal voltage and current sources; RLC circuits, steady state and transient analysis of DC circuits, network theorems; alternating currents and voltages, single-phase AC circuits, resonance; three-phase circuits.

Magnetic circuits: Mmf and flux, and their relationship with voltage and current; transformer, equivalent circuit of a practical transformer, three-phase transformer connections.

Electrical machines: Principle of operation, characteristics, efficiency and regulation of DC and synchronous machines; equivalent circuit and performance of three-phase and single-phase induction motors.

Electronic Circuits: Characteristics of p-n junction diodes, zener diodes, bipolar junction transistors (BJT) and junction field effect transistors (JFET); MOSFET's structure, characteristics, and operations; rectifiers, filters, and regulated power supplies; biasing circuits, different configurations of transistor amplifiers, class A, B and C of power amplifiers; linear applications of operational amplifiers; oscillators; tuned and phase shift types.

Digital circuits: Number systems, Boolean algebra; logic gates, combinational circuits, flip-flops (RS, JK, D and T) counters.

Measuring instruments: Moving coil, moving iron, and dynamometer type instruments; shunts, instrument transformers, cathode ray oscilloscopes; D/A and A/D converters.

SECTION D. FLUID MECHANICS

Fluid Properties: Relation between stress and strain rate for Newtonian fluids

Hydrostatics, buoyancy, manometry

Concept of local and convective accelerations; control volume analysis for mass, momentum and energy conservation.

Differential equations of continuity and momentum (Euler's equation of motion); concept of fluid rotation, stream function, potential function; Bernoulli's equation and its applications.

Qualitative ideas of boundary layers and its separation; streamlined and bluff bodies; drag and lift forces.

Fully-developed pipe flow; laminar and turbulent flows; friction factor; Darcy Weisbach relation; Moody's friction chart; losses in pipe fittings; flow measurements using venturimeter and orifice plates.

Dimensional analysis; similitude and concept of dynamic similarity; importance of dimensionless numbers in model studies.

SECTION E. MATERIALS SCIENCE

Atomic structure and bonding in materials: metals, ceramics and polymers.

Structure of materials: Crystal systems, unit cells and space lattice; determination of structures of simple crystals by X-ray diffraction; Miller indices for planes and directions. Packing geometry in metallic, ionic and covalent solids.

Concept of amorphous, single and polycrystalline structures and their effects on properties of materials.

Imperfections in crystalline solids and their role in influencing various properties.

Fick´s laws of diffusion and applications of diffusion in sintering, doping of semiconductors and surface hardening of metals.

Alloys: solid solution and solubility limit. Binary phase diagram, intermediate phases and intermetallic compounds; iron-iron carbide phase diagram. Phase transformation in steels. Cold and hot working of metals, recovery, recrystallization and grain growth.

Properties and applications of ferrous and nonferrous alloys.

Structure, properties, processing and applications of traditional and advanced ceramics.

Polymers: classification, polymerization, structure and properties, additives for polymer products, processing and application.

Composites: properties and application of various composites.

Corrosion and environmental degradation of materials (metals, ceramics and polymers).

Mechanical properties of materials: Stress-strain diagrams of metallic, ceramic and polymeric materials, modulus of elasticity, yield strength, plastic deformation and toughness, tensile strength and elongation at break; viscoelasticity, hardness, impact strength. ductile and brittle fracture. creep and fatigue properties of materials.

Heat capacity, thermal conductivity, thermal expansion of materials.

Concept of energy band diagram for materials; conductors, semiconductors and insulators in terms of energy bands. Electrical conductivity, effect of temperature on conductivity in materials, intrinsic and extrinsic semiconductors, dielectric properties of materials.

Refraction, reflection, absorption and transmission of electromagnetic radiation in solids.

Origin of magnetism in metallic and ceramic materials, paramagnetism, diamagnetism, antiferromagnetism, ferromagnetism, ferrimagnetism in materials and magnetic hysteresis.

Advanced materials: Smart materials exhibiting ferroelectric, piezoelectric, optoelectronic, semiconducting behaviour; lasers and optical fibers; photoconductivity and superconductivity in materials.

SECTION F. SOLID MECHANICS

Equivalent force systems; free-body diagrams; equilibrium equations; analysis of determinate and indeterminate trusses and frames; friction.

Simple relative motion of particles; force as function of position, time and speed; force acting on a body in motion; laws of motion; law of conservation of energy; law of conservation of momentum

Stresses and strains; principal stresses and strains; Mohr's circle; generalized Hooke's Law; equilibrium equations; compatibility conditions; yield criteria.

Axial, shear and bending moment diagrams; axial, shear and bending stresses; deflection (for symmetric bending); torsion in circular shafts; thin cylinders; energy methods (Castigliano's Theorems); Euler buckling.

SECTION G. THERMODYNAMICS

Basic Concepts: Continuum, macroscopic approach, thermodynamic system (closed and open or control volume); thermodynamic properties and equilibrium; state of a system, state diagram, path and process; different modes of work; Zeroth law of thermodynamics; concept of temperature; heat.

First Law of Thermodynamics: Energy, enthalpy, specific heats, first law applied to systems and control volumes, steady and unsteady flow analysis.

Second Law of Thermodynamics: Kelvin-Planck and Clausius statements, reversible and irreversible processes, Carnot theorems, thermodynamic temperature scale, Clausius inequality and concept of entropy, principle of increase of entropy; availability and irreversibility.

Properties of Pure Substances: Thermodynamic properties of pure substances in solid, liquid and vapour phases, P-V-T behaviour of simple compressible substances, phase rule, thermodynamic property tables and charts, ideal and real gases, equations of state, compressibility chart.

Thermodynamic Relations: T-ds relations, Maxwell equations, Joule-Thomson coefficient, coefficient of volume expansion, adiabatic and isothermal compressibilities, Clapeyron equation.

Ideal Gas Mixtures: Dalton's and Amagat's laws, calculations of properties, air-water vapour mixtures.

XL - LIFE SCIENCES

The syllabi of the Sections of this paper are as follows:

SECTION H. CHEMISTRY (Compulsory)

Atomic structure and periodicity: Quantum chemistry; Planck's quantum theory, wave particle duality, uncertainty principle, quantum mechanical model of hydrogen atom; electronic configuration of atoms; periodic table and periodic properties; ionization energy, election affinity, electronegativity, atomic size.

Structure and bonding: Ionic and covalent bonding M.O. and V.B. approaches for diatomic molecules, VSEPR theory and shape of molecules, hybridisation, resonance, dipole moment, structure parameters such as bond length, bond angle and bond energy, hydrogen bonding, van der Waals interactions. Ionic solids; ionic radii, lattice energy (Born-Haber Cycle).

s.p. and d Block Elements: Oxides, halides and hydrides of alkali and alkaline earth metals, B, Al, S, N, P and S, silicones, general characteristics of 3d elements, coordination complexes: valence bond and crystal field theory, color, geometry and magnetic properties.

Chemical Equilibria: Colligative properties of solutions, ionic equilibria in solution, solubility product, common ion effect, hydrolysis of salts, pH, buffer and their applications in chemical analysis.

Electrochemistry: Conductance, Kohlrausch law, Half Cell potentials, emf, Nernst equation, galvanic cells, thermodynamic aspects and their applications.

Reaction Kinetics: Rate constant, order of reaction, molecularity, activation energy, zero, first and second order kinetics, equilibrium constants (Kc, Kp and Kx) for homogeneous reactions, catalysis and elementary enzyme reactions.

Thermodynamics: First law, reversible and irreversible processes, internal energy, enthalpy, Kirchoff's equation, heat of reaction, Hess law, heat of formation, Second law, entropy, free energy, and work function. Gibbs-Helmholtz equation, Clausius-Clapeyron equation, free energy change and equilibrium constant, Troutons rule, Third law of thermodynamics.

Mechanistic Basis of Organic Reactions: Elementary treatment of SN1, SN2, E1 and E2 reactions, Hoffmann and Saytzeff rules, Addition reactions, Markonikoff rule and Kharash effect, Diels-Alder reaction, aromatic electrophilic substitution, orientation effect as exemplified by various functional groups.

Structure-Reactivity Correlations: Acids and bases, electronic and steric effects, optical and geometrical isomerism, tautomerism, concept of aromaticity

SECTION I. BIOCHEMISTRY

Organization of life. Importance of water. Cell structure and organelles. Structure and function of biomolecules: Carbohydrates, Lipids, Proteins and Nucleic acids. Biochemical separation techniques. Spectroscopic methods; UV-visible and fluorescence. Protein structure, folding and function: Myoglobin, Hemoglobin, Lysozyme, ribonuclease A, Carboxypeptidase and Chymotrypsin. Enzyme kinetics and regulation, Coenzymes.

Metabolism and bioenergitics. Generation and utilization of ATP. Photosynthesis. Major metabolic pathways and their regulation. Biological membranes. Transport across membranes. Signal transduction; hormones and neurotransmitters.

DNA replication, transcription and translation. Biochemical regulation of gene expression. Recombinant DNA technology and applications. Genomics and Proteomics.

The immune system. Active and passive immunity. Complement system. Antobody structure, function and diversity. Cells of the immune system: T, B and macrophages. T and B cell activation. Major histocompatibilty complex. T cell receptor. Immunological techniques: Immunodiffusion, immunoelectrophoresis, RIA and ELISA.

SECTION J. BIOTECHNOLOGY

Recombinant DNA technology for the production of therapeutic proteins. Micro array technology. Heterologous protein expression systems in bacteria, yeast etc.

Architecture of plant genome; plant tissue culture techniques; methods of gene transfer into plant cells; manipulation of phenotypic traits in plants; plant cell fermentations and production of secondary metabolites using suspension/ immobilized cell culture; methods for plant micro propagation; crop improvement and development of transgenic plants. Expression of animal proteins in plants.

Animal cell metabolism and regulation; cell cycle; primary cell culture; nutritional requirements for animal cell culture; techniques for the mass culture of animal cell lines; production of vaccines; growth hormones and interferons using animal cell culture; cytokines-production and therapeutic uses; hybridoma technology; vectors for gene transfer and expression in animal cells. Transgenic animals and molecular pharming.

Microbial production of industrial enzymes; methods for immobilization of enzymes; kinetics of soluble and immobilized enzymes; application of soluble and immobilized enzymes; enzyme-based sensors.

Microbial growth kinetics; batch, fed batch and continuous culture of microbial cells; media for industrial fermentations; sterilization of air and media; design features and operation of stirred tank, air-lift and fluidized bed reactors; aeration and agitation in aerobic fermentations; recovery and purification of fermentation products- filtration, centrifugation, cell disintegration, solvent extraction and chromatographic separations; industrial fermentations for the production of ethanol, citric acid, lysine, penicillin and other biomolecules; simple calculations based on material and energy balance of fermentation processes; application of microbes in the management of domestic and industrial wastes.

SECTION K. BOTANY

Anatomy: Roots, stem and leaves of land plants, meristems, vascular system, their ontogeny, structure and functions. Plant cell structure, organisation, organelles, cytoskeleton, cell wall and membranes.

Development: Cell cycle, cell division, senescence, hormonal regulation of growth; life cycle of an angiosperm, pollination, fertilization, embryogenesis, seed formation, seed storage proteins, seed dormancy and germination. Concept of cellular totipotency, organogenesis and somatic embryogenesis, somaclonal variation, embryo culture, in vitro fertilization.

Physiology and Biochemistry: Plant water relations, transport of minerals and solutes, N2 metabolism, proteins and nucleic acid, respiration, photophysiology, photosynthesis, photorespiration; biosynthesis, mechanism of action and physiological effects of plant growth regulators.

Genetics: Principles of Mendelian inheritance, linkage, recombination and genetic mapping; extrachromosomal inheritance; eukaryotic genome organization (chromatin structure) and regulation of gene expression, gene mutation, chromosome aberrations (numerical and structural), transposons.

Plant Breeding: Principles, methods - selection, hybridization, heterosis; male sterility, self and inter-specific incompatibility; haploidy; somatic cell hybridization; molecular marker-assisted selection; gene transfer methods viz. direct and vector-mediated, transgenic plants and their applications in agriculture.

Economic Botany: Economically important plants - cereals, pulses, plants yielding fiber, timber, sugar, beverages, oils, rubber, dyes, gums, drugs and narcotics - a general account.

Systematics: Systems of classification (non-phylogenetic vs. phylogenetic - outline), plant groups, molecular systematics.

Plant Pathology: Nature and classification of plant diseases, diseases of important crops caused by fungi, bacteria and viruses, and their control measures, mechanism(s) of pathogenesis and resistance, molecular detection of pathogens; plant-microbe beneficial interactions.

Ecology and Plant Geography: Ecosystems - types, dynamics, degradation, ecological succession; food chains; vegetation types of the world; pollution and global warming; speciation and extinction, conservation strategies, cryopreservation.

SECTION L. MICROBIOLOGY

Historical perspective - Discovery of the microbial world; Controversy over spontaneous generation; Role of microorganisms in transformation of organic matter and in the causation of diseases.

Methods in microbiology - Pure culture techniques; Theory and practice of sterilization; Principles of microbial nutrition; Construction of culture media; Enrichment culture techniques for isolation of chemoautotrophs, chemoheterotrophs and photosynthetic microorganisms.

Microbial evolution, systematics and taxonomy - Evolution of earth and earliest life forms; Primitive organisms and their metabolic strategies; New approaches to bacterial taxonomic classification including ribotyping; Nomenclature.

Microbial diversity - Bacteria, archea and their broad classification; Eukaryotic microbes, yeast, fungi, slime mold and protozoa; Viruses and their classification.

Microbial growth -The definition of growth, mathematical expression of growth, growth curve, measurement of growth and growth yields; Synchronous growth; Continuous culture.

Nutrition and metabolism - Overview of metabolism; Microbial nutrition; Energy classes of microorganisms; Culture media; Energetics, modes of ATP generation; ATP generation by heterotrophs; Fermentation; Glycolysis; Respiration; The citric acid cycle; Electron transport systems; Alternate modes of energy generation; Pathways (anabolism) in the biosynthesis of amino acids, purines, pyrimidines and fatty acids.

Metabolic diversity among microorganisms - Photosynthesis in microorganisms; Role of chlorophylls, carotenoids and phycobilins; Calvin cycle; Chemolithotrophy; Hydrogen- iron-nitrite-oxidizing bacteria; Nitrate and sulfate reduction; Methanogenesis and acetogenesis.

Prokaryotic cells: structure-function - Cells walls of eubacteria (peptidoglycan) and related molecules; Outer-membrane of gram-negative bacteria; Cell wall and cell membrane synthesis; Flagella and motility; Cell inclusions like endospores, gas vesicles.

Microbial diseases and host parasite relationships - Normal microflora of skin; Oral cavity; Gastrointestinal tract; Entry of pathogens into the host; Infectious disease transmission; Respiratory infections caused by bacteria and viruses; Tuberculosis; Sexually transmitted diseases including AIDS; Diseases transmitted by animals (Rabies, plague), insects and ticks (rikettsias, Lyme disease, malaria); Food and water borne diseases; Public health and water quality; Pahtogenic fungi; Emerging and resurgent infectious diseases.

Chemotherapy/Antibiotics - Antimicrobial agents; Sulfa drugs; Antibiotics; Pencillins and cephalosporins; Broad-spectrum antibiotics; Antibiotics from prokaryotes; Antifungal antibiotics; Mode of action; Resistance to antibiotics.

Microbial genetics - Genes, mutation and mutagenesis - UV and chemical mutagnes; Types of mutations; Ames test for mutagenesis; Methods of genetic analysis. Bacterial genetic system - Transformation; Conjugation; Transduction; Recombination; Plasmids and Transposons; Bacterial genetic map with reference to E. coli. Viruses and their genetic system - Phage ? and its life cycle; RNA phages; RNA viruses; Retroviruses; Genetic systems of yeast and Neurospora; Extrachromosomal inheritance and mitochondrial genetics; Basic concept of genomics.

SECTION M. ZOOLOGY

Animal world: Animal diversity, distribution, systematic and classification of animals, the phylogenetic relationship.

Evolution: Origin of life, history of life on earth, evolutionary theories, natural selection, adaptation, speciation.

Genetics: Principles of inheritance, molecular basis of heredity, the genetic material, transmission of genetic material, mutations, cytoplasmic inheritance.

Biochemistry and Molecular Biology: Nucleic acids, proteins and other biological macromolecules. Replication, transcription and translation, regulation of gene expression, organization of genome, Kreb's cycle, glycolysis, enzyme catalysis, hormones and their action.

Cell Biology: Structure of cell, cellular organelles and their structure and function, cell cycle, cell division, cellular differentiation, chromosome and chromatin structure. Eukaryotic gene organisation and expression.

Animal Anatomy and Physiology: Comparative physiology, the respiratory system, circulatory system, digestive system, the nervous system, the excretory system, the endocrine system, the reproductive system, the skeletal system, osmoregulation.

Parasitology and Immunology: Nature of parasite, host-parasite relation, protozoan and helminthic parasites, the immune response, cellular and humoral immune response, evolution of the immune system.

Development Biology: Embryonic development, cellular differentiation, organogenesis, metamorphosis, genetic basis of development.

Ecology: The ecosystem, habitats the food chain, population dynamics, species diversity, zoogeography, biogeochemical cycles, conservation biology.

Animal Behaviour: Types of behaviours, courtship, mating and territoriality, instinct, learning and memory, social behaviour across the animal taxa, communication, pheromones, evolution of animal behaviour.

IT - INFORMATION TECHNOLOGY

ENGINEERING MATHEMATICS

Mathematical Logic: Propositional Logic; First Order Logic.

Probability: Conditional Probability; Mean, Median, Mode and Standard Deviation; Random Variables; Distributions; uniform, normal, exponential, Poisson, Binomial.

Set Theory & Algebra: Sets; Relations; Functions; Groups; Partial Orders; Lattice; Boolean Algebra.

Combinatorics: Permutations; Combinations; Counting; Summation; generating functions; recurrence relations; asymptotics.

Graph Theory: Connectivity; spanning trees; Cut vertices & edges; covering; matching; independent sets; Colouring; Planarity; Isomorphism.

Linear Algebra: Algebra of matrices, determinants, systems of linear equations, Eigen values and Eigen vectors.

Numerical Methods: LU decomposition for systems of linear equations; numerical solutions of non linear algebraic equations by Secant, Bisection and Newton-Raphson Methods; Numerical integration by trapezoidal and Simpson's rules.

Calculus: Limit, Continuity & differentiability, Mean value Theorems, Theorems of integral calculus, evaluation of definite & improper integrals, Partial derivatives, Total derivatives, maxima & minima.

FORMAL LANGUAGES AND AUTOMATA

Regular Languages: finite automata, regular expressions, regular grammar.

Context free languages: push down automata, context free grammars

COMPUTER HARDWARE

Digital Logic: Logic functions, minimization, design and synthesis of combinatorial and sequential circuits, number representation and computer arithmetic (fixed and floating point)

Computer organization: Machine instructions and addressing modes, ALU and data path, hardwired and microprogrammed control, memory interface, I/O interface (interrupt and DMA mode), serial communication interface, instruction pipelining, cache, main and secondary storage

SOFTWARE SYSTEMS

Data structures and Algorithms: the notion of abstract data types, stack, queue, list, set, string, tree, binary search tree, heap, graph, tree and graph traversals, connected components, spanning trees, shortest paths, hashing, sorting, searching, design techniques (greedy, dynamic, divide and conquer), asymptotic analysis (best, worst, average cases) of time and space, upper and lower bounds, intractability

Programming Methodology: C programming, program control (iteration, recursion, functions), scope, binding, parameter passing, elementary concepts of object oriented programming

Operating Systems (in the context of Unix): classical concepts (concurrency, synchronization, deadlock), processes, threads and interprocess communication, CPU scheduling, memory management, file systems, I/O systems, protection and security

Information Systems and Software Engineering: information gathering, requirement and feasibility analysis, data flow diagrams, process specifications, input/output design, process life cycle, planning and managing the project, design, coding, testing, implementation, maintenance.

Databases: relational model, database design, integrity constraints, normal forms, query languages (SQL), file structures (sequential, indexed), b-trees, transaction and concurrency control

Data Communication: data encoding and transmission, data link control, multiplexing, packet switching, LAN architecture, LAN systems (Ethernet, token ring), Network devices: switches, gateways, routers

Networks: ISO/OSI stack, sliding window protocols, routing protocols, TCP/UDP, application layer protocols & systems (http, smtp, dns, ftp), network security

Web technologies: three tier web based architecture; JSP, ASP, J2EE, .NET systems; html, XML

AG - AGRICULTURAL ENGINEERING

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

FARM MACHINERY AND POWER:

Sources of power on the farm-human, animal, mechanical, electrical, wind, solar and biomass; design and selection of machine elements - gears, pulleys, chains and sprockets and belts; overload safety devices used in farm machinery; measurement of force, torque, speed, displacement and acceleration on machine elements.

Soil tillage; forces acting on a tillage tool; hitch systems and hitching of tillage implements; functional requirements, principles of working, construction and operation of manual, animal and power operated equipment for tillage. sowing, planting, fertilizer application, inter-cultivation, spraying, mowing, chaff cutting, harvesting, threshing and transport; testing of agricultural machinery and equipment; calculation of performance parameters -field capacity, efficiency, application rate and losses; cost analysis of implements and tractors.

Thermodynamic principles of I.C. engines; I.C. engine cycles; engine components; fuels and combustion; lubricants and their properties; I.C. engine systems - fuel, cooling, lubrication, ignition, electrical, intake and exhaust; selection, operation, maintenance and repair of I.C. engines; power efficiencies and measurement; calculation of power, torque, fuel consumption, heat load and power losses.

Tractors and power tillers - type, selection, maintenance and repair; tractor clutches and brakes; power transmission systems - gear trains, differential, final drives and power take-off; mechanics of tractor chassis; traction theory; three point hitches- free link and restrained link operations; mechanical steering and hydraulic control systems used in tractors; human engineering and safety in tractor design; tractor tests and performance.

SOIL AND WATER CONSERVATION ENGINEERING:

Ideal and real fluids, properties of fluids; hydrostatic pressure and its measurement; hydrostatic forces on plane and curved surface; continuity equation; Bernoulli's theorem; laminar and turbulent flow in pipes, Darcy-Weisbach and Hazen-Williams equations, Moody's diagram; flow through orifices and notches; flow in open channels.

Engineering properties of soils, fundamental definitions and relationships; index properties of soils; permeability and seepage analysis; shear strength, Mohr's circle of stresses; active and passive earth pressures; stability of slopes.

Hydrological cycle; precipitation measurement, analysis of precipitation data; abstraction from precipitation; runoff; hydrograph analysis, unit hydrograph theory and application; stream flow measurement; flood routing, hydrological reservoir and channel routing.

Mechanics of soil erosion, factors affecting erosion; soil loss estimation; biological and engineering measures to control erosion, terraces and bunds; vegetative waterways; gully control structures, drop, drop inlet and chute spillways; farm ponds; earthen dams; principles of watershed management.

Water requirement of crops; consumptive use and evapo-transpiration; irrigation scheduling; irrigation efficiencies; design of prismatic and silt loaded channels; methods of irrigation water application; design and evaluation of irrigation methods; drainage coefficient; surface and subsurface drainage systems; leaching requirement and salinity control; irrigation and drainage water quality; classification of pumps; pump characteristics; pump selection; types of aquifer; evaluation of aquifer properties; well hydraulics; ground water recharge.

AGRICULTURAL PROCESSING AND FOOD ENGINEERING:

Steady state heat transfer in conduction, convection and radiation; transient heat transfer in simple geometry; condensation and boiling heat transfer; working principles of heat exchangers; diffusive and convective mass transfer; simultaneous heat and mass transfer in agricultural processing operations.

Material and energy balances in food processing systems; water activity, sorption and desorption isotherms; centrifugal separation of solids, liquids and gases; kinetics of microbial death - pasteurisation and sterilization of liquid foods; preservation of food by cooling and freezing; psychrometry - properties of air-vapour mixture; concentration and dehydration of liquid foods - evaporators, tray, drum and spray dryers.

Mechanics and energy requirement in size reduction of granular solids; particle size analysis for comminuted solids; size separation by screening; fluidisation of granular solids; cleaning and grading efficiency and effectiveness of grain cleaners; conditioning and hydrothermal treatments for grains; dehydration of food grains; processes and machines for processing of cereals, pulses and oilseeds; design considerations for grain silos.

AR - ARCHITECTURE AND PLANNING

City planning: Historical development of cities; principles of city planning; new towns; survey methods, site planning, planning regulations and building bye-laws.

Housing: Concept of shelter; housing policies and design; community planning; role of government agencies; finance and management.

Landscape Design: Principles of landscape design and site planning; history and landscape styles; landscape elements and materials; planting design.

Computer Aided Design: Application of computers in architecture and planning; understanding elements of hardware and software; computer graphics; programming languages - C and Visual Basic and usage of packages such as AutoCAD.

Environmental and Building Science: Elements of environmental science; ecological principles concerning environment; role of micro-climate in design; climatic control through design elements; thermal comfort; elements of solar architecture; principles of lighting and illumination; basic principles of architectural acoustics; air pollution, noise pollution and their control.

Visual and Urban Design: Principles of visual composition; proportion, scale, rhythm, symmetry, harmony, balance, form and colour; sense of place and space, division of space; focal point, vista, imageability, visual survey.

History of Architecture: Indian - Indus valley, Vedic, Buddhist, Indo-Aryan, Dravidian and Mughal periods; European - Egyptian, Greek, Roman, medieval and renaissance periods.

Development of Contemporary Architecture: Architectural developments and impacts on society since industrial revolution; influence of modern art on architecture; works of national and international architects; post modernism in architecture.

Building Services: Water supply, Sewerage and Drainage systems; Sanitary fittings and fixtures; principles of electrification of buildings; elevators, their standards and uses; air-conditioning systems; fire fighting systems.

Building Construction and Management: Building construction techniques, methods and details; building systems and prefabrication of building elements; principles of modular coordination; estimation, specification, valuation, professional practice; project management, PERT, CPM.

Materials and Structural Systems: Behavioural characteristics of all types of building materials e.g. mud, timber, bamboo, brick, concrete, steel, glass, FRP; principles of strength of materials; design of structural elements in wood, steel and RCC; elastic and limit state design; complex structural systems; principles of pre-stressing.

Planning Theory: Planning process; multilevel planning; comprehensive planning; central place theory; settlement pattern; land use and land utilization.

Techniques of Planning: Planning surveys; Preparation of urban and regional structure plans, development plans, action plans; site planning principles and design; statistical methods; application of remote sensing techniques in urban and regional planning.

Traffic and Transportation Planning: Principles of traffic engineering and transportation planning; methods of conducting surveys; design of roads, intersections and parking areas; hierarchy of roads and levels of services; traffic and transport management in urban areas; traffic safety and traffic laws; public transportation planning; modes of transportation.

Services and Amenities: Principles and design of water supply systems, sewerage systems, solid waste disposal systems, power supply and communication systems; Health, education, recreation and demography related standards at various levels of the settlements.

Development Administration and Management: Planning laws; development control and zoning regulations; laws relating to land acquisition; development enforcements, land ceiling; regional and urban plan preparations; planning and municipal administration; taxation, revenue resources and fiscal management; public participation and role of NGO.

CE - CIVIL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

STRUCTURAL ENGINEERING

Mechanics: Bending moments and shear forces in statically determinate beams; simple stress and strain: relationship; stress and strain in two dimensions, principal stresses, stress transformation, Mohr's circle; simple bending theory; flexural shear stress; thin-walled pressure vessels; uniform torsion.

Structural Analysis: Analysis of statically determinate trusses, arches and frames; displacements in statically determinate structures and analysis of statically indeterminate structures by force/energy methods; analysis by displacement methods (slope-deflection and moment-distribution methods); influence lines for determinate and indeterminate structures; basic concepts of matrix methods of structural analysis.

Concrete Structures: Basic working stress and limit states design concepts; analysis of ultimate load capacity and design of members subject to flexure, shear, compression and torsion (beams, columns and isolated footings); basic elements of prestressed concrete: analysis of beam sections at transfer and service loads.

Steel Structures: Analysis and design of tension and compression members, beams and beam-columns, column bases; connections - simple and eccentric, beam-column connections, plate girders and trusses; plastic analysis of beams and frames.

GEOTECHNICAL ENGINEERING

Soil Mechanics: Origin of soils; soil classification; three-phase system, fundamental definitions, relationship and inter-relationships; permeability and seepage; effective stress principle: consolidation, compaction; shear strength.

Foundation Engineering: Sub-surface investigation - scope, drilling bore holes, sampling, penetrometer tests, plate load test; earth pressure theories, effect of water table, layered soils; stability of slopes - infinite slopes, finite slopes; foundation types - foundation design requirements; shallow foundations; bearing capacity, effect of shape, water table and other factors, stress distribution, settlement analysis in sands and clays; deep foundations - pile types, dynamic and static formulae, load capacity of piles in sands and clays.

WATER RESOURCES ENGINEERING

Fluid Mechanics and Hydraulics: Hydrostatics, applications of Bernoulli equation, laminar and turbulent flow in pipes, pipe networks; concept of boundary layer and its growth; uniform flow, critical flow and gradually varied flow in channels, specific energy concept, hydraulic jump; forces on immersed bodies; flow measurement in channels; tanks and pipes; dimensional analysis and hydraulic modeling. Applications of momentum equation, potential flow, kinematics of flow; velocity triangles and specific speed of pumps and turbines.

Hydrology: Hydrologic cycle; rainfall; evaporation infiltration, unit hydrographs, flood estimation, reservoir design, reservoir and channel routing, well hydraulics.

Irrigation: Duty, delta, estimation of evapo-transpiration; crop water requirements; design of lined and unlined canals; waterways; head works, gravity dams and Ogee spillways. Designs of weirs on permeable foundation, irrigation methods.

ENVIRONMENTAL ENGINEERING

Water requirements; quality and standards, basic unit processes and operations for water treatment, distribution of water. Sewage and sewerage treatment: quantity and characteristic of waste water sewerage; primary and secondary treatment of waste water; sludge disposal; effluent discharge standards.

TRANSPORTATION ENGINEERING

Highway planning; geometric design of highways; testing and specifications of paving materials; design of flexible and rigid pavements.

CH - CHEMICAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional

probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

CHEMICAL ENGINEERING

Process Calculations and Thermodynamics: Laws of conservation of mass and energy; use of tie components; recycle, bypass and purge calculations; degree of freedom analysis.

First and Second laws of thermodynamics and their applications; equations of state and thermodynamic properties of real systems; phase equilibria; fugacity, excess properties and correlations of activity coefficients; chemical reaction equilibria.

Fluid Mechanics and Mechanical Operations: Fluid statics, Newtonian and non-Newtonian fluids, Bernoulli equation, Macroscopic friction factors, energy balance, dimensional analysis, shell balances, flow through pipeline systems, flow meters, pumps and compressors, packed and fluidized beds, elementary boundary layer theory, size reduction and size separation; free and hindered settling; centrifuge and cyclones; thickening and classification, filtration, mixing and agitation; conveying of solids.

Heat Transfer: Conduction, convection and radiation, heat transfer coefficients, steady and unsteady heat conduction, boiling, condensation and evaporation; types of heat exchangers and evaporators and their design.

Mass Transfer: Fick's law, molecular diffusion in fluids, mass transfer coefficients, film, penetration and surface renewal theories; momentum, heat and mass transfer analogies; stagewise and continuous contacting and stage efficiencies; HTU & NTU concepts design and operation of equipment for distillation, absorption, leaching, liquid-liquid extraction, crystallization, drying, humidification, dehumidification and adsorption.

Chemical Reaction Engineering: Theories of reaction rates; kinetics of homogeneous reactions, interpretation of kinetic data, single and multiple reactions in ideal reactors, non-ideal reactors; residence time; non-isothermal reactors; kinetics of heterogeneous catalytic reactions; diffusion effects in catalysis.

Instrumentation and Process Control: Measurement of process variables; sensors, transducers and their dynamics, dynamics of simple systems, dynamics such as CSTRs, transfer functions and responses of simple systems, process reaction curve, controller modes (P, PI, and PID); control valves; analysis of closed loop systems including stability, frequency response (including Bode plots) and controller tuning, cascade, feed forward control.

Plant Design and Economics: Design and sizing of chemical engineering equipment such as compressors, heat exchangers, multistage contactors; principles of process economics and cost estimation including total annualized cost, cost indexes, rate of return, payback period, discounted cash flow, optimization in Design.

Chemical Technology: Inorganic chemical industries; sulfuric acid, NaOH, fertilizers (Ammonia, Urea, SSP and TSP); natural products industries (Pulp and Paper, Sugar, Oil, and Fats); petroleum refining and petrochemicals; polymerization industries; polyethylene, polypropylene, PVC and polyester synthetic fibers.

CS - COMPUTER SCIENCE AND ENGINEERING

ENGINEERING MATHEMATICS

Mathematical Logic: Propositional Logic; First Order Logic.

Probability: Conditional Probability; Mean, Median, Mode and Standard Deviation; Random Variables; Distributions; uniform, normal, exponential, Poisson, Binomial.

Set Theory & Algebra: Sets; Relations; Functions; Groups; Partial Orders; Lattice; Boolean Algebra.

Combinatorics: Permutations; Combinations; Counting; Summation; generating functions; recurrence relations; asymptotics.

Graph Theory: Connectivity; spanning trees; Cut vertices & edges; covering; matching; independent sets; Colouring; Planarity; Isomorphism.

Linear Algebra: Algebra of matrices, determinants, systems of linear equations, Eigen values and Eigen vectors.

Numerical Methods: LU decomposition for systems of linear equations; numerical solutions of non linear algebraic equations by Secant, Bisection and Newton-Raphson Methods; Numerical integration by trapezoidal and Simpson's rules.

Calculus: Limit, Continuity & differentiability, Mean value Theorems, Theorems of integral calculus, evaluation of definite & improper integrals, Partial derivatives, Total derivatives, maxima & minima.

THEORY OF COMPUTATION

Formal Languages and Automata Theory: Regular languages and finite automata, Context free languages and Push-down automata, Recursively enumerable sets and Turing machines, Undecidability;

Analysis of Algorithms and Computational Complexity: Asymptotic analysis (best, worst, average case) of time and space, Upper and lower bounds on the complexity of specific problems, NP-completeness.

COMPUTER HARDWARE

Digital Logic: Logic functions, Minimization, Design and synthesis of Combinational and Sequential circuits; Number representation and Computer Arithmetic (fixed and floating point);

Computer Organization: Machine instructions and addressing modes, ALU and Data-path, hardwired and micro-programmed control, Memory interface, I/O interface (Interrupt and DMA mode), Serial communication interface, Instruction pipelining, Cache, main and secondary storage.

SOFTWARE SYSTEMS

Data structures: Notion of abstract data types, Stack, Queue, List, Set, String, Tree, Binary search tree, Heap, Graph;

Programming Methodology: C programming, Program control (iteration, recursion, Functions), Scope, Binding, Parameter passing, Elementary concepts of Object oriented, Functional and Logic Programming;

Algorithms for problem solving: Tree and graph traversals, Connected components, Spanning trees, Shortest paths; Hashing, Sorting, Searching; Design techniques (Greedy, Dynamic Programming, Divide-and-conquer);

Compiler Design: Lexical analysis, Parsing, Syntax directed translation, Runtime environment, Code generation, Linking (static and dynamic); Operating Systems: Classical concepts (concurrency, synchronization, deadlock), Processes, threads and Inter-process communication, CPU scheduling, Memory management, File systems, I/O systems, Protection and security.

Databases: Relational model (ER-model, relational algebra, tuple calculus), Database design (integrity constraints, normal forms), Query languages (SQL), File structures (sequential files, indexing, B+ trees), Transactions and concurrency control;

Computer Networks: ISO/OSI stack, sliding window protocol, LAN Technologies (Ethernet, Token ring), TCP/UDP, IP, Basic concepts of switches, gateways, and routers.

CH - CHEMISTRY

PHYSICAL CHEMISTRY

Structure: Quantum theory - principles and techniques; applications to particle in a box, harmonic oscillator, rigid rotor and hydrogen atom; valence bond and molecular orbital theories and Huckel approximation, approximate techniques: variation and perturbation; symmetry, point groups; rotational, vibrational, electronic, NMR and ESR spectroscopy.

Equilibrium: First law of thermodynamics, heat, energy and work; second law of thermodynamics and entropy; third law and absolute entropy; free energy; partial molar quantities; ideal and non-ideal solutions; phase transformation: phase rule and phase diagrams- one, two, and three component systems; activity, activity coefficient, fugacity and fugacity coefficient ; chemical equilibrium, response of chemical equilibrium to temperature and pressure; colligative properties; kinetic theory of gases; thermodynamics of electrochemical cells; standard electrode potentials: applications - corrosion and energy conversion; molecular partition function (translational, rotational, vibrational and electronic).

Kinetics: Rates of chemical reactions, theories of reaction rates, collision and transition state theory; temperature dependence of chemical reactions; elementary reactions, consecutive elementary reactions; steady state approximation, kinetics of photochemical reactions and free radical polymerization, homogenous and heterogeneous catalysis.

INORGANIC CHEMISTRY

Non-Transition Elements: General characteristics, structure and reactions of simple and industrially important compounds, boranes, carboranes, silicates, silicones, diamond and graphite; hydrides, oxides and oxoacids of N, P, S and halogens; boron nitride, borazines and phosphazenes; xenon compounds. Shapes of molecules, hard-soft acid base concept.

Transition Elements: General characteristics of d and f block elements; coordination chemistry: structure and isomerism, stability, theories of metal-ligand bonding (CFT and LFT), electronic spectra and magnetic properties of transition metal complexes and lanthanides; metal carbonyls, metal-metal bonds and metal atom clusters, metallocenes; transition metal complexes with bonds to hydrogen, alkyls, alkenes, and arenes; metal carbenes; use of organometallic compounds as catalysts in organic synthesis; mechanisms of substitution and electron transfer reactions of coordination complexes. Role of metals with special reference to Na, K, Mg, Ca, Fe, Co, Zn, and Mo in biological systems.

Solids: Crystal systems and lattices, Miller planes, crystal packing, crystal defects; Bragg's Law; ionic crystals, band theory, metals and semiconductors. Spinels.

Instrumental methods of analysis: atomic absorption, UV-visible spectrometry, chromatographic and electro-analytical methods.

ORGANIC CHEMISTRY

Synthesis, reactions and mechanisms involving the following: Alkenes, alkynes, arenes, alcohols, phenols, aldehydes, ketones, carboxylic acids and their derivatives; halides, nitro compounds and amines; stereochemical and conformational effects on reactivity and specificity; reactions with diborane and peracids. Michael reaction, Robinson annulation, reactivity umpolung, acyl anion equivalents; molecular rearrangements involving electron deficient atoms.

Photochemistry: Basic principles, photochemistry of olefins, carbonyl compounds, arenes, photo oxidation and reduction.

Pericyclic reactions: Cycloadditions, electrocyclic reactions, sigmatropic reactions; Woodward-Hoffmann rules.

Heterocycles: Structural properties and reactions of furan, pyrrole, thiophene, pyridine, indole.

Biomolecules: Structure, properties and reactions of mono- and di-saccharides, physico-chemical properties of amino acids, structural features of proteins and nucleic acids.

Spectroscopy: Principles and applications of IR, UV-visible, NMR and mass spectrometry in the determination of structures of organic compounds.

EC - ELECTRONICS AND COMMUNICATION ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix Algebra, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Mean value theorems, Theorems of integral calculus, Evaluation of definite and improper integrals, Partial Derivatives, Maxima and minima, Multiple integrals, Fourier series. Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equation (linear and nonlinear), Higher order linear differential equations with constant coefficients, Method of variation of parameters, Cauchy's and Euler's equations, Initial and boundary value problems, Partial Differential Equations and variable separable method.

Complex variables: Analytic functions, Cauchy's integral theorem and integral formula, Taylor's and Laurent' series, Residue theorem, solution integrals.

Probability and Statistics: Sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Discrete and continuous distributions, Poisson, Normal and Binomial distribution, Correlation and regression analysis.

Numerical Methods: Solutions of non-linear algebraic equations, single and multi-step methods for differential equations.

Transform Theory: Fourier transform, Laplace transform, Z-transform.

ELECTRONICS & COMMUNICATION ENGINEERING

Networks: Network graphs: matrices associated with graphs; incidence, fundamental cut set and fundamental circuit matrices. Solution methods: nodal and mesh analysis. Network theorems: superposition, Thevenin and Norton's maximum power transfer, Wye-Delta transformation. Steady state sinusoidal analysis using phasors. Linear constant coefficient differential equations; time domain analysis of simple RLC circuits, Solution of network equations using Laplace transform: frequency domain analysis of RLC circuits. 2-port network parameters: driving point and transfer functions. State equations for networks.

Electronic Devices: Energy bands in silicon, intrinsic and extrinsic silicon. Carrier transport in silicon: diffusion current, drift current, mobility, resistivity. Generation and recombination of carriers. p-n junction diode, Zener diode, tunnel diode, BJT, JFET, MOS capacitor, MOSFET, LED, p-I-n and avalanche photo diode, LASERs. Device technology: integrated circuits fabrication process, oxidation, diffusion, ion implantation, photolithography, n-tub, p-tub and twin-tub CMOS process.

Analog Circuits: Equivalent circuits (large and small-signal) of diodes, BJTs, JFETs, and MOSFETs. Simple diode circuits, clipping, clamping, rectifier. Biasing and bias stability of transistor and FET amplifiers. Amplifiers: single-and multi-stage, differential, operational, feedback and power. Analysis of amplifiers; frequency response of amplifiers. Simple op-amp circuits. Filters. Sinusoidal oscillators; criterion for oscillation; single-transistor and op-amp configurations. Function generators and wave-shaping circuits. Power supplies.

Digital circuits: Boolean algebra, minimization of Boolean functions; logic gates digital IC families (DTL, TTL, ECL, MOS, CMOS). Combinational circuits: arithmetic circuits, code converters, multiplexers and decoders. Sequential circuits: latches and flip-flops, counters and shift-registers. Sample and hold circuits, ADCs, DACs. Semiconductor memories. Microprocessor(8085): architecture, programming, memory and I/O interfacing.

Signals and Systems: Definitions and properties of Laplace transform, continuous-time and discrete-time Fourier series, continuous-time and discrete-time Fourier Transform, z-transform. Sampling theorems. Linear Time-Invariant (LTI) Systems: definitions and properties; casuality, stability, impulse response, convolution, poles and zeros frequency response, group delay, phase delay. Signal transmission through LTI systems. Random signals and noise: probability, random variables, probability density function, autocorrelation, power spectral density.

Controls Systems: Basic control system components; block diagrammatic description, reduction of block diagrams. Open loop and closed loop (feedback) systems and stability analysis of these systems. Signal flow graphs and their use in determining transfer functions of systems; transient and steady state analysis of LTI control systems and frequency response. Tools and techniques for LTI control system analysis: root loci, Routh-Hurwitz criterion, Bode and Nyquist plots. Control system compensators: elements of lead and lag compensation, elements of Proportional-Integral-Derivative(PID) control. State variable representation and solution of state equation of LTI control systems.

Communications: Analog communication systems: amplitude and angle modulation and demodulation systems, spectral analysis of these operations, superheterodyne receivers; elements of hardware, realizations of analog communication systems; signal-to-noise ratio (SNR) calculations for amplitude modulation (AM) and frequency modulation (FM) for low noise conditions. Digital communication systems: pulse code modulation (PCM), differential pulse code modulation (DPCM), delta modulation (DM); digital modulation schemes-amplitude, phase and frequency shift keying schemes (ASK, PSK, FSK), matched filter receivers, bandwith consideration and probability of error calculations for these schemes.

Electromagnetics: Elements of vector calculus: divergence and curl; Gauss' and Stokes' theorems, Maxwell's equations: differential and integral forms. Wave equation, Poynting vector. Plane waves: propagation through various media; reflection and refraction; phase and group velocity; skin depth. Transmission lines: characteristic impedance; impedance transformation; Smith chart; impedance matching; pulse excitation. Waveguides: modes in rectangular waveguides; boundary conditions; cut-off frequencies; dispersion relations. Antennas: Dipole antennas; antenna arrays; radiation pattern; reciprocity theorem, antenna gain.

EE - ELECTRICAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix Algebra, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Mean value theorems, Theorems of integral calculus, Evaluation of definite and improper integrals, Partial Derivatives, Maxima and minima, Multiple integrals, Fourier series. Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equation (linear and nonlinear), Higher order linear differential equations with constant coefficients, Method of variation of parameters, Cauchy's and Euler's equations, Initial and boundary value problems, Partial Differential Equations and variable separable method.

Complex variables: Analytic functions, Cauchy's integral theorem and integral formula, Taylor's and Laurent' series, Residue theorem, solution integrals.

Probability and Statistics: Sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Discrete and continuous distributions, Poisson, Normal and Binomial distribution, Correlation and regression analysis.

Numerical Methods: Solutions of non-linear algebraic equations, single and multi-step methods for differential equations.

Transform Theory: Fourier transform, Laplace transform, Z-transform.

ELECTRICAL ENGINEERING

Electrical Circuits and Fields: Network graph, KCL, KVL, node/ cut set, mesh/ tie set analysis, transient response of d.c. and a.c. networks; sinusoidal steady-state analysis; resonance in electrical circuits; concepts of ideal voltage and current sources, network theorems, driving point, immittance and transfer functions of two port networks, elementary concepts of filters; three phase circuits; Fourier series and its application; Gauss theorem, electric field intensity and potential due to point, line, plane and spherical charge distribution, dielectrics, capacitance calculations for simple configurations; Ampere's and Biot-Savart's law, inductance calculations for simple configurations.

Electrical Machines: Single phase transformer - equivalent circuit, phasor diagram, tests, regulation and efficiency; three phase transformers - connections, parallel operation; auto transformer and three-winding transformer; principles of energy conversion, windings of rotating machines: D. C. generators and motors - characteristics, starting and speed control, armature reaction and commutation; three phase induction motors-performance characteristics, starting and speed control; single-phase induction motors; synchronous generators-performance, regulation, parallel operation; synchronous motors - starting, characteristics, applications, synchronous condensers; fractional horse power motors; permanent magnet and stepper motors.

Power Systems: Electric power generation - thermal, hydro, nuclear; transmission line parameters; steady-state performance of overhead transmission lines and cables and surge propagation; distribution systems, insulators, bundle conductors, corona and radio interference effects; per-unit quantities; bus admittance and impedance matrices; load flow; voltage control and power factor correction; economic operation; symmetrical components, analysis of symmetrical and unsymmetrical faults; principles of over current, differential and distance protections; concept of solid state relays and digital protection; circuit breakers; concept of system stability-swing curves and equal area criterion; basic concepts of HVDC transmission.

Control Systems: Principles of feedback; transfer function; block diagrams: steady-state errors; stability-Routh and Nyquist criteria; Bode plots; compensation; root loci; elementary state variable formulation; state transition matrix and response for Linear Time Invariant systems.

Electrical and Electronic Measurements: Bridges and potentiometers, PMMC, moving iron, dynamometer and induction type instruments; measurement of voltage, current, power, energy and power factor; instrument transformers; digital voltmeters and multimeters; phase, time and frequency measurement; Q-meter, oscilloscopes, potentiometric recorders, error analysis.

Analog and Digital Electronics: Characteristics of diodes, BJT, FET, SCR; amplifiers-biasing, equivalent circuit and frequency response; oscillators and feedback amplifiers, operational amplifiers- characteristics and applications; simple active filters; VCOs and timers; combinational and sequential logic circuits, multiplexer, Schmitt trigger, multivibrators, sample and hold circuits, A/D and D/A converters; microprocessors and their applications.

Power Electronics and Electric Drives: Semiconductor power devices-diodes, transistors, thyristors, triacs, GTOs, MOSFETs and IGBTs - static characteristics and principles of operation; triggering circuits; phase control rectifiers; bridge converters-fully controlled and half controlled; principles of choppers and inverters, basic concepts of adjustable speed dc and ac drives.

GG - GEOLOGY AND GEOPHYSICS

PART - I

Earth and planetary system; size, shape, internal structure and composition of the earth; atmosphere and greenhouse effect; isostasy; elements of seismology; continents and continental processes; physical oceanography; palaeomagnetism, continental drift plate tectonics, geothermal energy.

Weathering; soil formation; action of river, wind and glacier; oceans and oceanic features; earthquakes, volcanoes, orogeny and mountain building; elements of structural geology; crystallography; classification, composition and properties of minerals and rocks; engineering properties of rocks and soils, role of geology in the construction of engineering structures.

Processes of ore formation, occurrence and distribution of ores on land and on ocean floor; coal and petroleum resources in India; ground water geology including well hydraulics, geological time scale and geochronology; stratigraphic principles and stratigraphy of India; basics concepts of gravity, magnetic and electrical prospecting for ores and ground water.

PART - IIA: GEOLOGY

Crystal symmetry, forms, twinning; crystal chemistry; optical mineralogy, classification of minerals, diagnostic properties of rock minerals.

Mineralogy, structure, texture and classification of igneous, sedimentary and metamorphic rock, their origin and evolution; application of thermodynamics; structure and petrology of sedimentary rocks; sedimentary processes and environments, sedimentary facies, basin studies; basement cover relationship;

Primary and secondary structures; geometry and genesis of folds, faults, joints, unconformities, cleavage, schistosity and lineation; methods of projection. Tectonites and their significance; shear zone; superposed folding.

Morphology, classification and geological significance of important invertebrates, vertebrates, microfossils and palaeoflora; stratigraphic principles and Indian stratigraphy; geomorphic processes and agents; development and evolution of landforms; slope and drainage; processes on deep oceanic and near-shore regions; quantitative and applied geomorphology; air photo interpretation and remote sensing; chemical and optical properties of ore minerals; formation and localization of ore deposits; prospecting and exploration of economic minerals; coal and petroleum geology; origin and distribution of mineral and fuel deposits in India; ore dressing and mineral economics.

Cosmic abundance; meteorites; geochemical evolution of the earth; geochemical cycles; distribution of major, minor and trace elements; isotope geochemistry; geochemistry of waters including solution equilibria and water rock interaction.

Engineering properties of rocks and soils; rocks as construction material; geology of dams, tunnels and excavation sites; natural hazards; the fly ash problem; ground water geology and exploration; water quality; impact of human activity; Remote sensing techniques for the interpretation of landforms and resource management.

PART - II B: GEOPHYSICS

The earth as a planet; different motions of the earth; gravity filed of the earth and its shape; geochronology; isostasy, seismology and interior of the earth; variation of density, velocity, pressure, temperature, electrical and magnetic properties inside the earth; earthquakes-causes and measurements; zonation and seismic hazards; geomagnetic field, palaeomagnetism; oceanic and continental lithosphere; plate tectonics; heat flow; upper and lower atmospheric phenomena.

Theories of scalar and vector potential fields; Laplace, Maxwell and Helmholtz equations for solution of different types of boundary value problems for Cartesian, cylindrical and spherical polar coordinates; Green's theorem; Image theory; integral equations and conformal transformations in potential theory; Eikonal equation and ray theory.

'G' and 'g' units of measurement, density of rocks, gravimeters, preparation, analysis and interpretation of gravity maps; derivative maps, analytical continuation; gravity anomaly type curves; calculation of mass.

Earth's magnetic field, units of measurement, magnetic susceptibility of rocks, magnetometers, corrections, preparation of magnetic maps, magnetic anomaly type curve, analytical continuation, interpretation and application; magnetic well logging.

Conduction of electricity through rocks, electrical conductivities of metals, metallic, non-metallic and rock forming minerals, D.C. resistivity units and methods of measurement, electrode configuration for sounding and profiling, application of filter theory, interpretation of resistivity field data, application; self potential origin, classification, field measurement, interpretation of induced polarization time frequency, phase domain; IP units and methods of measurement, interpretation and application; ground-water exploration.

Origin of electromagnetic field elliptic polarization, methods of measurement for different source-receiver configuration components in EM measurements, interpretation and applications; earth's natural electromagnetic field, tellurics, magneto-tellurics; geomagnetic depth sounding principles, methods of measurement, processing of data and interpretation.

Seismic methods of prospecting: Reflection, refraction and CDP surveys; land and marine seismic sources, generation and propagation of elastic waves, velocity increasing with depth, geophones, hydrophones, recording instruments (DFS), digital formats, field layouts, seismic noises and noise profile analysis, optimum geophone grouping, noise cancellation by shot and geophone arrays, 2D and 3D seismic data acquisition and processing, CDP stacking charts, binning, filtering, dip-moveout, static and dynamic corrections, deconvolution, migration, signal processing, Fourier and Hilbert transforms, attribute analysis, bright and dim spots, seismic stratigraphy, high resolution seismics, VSP.

Principles and techniques of geophysical well-logging, SP, resistivity, induction, micro gamma ray, neutron, density, sonic, temperature, dip meter, caliper, nuclear magnetic, cement bond logging. Quantitative evaluation of formations from well logs; well hydraulics and application of geophysical methods for groundwater study; application of bore hole geophysics in ground water, mineral and oil exploration. Remote sensing techniques and application of remote sensing methods in geophysics.

IN - INSTRUMENTATION ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix Algebra, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Mean value theorems, Theorems of integral calculus, Evaluation of definite and improper integrals, Partial Derivatives, Maxima and minima, Multiple integrals, Fourier series. Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equation (linear and nonlinear), Higher order linear differential equations with constant coefficients, Method of variation of parameters, Cauchy's and Euler's equations, Initial and boundary value problems, Partial Differential Equations and variable separable method.

Complex variables: Analytic functions, Cauchy's integral theorem and integral formula, Taylor's and Laurent' series, Residue theorem, solution integrals.

Probability and Statistics: Sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Discrete and continuous distributions, Poisson, Normal and Binomial distribution, Correlation and regression analysis.

Numerical Methods: Solutions of non-linear algebraic equations, single and multi-step methods for differential equations.

Transform Theory: Fourier transform, Laplace transform, Z-transform.

INSTRUMENTATION ENGINEERING

Measurement Basics and Metrology: Static and dynamic characteristics of measurement systems. Standards and calibration. Error and uncertainty analysis, statistical analysis of data, and curve fitting. Linear and angular measurements; Measurement of straightness, flatness, roundness and roughness.

Transducers, Mechanical Measurements and Industrial Instrumentation: Transducers - elastic, resistive, inductive, capacitive, thermo-electric, piezoelectric, photoelectric, electro-mechanical, electro-chemical, and ultrasonic. Measurement of displacement, velocity (linear and rotational), acceleration, shock, vibration, force, torque, power, strain, stress, pressure, flow, temperature, humidity, viscosity, and density. energy storing elements, suspension systems and dampers.

Analog Electronics: Characteristics of diodes, BJTs, JFETs and MOSFETs; Diode circuits; Amplifiers: single and multi-stage, feedback; Frequency response; Operational amplifiers - design, characteristic, linear and non-linear applications: difference amplifiers; instrumentation amplifiers; precision rectifiers, I-to-V converters, active filters, oscillators, comparators, signal generators, wave shaping circuits.

Digital Electronics: Combinational logic circuits, minimization of Boolean functions; IC families (TTL, MOS, CMOS), arithmetic circuits, multiplexer and decoders. Sequential circuits: flip-flops, counters, shift registers. Schmitt trigger, timers, and multivibrators. Analog switches, multiplexers, S/H circuits. Analog-to-digital and digital-to-analog converters. Basics of computer organization and architecture. 8-bit microprocessor (8085), applications, memory, I/O interfacing, and microcontrollers.

Signals and Systems: Vectors and matrices; Fourier series; Fourier transforms; Ordinary differential equations. Impulse and frequency responses of first and second order systems.

Laplace transform and transfer function, convolution and correlation. Amplitude and frequency modulations and demodulations. Discrete time systems, difference equations, impulse and frequency responses; Z-transforms and transfer functions; IIR and FIR filters.

Electrical and Electronic Measurements: Measurement of R, L and C; bridges and potentiometers. Measurement of voltage, current, power, power factor, and energy; Instrument transformers; Q meter, waveform analyzers. Digital volt-meters and multi-meters. Time, phase and frequency measurements; Oscilloscope. Noise and interference in instrumentation.

Control Systems & Process Control: Principles of feedback; transfer function, signal flow graphs. Stability criteria, Bode plots, root-loci, Routh and Nyquist criteria. Compensation techniques; State space analysis. System components: mechanical, hydraulic, pneumatic, electrical and electronic; Servos and synchros; Stepper motors. On-off, cascade, P, PI, PID and feed-forward controls. Controller tuning and general frequency response.

Analytical, Optical and Biomedical Instrumentation: Principles of spectrometry, UV, visible, IR mass spectrometry, X-ray methods; nuclear radiation measurements, gas, solid and semi conductor lasers and their characteristics, interferometers, basics of fibre optics, transducers in biomedical applications, cardiovascular system measurements, instrumentation for clinical laboratory.

MA - MATHEMATICS

Linear Algebra: Finite dimensional vector spaces. Linear transformations and their matrix representations, rank; systems of linear equations, eigenvalues and eigenvectors, minimal polynomial, Cayley-Hamilton theorem, diagonalisation, Hermitian, Skew-Hermitian and unitary matrices. Finite dimensional inner product spaces, self-adjoint and Normal linear operators, spectral theorem, Quadratic forms.

Complex Analysis: Analytic functions, conformal mappings, bilinear transformations, complex integration: Cauchy's integral theorem and formula, Liouville's theorem, maximum modulus principle, Taylor and Laurent's series, residue theorem and applications for evaluating real integrals.

Real Analysis: Sequences and series of functions, uniform convergence, power series, Fourier series, functions of several variables, maxima, minima, multiple integrals, line, surface and volume integrals, theorems of Green, Stokes and Gauss; metric spaces, completeness, Weierstrass approximation theorem, compactness. Lebesgue measure, measurable functions; Lebesgue integral, Fatou's lemma, dominated convergence theorem.

Ordinary Differential Equations: First order ordinary differential equations, existence and uniqueness theorems, systems of linear first order ordinary differential equations, linear ordinary differential equations of higher order with constant coefficients; linear second order ordinary differential equations with variable coefficients, method of Laplace transforms for solving ordinary differential equations, series solutions; Legendre and Bessel functions and their orthogonality, Sturm Liouville system, Greeen's functions.

Algebra: Normal subgroups and homomorphisms theorems, automorphisms. Group actions, sylow's theorems and their applications groups of order less than or equal to 20, Finite p-groups. Euclidean domains, Principal ideal domains and unique factorizations domains. Prime ideals and maximal ideals in commutative rings.

Functional Analysis: Banach spaces, Hahn-Banach theorems, open mapping and closed graph theorems, principle of uniform boundedness; Hilbert spaces, orthonormal sets, Riesz representation theorem, self-adjoint, unitary and normal linear operators on Hilbert Spaces.

Numerical Analysis: Numerical solution of algebraic and transcendental equations; bisection, secant method, Newton-Raphson method, fixed point iteration, interpolation: existence and error of polynomial interpolation, Lagrange, Newton, Hermite(osculatory)interpolations; numerical differentiation and integration, Trapezoidal and Simpson rules; Gaussian quadrature; (Gauss-Legendre and Gauss-Chebyshev), method of undetermined parameters, least square and orthonormal polynomial approximation; numerical solution of systems of linear equations: direct and iterative methods, (Jacobi Gauss-Seidel and SOR) with convergence; matrix eigenvalue problems: Jacobi and Given's methods, numerical solution of ordinary differential equations: initial value problems, Taylor series method, Runge-Kutta methods, predictor-corrector methods; convergence and stability.

Partial Differential Equations: Linear and quasilinear first order partial differential equations, method of characteristics; second order linear equations in two variables and their classification; Cauchy, Dirichlet and Neumann problems, Green's functions; solutions of Laplace, wave and diffusion equations in two variables Fourier series and transform methods of solutions of the above equations and applications to physical problems.

Mechanics: Forces in three dimensions, Poinsot central axis, virtual work, Lagrange's equations for holonomic systems, theory of small oscillations, Hamiltonian equations;

Topology: Basic concepts of topology, product topology, connectedness, compactness, countability and separation axioms, Urysohn's Lemma, Tietze extension theorem, metrization theorems, Tychonoff theorem on compactness of product spaces.

Probability and Statistics: Probability space, conditional probability, Bayes' theorem, independence, Random variables, joint and conditional distributions, standard probability distributions and their properties, expectation, conditional expectation, moments. Weak and strong law of large numbers, central limit theorem. Sampling distributions, UMVU estimators, sufficiency and consistency, maximum likelihood estimators. Testing of hypotheses, Neyman-Pearson tests, monotone likelihood ratio, likelihood ratio tests, standard parametric tests based on normal, X2 ,t, F-distributions. Linear regression and test for linearity of regression. Interval estimation.

Linear Programming: Linear programming problem and its formulation, convex sets their properties, graphical method, basic feasible solution, simplex method, big-M and two phase methods, infeasible and unbounded LPP's, alternate optima. Dual problem and duality theorems, dual simplex method and its application in post optimality analysis, interpretation of dual variables. Balanced and unbalanced transportation problems, unimodular property and u-v method for solving transportation problems. Hungarian method for solving assignment problems.

Calculus of Variations and Integral Equations: Variational problems with fixed boundaries; sufficient conditions for extremum, Linear integral equations of Fredholm and Volterra type, their iterative solutions. Fredholm alternative.

ME - MECHANICAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

APPLIED MECHANICS AND DESIGN

Engineering Mechanics: Equivalent force systems, free-body concepts, equations of equilibrium, trusses and frames, virtual work and minimum potential energy. Kinematics and dynamics of particles and rigid bodies, impulse and momentum (linear and angular), energy methods, central force motion.

Strength of Materials: Stress and strain, stress-strain relationship and elastic constants, Mohr's circle for plane stress and plane strain, shear force and bending moment diagrams, bending and shear stresses, deflection of beams, torsion of circular shafts, thin and thick cylinders, Euler's theory of columns, strain energy methods, thermal stresses.

Theory of Machines: Displacement, velocity and acceleration, analysis of plane mechanisms, dynamic analysis of slider-crank mechanism, planar cams and followers, gear tooth profiles, kinematics of gears, governors and flywheels, balancing of reciprocating and rotating masses.

Vibrations: Free and forced vibration of single degree freedom systems, effect of damping, vibration isolation, resonance, critical speed of rotors.

Design of Machine Elements: Design for static and dynamic loading, failure theories, fatigue strength; design of bolted, riveted and welded joints; design of shafts and keys; design of spur gears, rolling and sliding contact bearings; brakes and clutches; belt, rope and chain drives.

FLUID MECHANICS AND THERMAL SCIENCES

Fluid Mechanics: Fluid properties, fluid statics, manometry, buoyancy; control-volume analysis of mass, momentum and energy; fluid acceleration; differential equations of continuity and momentum; Bernoulli's equation; viscous flow of incompressible fluids; boundary layer; elementary turbulent flow; flow through pipes, head losses in pipes, bends etc.

Heat-Transfer: Modes of heat transfer; one dimensional heat conduction, resistance concept, electrical analogy, unsteady heat conduction, fins; dimensionless parameters in free and forced convective heat transfer, various correlations for heat transfer in flow over flat plates and through pipes; thermal boundary layer; effect of turbulence; radiative heat transfer, black and grey surfaces, shape factors, network analysis; heat exchanger performance, LMTD and NTU methods.

Thermodynamics: Zeroth, First and Second laws of thermodynamics; thermodynamic system and processes; irreversibility and availability; behaviour of ideal and real gases, properties of pure substances, calculation of work and heat in ideal processes; analysis of thermodynamic cycles related to energy conversion; Carnot, Rankine, Otto, Diesel, Brayton and vapour compression cycles.

Power Plant Engineering: Steam generators; steam power cycles; steam turbines; impulse and reaction principles, velocity diagrams, pressure and velocity compounding; reheating and reheat factor; condensers and feed heaters.

I.C. Engines: Requirements and suitability of fuels in IC engines, fuel ratings, fuel-air mixture requirements; normal combustion in SI and CI engines; engine performance calculations.

Refrigeration and air-conditioning: Refrigerant compressors, expansion devices, condensers and evaporators; properties of moist air, psychrometric chart, basic psychometric processes.

Turbomachinery: Components of gas turbines; compression processes, centrifugal and axial flow compressors; axial flow turbines, elementary theory; hydraulic turbines; Euler-turbine equation; specific speed, Pelton-wheel, Francis and Kaplan turbines; centrifugal pumps.

MANUFACTURING AND INDUSTRIAL ENGINEERING

Engineering Materials: Structure and properties of engineering materials and their applications, heat treatment.

Metal Casting: Casting processes (expendable and non-expendable) -pattern, moulds and cores, heating and pouring, solidification and cooling, gating design, design considerations, defects.

Forming Processes: Stress-strain diagrams for ductile and brittle material, Plastic deformation and yield criteria, fundamentals of hot and cold working processes, Bulk metal forming processes (forging, rolling, extrusion, drawing), sheet metal working processes (punching, blanking, bending, deep drawing, coining, spinning, load estimation using homogeneous deformation methods, defects). processing of powder metals- atomization, compaction, sintering, secondary and finishing operations. forming and shaping of plastics- extrusion, injection moulding.

Joining Processes: Physics of welding, fusion and non-fusion welding processes, brazing and soldering, adhesive bonding, design considerations in welding, weld quality defects.

Machining and Machine Tool Operations: Mechanics of machining, single and multi-point cutting tools, tool geometry and materials, tool life and wear, cutting fluids, machinability, economics of machining, non-traditional machining processes.

Metrology and Inspection: Limits, fits and tolerances, linear and angular measurements, comparators, gauge design, interferometry, form and finish measurement, measurement of screw threads, alignment and testing methods.

Tool Engineering: Principles of work holding, design of jigs and fixtures.

Computer Integrated Manufacturing: Basic concepts of CAD, CAM and their integration tools.

Manufacturing Analysis: Part-print analysis, tolerance analysis in manufacturing and assembly, time and cost analysis.

Work-Study: Method study, work measurement, time study, work sampling, job evaluation, merit rating.

Production Planning and Control: Forecasting models, aggregate production planning, master scheduling, materials requirements planning.

Inventory Control: Deterministic and probabilistic models, safety stock inventory control systems.

Operations Research: Linear programming, simplex and duplex method, transportation, assignment, network flow models, simple queuing models, PERT and CPM

MN - MINING ENGINEERING

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

MINING ENGINEERING

Mechanics: Equivalent force systems, equations of equilibrium, two dimensional frames and trusses, free body diagrams, friction forces, particle kinematics and dynamics.

Mine Development, Geomechanics and Strata Control: Drivages for underground mine development, drilling methods and machines, explosives, blasting devices and practices, shaft sinking. Physico-mechanical properties of rocks, rock mass classification, ground control instrumentation and stress measurement techniques, theories of rock failure, ground vibrations, stress distribution around mine openings, subsidence, design of supports in roadways and workings, stability of open pits, slopes.

Mining Methods and Machinery: Surface mining - layout, development, loading, transportation and mechanization, continuous surface mining systems. Underground coal mining - bord and pillar system, longwall mining, thick seam mining methods. Underground metal mining: different stoping methods, stope mechanization, ore handling systems, mine filling. Generation and transmission of mechanical, hydraulic, and pneumatic power. Materials handling - haulages, conveyors, ropeways, face and development machinery, hoisting systems, and pumps.

Ventilation, Underground Hazards and Surface Environment: Underground atmosphere, heat load sources and thermal environment, air cooling, mechanics of air flow distribution, natural and mechanical ventilation, mine fans and their usage, auxiliary ventilation. Subsurface hazards from fires, explosions, gases, dust, and inundation, rescue apparatus and practices, safety in mines, accident analysis, noise, mine lighting. Air and water pollution: causes, dispersion, quality standards, and control.

Surveying, Mine Planning and Systems Engineering: Fundamentals of engineering surveying, Levels and levelling, Theodolite, tacheometry, triangulation, contouring, errors and adjustments, correlation, underground surveying, curves, photogrammetry, field astronomy, GPS fundamentals. Principles of planning - Sampling methods and practices, reserve estimation techniques, basics of geostatistics, optimization of facility location, cash flow concepts and mine valuation, open pit design. Work study, concepts of reliability, reliability of series and parallel systems. Linear programming, transportation and assignment problems, queueing, network analysis, inventory control.

MT - METALLURGICAL ENGINEERING

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

METALLURGICAL ENGINEERING

Thermodynamics and Rate Processes: Laws of thermodynamics, activity, equilibrium constant, applications to metallurgical systems, solutions, phase equilibria, basic kinetic laws, order of reactions, rate constants and rate limiting steps principles of electro chemistry, aqueous, corrosion and protection of metals, oxidation and high temperature corrosion - characterization and control; momentum transfer - concepts of viscosity, shell balances, Bernoulli's equation; heat transfer - conduction, convection and heat transfer coefficient relations, radiation, mass transfer - diffusion and Fick's laws.

Extractive Metallurgy: Flotation, gravity and other methods of mineral processing; agglomeration, pyro-hydro-and electro-metallurgical processes; material and energy balances; principles and processes for the extraction of non-ferrous metals - aluminium, copper, zinc, lead, magnesium, nickel, titanium and other rare metals; iron and steel making - principles, blast furnace, direct reduction processes, primary and secondary steel making, deoxidation and inclusion in steel; ingot and continuous casting; stainless steel making, design of furnaces; fuels and refractories.

Physical Metallurgy: Crystal structure and bonding characteristics of metals, alloys, ceramics and polymers; solid solutions; solidification; phase transformation and binary phase diagrams; principles of heat treatment of steels, aluminum alloys and cast irons; recovery, recrystallization and grain growth; industrially important ferrous and non-ferrous alloys; elements of X-ray and electron diffraction; principles of scanning and transmission electron microscopy; elements of ceramics, composites and electronic materials; electronic basis of thermal, optical, electrical and magnetic properties of materials.

Mechanical Metallurgy: Elements of elasticity and plasticity; defects in crystals; elements of dislocation theory - types of dislocations, slip and twinning, stress fields of dislocations, dislocation interactions and reactions, methods of seeing dislocations; strengthening mechanisms; tensile, fatigue and creep behaviour; superplasticity; fracture - Griffith theory, ductile to brittle transition, fracture toughness; failure analysis; mechanical testing - tension, compression, torsion, hardness, impact, creep, fatigue, fracture toughness and formability tests.

Manufacturing Processes: Metal casting - patterns, moulds, melting, gating, feeding and casting processes, defects and castings, hot and cold working of metals; Metal forming - fundamentals of metal forming, rolling wire drawing, extrusion, forming, sheet metal forming processes, defects in forming; Metal joining - soldering, brazing and welding, common welding processes, welding metallurgy, problems associated with welding of steels and aluminium alloys, defects in welding, powder metallurgy; NDT methods - ultrasonic, radiography, eddy current, acoustic emission and magnetic.

PH - PHYSICS

Mathematical Physics: Linear vector space, matrices; vector calculus; linear differential equations; elements of complex analysis; Laplace transforms, Fourier analysis, elementary ideas about tensors.

Classical Mechanics: Conservation laws; central forces; collisions and scattering in laboratory and centre of mass reference frames; mechanics of system of particles; rigid body dynamics; moment of inertia tensor; noninertial frames and pseudo forces; variational principle; Lagrange's and Hamilton's formalisms; equation of motion, cyclic coordinates, Poisson bracket; periodic motion, small oscillations, normal modes; wave equation and wave propagation; special theory of relativity - Lorentz transformations, relativistic kinematics, mass-energy equivalence.

Electromagnetic Theory: Laplace and Poisson equations; conductors and dielectrics; boundary value problems; Ampere's and Biot-Savart's laws; Faraday's law; Maxwell's equations; scalar and vector potentials; Coulomb and Lorentz gauges; boundary conditions at interfaces; electromagnetic waves; interference, diffraction and polarization; radiation from moving charges.

Quantum Mechanics: Physical basis of quantum mechanics; uncertainty principle; Schrodinger equation; one and three dimensional potential problems; Particle in a box, harmonic oscillator, hydrogen atom; linear vectors and operators in Hilbert space; angular momentum and spin; addition of angular momentum; time independent perturbation theory; elementary scattering theory.

Atomic and Molecular Physics: Spectra of one-and many-electron atoms; LS and jj coupling; hyperfine structure; Zeeman and Stark effects; electric dipole transitions and selection rules; X-ray spectra; rotational and vibrational spectra of diatomic molecules; electronic transition in diatomic molecules, Franck-Condon principle; Raman effect; NMR and ESR; lasers.

Thermodynamics and Statistical Physics: Laws of thermodynamics; macrostates, phase space; probability ensembles; partition function, free energy, calculation of thermodynamic quantities; classical and quantum statistics; degenerate Fermi gas; black body radiation and Planck's distribution law; Bose-Einstein condensation; first and second order phase transitions, critical point.

Solid State Physics: Elements of crystallography; diffraction methods for structure determination; bonding in solids; elastic properties of solids; defects in crystals; lattice vibrations and thermal properties of solids; free electron theory; band theory of solids; metals, semiconductors and insulators; transport properties; optical, dielectric and magnetic properties of solids; elements of superconductivity.

Nuclear and Particle Physics: Rutheford scattering; basic properties of nuclei; radioactive decay; nuclear forces; two nucleon problem; nuclear reactions; conservation laws; fission and fusion; nuclear models; particle accelerators, detectors; elementary particles; photons, baryons, mesons and leptons; Quark model.

Electronics: Network analysis; semiconductor devices; bipolar transistors; FETs; power supplies, amplifier, oscillators; operational amplifiers; elements of digital electronics; logic circuits.

PI - PRODUCTION AND INDUSTRIAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

GENERAL ENGINEERING:

Engineering Materials: Structure and properties of engineering materials and their applications; effect of strain, strain rate and temperature on mechanical properties of metals and alloys; heat treatment of metals and alloys.

Applied Mechanics: Engineering mechanics - equivalent force systems, free body concepts, equations of equilibrium, virtual work and minimum potential energy; strength of materials-stress, strain and their relationship, Mohr's circle, deflection of beams, bending and shear stress, Euler's theory of columns.

Theory of Machines and Design: Analysis of planar mechanisms, plane cams and followers; governers and fly wheels; design of elements-failure theories; design of bolted, riveted and welded joints; design of shafts, keys, belt drives, brakes and clutches.

Thermal Engineering: Fluid machines - fluid statics, Bernoulli's equation, flow through pipes, equations of continuity and momentum; Thermodynamics - zeroth, First and Second laws of thermodynamics, thermodynamic system and processes, calculation of work and heat for systems and control volumes; Heat transfer - fundamentals of conduction, convection and radiation.

PRODUCTION ENGINEERING

Metal Casting: Casting processes; patterns-materials; allowances; moulds and cores - materials, making and testing; melting and founding of cast iron, steels and nonferrous metals and alloys; solidification; design of casting, gating and risering; casting defects and inspection.

Metal working: Stress-strain in elastic and plastic deformation; deformation mechanisms; hot and cold working-forging, rolling, extrusion, wire and tube drawing; sheet metal working; analysis of rolling, forging, extrusion and wire /rod drawing; metal working defects, high energy rate forming processes-explosive, magnetic, electro and electrohydraulic.

Metal Joining Processes: Welding processes - gas shielded metal arc, TIG, MIG, submerged arc, electroslag, thermit, resistance, pressure and forge welding; thermal cutting; other joining processes - soldering, brazing, braze welding; welding codes, welding symbols, design of welded joints, defects and inspection; introduction to modern welding processes - friction, ultrasonic, explosive, electron beam, laser and plasma.

Machining and Machine Tool Operations: Machining processes-turning, drilling, boring, milling, shaping, planing, sawing, gear cutting, thread production, broaching, grinding, lapping, honing super finishing; mechanics of cutting- Merchant's analysis, geometry of cutting tools, cutting forces, power requirements; selection of process parameters; tool materials, tool wear and tool life, cutting fluids, machinability; nontraditional machining processes and hybrid processes- EDM, CHM, ECM, USM, LBM, EBM, AJM, PAM AND WJM; economics of machining.

Metrology and Inspection: Limits and fits, linear and angular measurements by mechanical and optical methods, comparators; design of limit gauges; interferometry; measurement of straightness, flatness, roundness, squareness and symmetry; surface finish measurement; inspection of screw threads and gears; alignment testing.

Powder Metallurgy and Processing of Plastics: Production of powders, compaction, sintering; Polymers and composites; injection, compression and blow molding, extrusion, calendaring and thermoforming; molding of composites.

Tool Engineering: Work-holding-location and clamping; principles and methods; design of jigs and fixtures; design of press working tools, forging dies.

Manufacturing Analysis: Sources of errors in manufacturing; process capability; part-print analysis; tolerance analysis in manufacturing and assembly; process planning; parameter selection and comparison of production alternatives; time and cost analysis; Issues in choosing manufacturing technologies and strategies.

Computer Integrated Manufacturing: Basic concepts of CAD, CAM, CAPP, group technology, NC, CNC, DNC, FMS, Robotics and CIM.

INDUSTRIAL ENGINEERING

Product Design and Development: Principles of good product design, component and tolerance design; efficiency, quality and cost considerations; product life cycle; standardization, simplification, diversification, value analysis, concurrent engineering.

Engineering Economy and Costing: Financial statements; elementary cost accounting, methods of depreciation; break-even analysis, techniques for evaluation of capital investments.

Work System Design: Taylor's scientific management, Gilbreths's contributions; productivity concepts and measurements; method study, micro-motion study, principles of motion economy; human factors engineering, ergonomics; work measurement - time study, PMTS, work sampling; job evaluation, merit rating, wage administration, incentive systems; business process reengineering.

Logistics and Facility Design: Facility location factors, evaluation of alternatives, types of plant layout, evaluation; computer aided layout; assembly line balancing; material handling systems; supply chain management.

Production Planning and Inventory Control: Inventory Function costs, classifications - deterministic and probabilistic models; quantity discount; safety stock; inventory control system; Forecasting techniques - causal and time series models, moving average, exponential smoothing; trend and seasonality; aggregate production planning; master scheduling; bill of materials and material requirement planning; order control and flow control, routing, scheduling and priority dispatching; JIT; Kanban PULL systems; bottleneck scheduling and theory of constraints.

Operation Research: Linear programming - problem formulation, simplex method, duality and sensitivity analysis; transportation; assignment; network flow models, constrained optimization and Lagrange multipliers; simple queuing models; dynamic programming; simulation; PERT and CPM, time-cost trade-off, resource leveling.

Quality Control: Taguchi method; design of experiments; quality costs, statistical quality assurance, process control charts, acceptance sampling, zero defects; quality circles, total quality management.

Reliability and Maintenance: Reliability, availability and maintainability; probabilistic failure and repair times; system reliability; preventive maintenance and replacement, TPM.

Management Information System: Value of information; information storage and retrieval system - database and data structures; interactive systems; knowledge based systems.

Intellectual Property System: Definition of intellectual property, importance of IPR; TRIPS, and its implications, WIPO and Global IP structure, and IPS in India; patent, copyright, industrial design and trademark; meanings, rules and procedures, terms, infringements and remedies.

PY - PHARMACEUTICAL SCIENCES

Natural Products: Pharmacognosy & Phytochemistry - Chemistry, tests, isolation, characterization and estimation of phytopharmaceuticals belonging to the group of Alkaloids, Glycosides, Terpenoids, Steroids, Bioflavanoids, Purines, Guggul lipids. Pharmacognosy of crude drugs which contain the above constituents. Standardisation of raw materials and herbal products. WHO guide lines. Quantitative microscopy including modern techniques used for evaluation. Biotechnological principles and techniques for plant development Tissue culture.

Pharmacology: General pharmacological principles including Toxicology. Drug interaction. Pharmacology of drugs acting on Central nervous system, Cardiovascular system, Autonomic nervous system, Gastro intestinal system and Respiratory system. Pharmacology of Autocoids, Hormones, Chemotherapeutic agents including anticancer drugs. Bioassays. Immuno Pharmacology.

Medicinal Chemistry: Structure, nomenclature, classification, synthesis, SAR and metabolism of the following category of drugs which are official in Indian Pharmacopoeia and British Pharmacopoeia Hypnotics and Sedatives, Analgesics, NSAIDS, Neuroleptics, Antidepressants, Anxiolytics, Anticonvulsants, Antihistaminics, Local anaesthetics, Cardio Vascular drugs - Antianginal agents Vasodilators, Adrenergic & cholinergic drugs, Cardiotonic agents, Diuretics, Antihypertensive drugs, Hypoglycemic agents, Antilipedmic agents, Coagulants, Anticoagulants, Antiplatelet agents. Chemotherapeutic agents - Antibiotics, Antibacterials, Sulphadrugs. Antiproliozoal drugs, Antiviral, Antitubercular, Antimalarial, Anticancer, Antiamoebic drugs. Diagnostic agents. Preparation and storage and uses of official Radiopharmaceuticals. Vitamins and Hormones.

Pharmaceutics: Development, manufacturing standards, labeling, packing as per the pharmacopoeal requirements, Storage of different dosage forms and new drug delivery systems. Biopharmaceutics and Pharmacokinetics and their importance in formulation. Formulation and preparation of cosmetics - lipstick, shampoo, creams, nail preparations and dentifrices. Pharmaceutical calculations.

Pharmaceutical Jurisprudence: Legal aspects of manufacture, storage, sale of drugs. D and C act and rules. Pharmacy act.

Pharmaceutical Analysis: Principles, instrumentation and applications of the following. Absorption spectroscopy (UV, visible & IR), Fluorimetry, Flame photometry, Potentiometry, Conductometry and Plarography. Pharmacopoeial assays. Principles of NMR, ESR, Mass spectroscopy, X-ray diffraction analysis and different chromatographic methods.

Biochemistry and Clinical Pharmacy: Biochemical role of hormones, Vitamins, Enzymes, Nucleic acids. Bioenergetics. General principles of immunology. Immunological techniques. Adverse drug interaction.

Microbiology: Principles and methods of microbiological assays of the Pharmacopoeia. Methods of preparation of official sera and vaccines. Serological and diagnostic tests. Applications of microorganisms in Bio Conversions and in Pharmaceutical industry.

TF - TEXTILE ENGINEERING AND FIBRE SCIENCE

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

TEXTILE ENGINEERING & FIBRE SCIENCE

Textile Fibres: Classification of textile fibres according to their nature and origin; general characteristics of textile fibres-their chemical and physical structures and their properties; essential characteristics of fibre forming polymers; uses of natural and man-made fibres; physical and chemical methods of fibre and blend identification and blend analysis.

Melt Spinning processes with special reference to polyamide and polyester fibres; wet and dry spinning of viscose and acrylic fibres; post spinning operations-drawing, heat setting, texturing- false twist and air-jet, tow-to-top conversion. Methods of investigating fibre structure e.g. X-ray diffraction, birefringence, optical and electron microscopy, I.R. absorption, thermal methods; structure and morphology and principal natural and man-made fibres, mechanical properties of fibres, moisture sorption in fibres; fibre structure and property correlation.

Textile Testing: Sampling techniques, sample size and sampling errors; measurement of fibre length, fineness, crimp, strength and reflectance; measurement of cotton fibre maturity ad trash content; HVI and AFIS for fibre testing. Measurement of yarn count, twist and hairiness; tensile testing of fibres, yarn and fabrics; evenness testing of slivers, rovings and yarns; testing equipment for measurement test methods of fabric properties like thickness, compressibility, air permeability, drape, crease recovery, tear strength bursting strength and abrasion resistance. Correlation analysis, significance tests and analysis of variance; frequency distributions and control charts.

Yarn Manufacture and Yarn Structure: Modern methods of opening, cleaning and blending of fibrous materials; the technology of carding with particular reference to modern developments; causes of irregularity introduced by drafting, the development of modern drafting systems; principles and techniques of preparing material for combing; recent development in combers; functions and synchronization of various mechanisms concerned with roving production; forces acting on yarn and traveller, ring and traveller designs; causes of end breakages; properties of doubles yarns; new methods of yarn production such as rotor spinning, air jet spinning and friction spinning.

Yarn diameter; specific volume, packing coefficient; twist-strength relationship; fibre orientation in yarn; fibre migration.

Fabric Manufacture and Fabric Structure: Principles of cheese and cone winding processes and machines; random and precision winding; package faults and their remedies; yarn clearers and tensioners; different systems of yarn splicing; features of modern cone winding machines; different types of warping creels; features of modern beam and sectional warping machines; different sizing systems, sizing of spun and filament yarns, modern sizing machines; principles of pirn winding processes and machines; primary and secondary motions of loom, effect of their settings and timings on fabric formation, fabric appearance and weaving performance; dobby and jacquard shedding; mechanics of weft insertion with shuttle; warp and weft stop motions, warp protection, weft replenishment; functional principles of weft insertion systems of shuttleless weaving machines, principles of multiphase and circular looms. Principles of weft and warp knitting; basic weft and warp knitted structures; classification, production and areas of application of nonwoven fabrics.

Basic woven fabric constructions and their derivatives; crepe, cord, terry, gauze, lino and double cloth constructions.

Peirce's equations for fabric geometry; thickness, cover and maximum sett of woven fabrics

Textile Chemical Processing: Preparatory processes for natural-and and their blends; mercerization of cotton; machines for yarn and fabric mercerization.

Dyeing and printing of natural- and synthetic- fibre fabrics and their blends with different dye classes; dyeing and printing machines; styles of printing; fastness properties of dyed and printed textile materials.

Finishing of textile materials, wash and wear, durable press, soil release, water repellent, flame retardant and antistatic finishes; shrink-resistance finish for wool; heat setting of synthetic-fibre fabrics, finishing machines; energy efficient processes; pollution control.

XE - ENGINERING SCIENCES

The syllabi of the sections of this paper are as follows:

SECTION A. ENGINEERING MATHEMATICS (Compulsory)

Linear Algebra : Determinates, algebra of matrices, rank, inverse, system of linear equations, symmetric, skew-symmetric and orthogonal matrices. Hermitian, skew-hermitian and unitary matrices. eigenvalues and eigenvectors, diagonalisation of matrices, Cayley-Hamiltonian, quadratic forms.

Calculus : Functions of single variables, limit, continuity and differentiability, Mean value theorems, Intermediate forms and L'Hospital rule, Maxima and minima, Taylor's series, Fundamental and mean value-theorems of integral calculus. Evaluation of definite and improper integrals, Beta and Gamma functions, Functions of two variables, limit, continuity, partial derivatives, Euler's theorem for homogeneous functions, total derivatives, maxima and minima, Lagrange method of multipliers, double and triple integrals and their applications, sequence and series, tests for convergence, power series, Fourier Series, Fourier integrals.

Complex variable: Analytic functions, Cauchy's integral theorem and integral formula without proof. Taylor's and Laurent' series, Residue theorem (without proof) with application to the evaluation of real integarls.

Vector Calculus: Gradient, divergence and curl, vector identities, directional derivatives, line, surface and volume integrals, Stokes, Gauss and Green's theorems (without proofs) with applications.

Ordinary Differential Equations: First order equation (linear and nonlinear), higher order linear differential equations with constant coefficients, method of variation of paramaters, Cauchy's and Euler's equations, initial and boundary value problems, power series solutions, Legendre polynomials and Bessel's functions of the first kind.

Partial Differential Equations: Variables separable method, solutions of one dimensional heat, wave and Laplace equations.

Probability and Statistics: Definitions of probability and simple theorems, conditional probability, mean, mode and standard deviation, random variables, discrete and continuous distributions, Poisson, normal and Binomial distribution, correlation and regression

Numerical Methods: L-U decomposition for systems of linear equations,Newton-Raphson method, numerical integration(trapezoidal and Simpson's rule), numerical methods for first order differential equation (Euler method)

SECTION B. COMPUTATIONAL SCIENCE

Numerical Methods: Truncation errors, round off errors and their propagation; Interpolation; Lagrange, Newton's forward, backward and divided difference formulas, least square curve fitting, solution of non-linear equations of one variables using bisection, false position, secant and Newton Raphson methods; Rate of convergence of these methods, general iterative methods. Simple and multiple roots of polynomials. Solutions of system of linear algebraic equations using Gauss elimination methods, Jacobi and Gauss-Seidel iterative methods and their rate of convergence; ill conditioned and well conditioned system. eigen values and eigen vectors using power methods. Numerical integration using trapezoidal, Simpson's rule and other quadrature formulas. Numerical Differentiation. Solution of boundary value problems. Solution of initial value problems of ordinary differential equations using Euler's method, predictor corrector and Runge Kutta method.

Programming : Elementary concepts and terminology of a computer system and system software, Fortran77 and C programming.

Fortran : Program organization, arithmetic statements, transfer of control, Do loops, subscripted variables, functions and subroutines.

C language : Basic data types and declarations, flow of control- iterative statement, conditional statement, unconditional branching, arrays, functions and procedures.

SECTION C. ELECTRICAL SCIENCES

Electric Circuits: Ideal voltage and current sources; RLC circuits, steady state and transient analysis of DC circuits, network theorems; alternating currents and voltages, single-phase AC circuits, resonance; three-phase circuits.

Magnetic circuits: Mmf and flux, and their relationship with voltage and current; transformer, equivalent circuit of a practical transformer, three-phase transformer connections.

Electrical machines: Principle of operation, characteristics, efficiency and regulation of DC and synchronous machines; equivalent circuit and performance of three-phase and single-phase induction motors.

Electronic Circuits: Characteristics of p-n junction diodes, zener diodes, bipolar junction transistors (BJT) and junction field effect transistors (JFET); MOSFET's structure, characteristics, and operations; rectifiers, filters, and regulated power supplies; biasing circuits, different configurations of transistor amplifiers, class A, B and C of power amplifiers; linear applications of operational amplifiers; oscillators; tuned and phase shift types.

Digital circuits: Number systems, Boolean algebra; logic gates, combinational circuits, flip-flops (RS, JK, D and T) counters.

Measuring instruments: Moving coil, moving iron, and dynamometer type instruments; shunts, instrument transformers, cathode ray oscilloscopes; D/A and A/D converters.

SECTION D. FLUID MECHANICS

Fluid Properties: Relation between stress and strain rate for Newtonian fluids

Hydrostatics, buoyancy, manometry

Concept of local and convective accelerations; control volume analysis for mass, momentum and energy conservation.

Differential equations of continuity and momentum (Euler's equation of motion); concept of fluid rotation, stream function, potential function; Bernoulli's equation and its applications.

Qualitative ideas of boundary layers and its separation; streamlined and bluff bodies; drag and lift forces.

Fully-developed pipe flow; laminar and turbulent flows; friction factor; Darcy Weisbach relation; Moody's friction chart; losses in pipe fittings; flow measurements using venturimeter and orifice plates.

Dimensional analysis; similitude and concept of dynamic similarity; importance of dimensionless numbers in model studies.

SECTION E. MATERIALS SCIENCE

Atomic structure and bonding in materials: metals, ceramics and polymers.

Structure of materials: Crystal systems, unit cells and space lattice; determination of structures of simple crystals by X-ray diffraction; Miller indices for planes and directions. Packing geometry in metallic, ionic and covalent solids.

Concept of amorphous, single and polycrystalline structures and their effects on properties of materials.

Imperfections in crystalline solids and their role in influencing various properties.

Fick´s laws of diffusion and applications of diffusion in sintering, doping of semiconductors and surface hardening of metals.

Alloys: solid solution and solubility limit. Binary phase diagram, intermediate phases and intermetallic compounds; iron-iron carbide phase diagram. Phase transformation in steels. Cold and hot working of metals, recovery, recrystallization and grain growth.

Properties and applications of ferrous and nonferrous alloys.

Structure, properties, processing and applications of traditional and advanced ceramics.

Polymers: classification, polymerization, structure and properties, additives for polymer products, processing and application.

Composites: properties and application of various composites.

Corrosion and environmental degradation of materials (metals, ceramics and polymers).

Mechanical properties of materials: Stress-strain diagrams of metallic, ceramic and polymeric materials, modulus of elasticity, yield strength, plastic deformation and toughness, tensile strength and elongation at break; viscoelasticity, hardness, impact strength. ductile and brittle fracture. creep and fatigue properties of materials.

Heat capacity, thermal conductivity, thermal expansion of materials.

Concept of energy band diagram for materials; conductors, semiconductors and insulators in terms of energy bands. Electrical conductivity, effect of temperature on conductivity in materials, intrinsic and extrinsic semiconductors, dielectric properties of materials.

Refraction, reflection, absorption and transmission of electromagnetic radiation in solids.

Origin of magnetism in metallic and ceramic materials, paramagnetism, diamagnetism, antiferromagnetism, ferromagnetism, ferrimagnetism in materials and magnetic hysteresis.

Advanced materials: Smart materials exhibiting ferroelectric, piezoelectric, optoelectronic, semiconducting behaviour; lasers and optical fibers; photoconductivity and superconductivity in materials.

SECTION F. SOLID MECHANICS

Equivalent force systems; free-body diagrams; equilibrium equations; analysis of determinate and indeterminate trusses and frames; friction.

Simple relative motion of particles; force as function of position, time and speed; force acting on a body in motion; laws of motion; law of conservation of energy; law of conservation of momentum

Stresses and strains; principal stresses and strains; Mohr's circle; generalized Hooke's Law; equilibrium equations; compatibility conditions; yield criteria.

Axial, shear and bending moment diagrams; axial, shear and bending stresses; deflection (for symmetric bending); torsion in circular shafts; thin cylinders; energy methods (Castigliano's Theorems); Euler buckling.

SECTION G. THERMODYNAMICS

Basic Concepts: Continuum, macroscopic approach, thermodynamic system (closed and open or control volume); thermodynamic properties and equilibrium; state of a system, state diagram, path and process; different modes of work; Zeroth law of thermodynamics; concept of temperature; heat.

First Law of Thermodynamics: Energy, enthalpy, specific heats, first law applied to systems and control volumes, steady and unsteady flow analysis.

Second Law of Thermodynamics: Kelvin-Planck and Clausius statements, reversible and irreversible processes, Carnot theorems, thermodynamic temperature scale, Clausius inequality and concept of entropy, principle of increase of entropy; availability and irreversibility.

Properties of Pure Substances: Thermodynamic properties of pure substances in solid, liquid and vapour phases, P-V-T behaviour of simple compressible substances, phase rule, thermodynamic property tables and charts, ideal and real gases, equations of state, compressibility chart.

Thermodynamic Relations: T-ds relations, Maxwell equations, Joule-Thomson coefficient, coefficient of volume expansion, adiabatic and isothermal compressibilities, Clapeyron equation.

Ideal Gas Mixtures: Dalton's and Amagat's laws, calculations of properties, air-water vapour mixtures.

XL - LIFE SCIENCES

The syllabi of the Sections of this paper are as follows:

SECTION H. CHEMISTRY (Compulsory)

Atomic structure and periodicity: Quantum chemistry; Planck's quantum theory, wave particle duality, uncertainty principle, quantum mechanical model of hydrogen atom; electronic configuration of atoms; periodic table and periodic properties; ionization energy, election affinity, electronegativity, atomic size.

Structure and bonding: Ionic and covalent bonding M.O. and V.B. approaches for diatomic molecules, VSEPR theory and shape of molecules, hybridisation, resonance, dipole moment, structure parameters such as bond length, bond angle and bond energy, hydrogen bonding, van der Waals interactions. Ionic solids; ionic radii, lattice energy (Born-Haber Cycle).

s.p. and d Block Elements: Oxides, halides and hydrides of alkali and alkaline earth metals, B, Al, S, N, P and S, silicones, general characteristics of 3d elements, coordination complexes: valence bond and crystal field theory, color, geometry and magnetic properties.

Chemical Equilibria: Colligative properties of solutions, ionic equilibria in solution, solubility product, common ion effect, hydrolysis of salts, pH, buffer and their applications in chemical analysis.

Electrochemistry: Conductance, Kohlrausch law, Half Cell potentials, emf, Nernst equation, galvanic cells, thermodynamic aspects and their applications.

Reaction Kinetics: Rate constant, order of reaction, molecularity, activation energy, zero, first and second order kinetics, equilibrium constants (Kc, Kp and Kx) for homogeneous reactions, catalysis and elementary enzyme reactions.

Thermodynamics: First law, reversible and irreversible processes, internal energy, enthalpy, Kirchoff's equation, heat of reaction, Hess law, heat of formation, Second law, entropy, free energy, and work function. Gibbs-Helmholtz equation, Clausius-Clapeyron equation, free energy change and equilibrium constant, Troutons rule, Third law of thermodynamics.

Mechanistic Basis of Organic Reactions: Elementary treatment of SN1, SN2, E1 and E2 reactions, Hoffmann and Saytzeff rules, Addition reactions, Markonikoff rule and Kharash effect, Diels-Alder reaction, aromatic electrophilic substitution, orientation effect as exemplified by various functional groups.

Structure-Reactivity Correlations: Acids and bases, electronic and steric effects, optical and geometrical isomerism, tautomerism, concept of aromaticity

SECTION I. BIOCHEMISTRY

Organization of life. Importance of water. Cell structure and organelles. Structure and function of biomolecules: Carbohydrates, Lipids, Proteins and Nucleic acids. Biochemical separation techniques. Spectroscopic methods; UV-visible and fluorescence. Protein structure, folding and function: Myoglobin, Hemoglobin, Lysozyme, ribonuclease A, Carboxypeptidase and Chymotrypsin. Enzyme kinetics and regulation, Coenzymes.

Metabolism and bioenergitics. Generation and utilization of ATP. Photosynthesis. Major metabolic pathways and their regulation. Biological membranes. Transport across membranes. Signal transduction; hormones and neurotransmitters.

DNA replication, transcription and translation. Biochemical regulation of gene expression. Recombinant DNA technology and applications. Genomics and Proteomics.

The immune system. Active and passive immunity. Complement system. Antobody structure, function and diversity. Cells of the immune system: T, B and macrophages. T and B cell activation. Major histocompatibilty complex. T cell receptor. Immunological techniques: Immunodiffusion, immunoelectrophoresis, RIA and ELISA.

SECTION J. BIOTECHNOLOGY

Recombinant DNA technology for the production of therapeutic proteins. Micro array technology. Heterologous protein expression systems in bacteria, yeast etc.

Architecture of plant genome; plant tissue culture techniques; methods of gene transfer into plant cells; manipulation of phenotypic traits in plants; plant cell fermentations and production of secondary metabolites using suspension/ immobilized cell culture; methods for plant micro propagation; crop improvement and development of transgenic plants. Expression of animal proteins in plants.

Animal cell metabolism and regulation; cell cycle; primary cell culture; nutritional requirements for animal cell culture; techniques for the mass culture of animal cell lines; production of vaccines; growth hormones and interferons using animal cell culture; cytokines-production and therapeutic uses; hybridoma technology; vectors for gene transfer and expression in animal cells. Transgenic animals and molecular pharming.

Microbial production of industrial enzymes; methods for immobilization of enzymes; kinetics of soluble and immobilized enzymes; application of soluble and immobilized enzymes; enzyme-based sensors.

Microbial growth kinetics; batch, fed batch and continuous culture of microbial cells; media for industrial fermentations; sterilization of air and media; design features and operation of stirred tank, air-lift and fluidized bed reactors; aeration and agitation in aerobic fermentations; recovery and purification of fermentation products- filtration, centrifugation, cell disintegration, solvent extraction and chromatographic separations; industrial fermentations for the production of ethanol, citric acid, lysine, penicillin and other biomolecules; simple calculations based on material and energy balance of fermentation processes; application of microbes in the management of domestic and industrial wastes.

SECTION K. BOTANY

Anatomy: Roots, stem and leaves of land plants, meristems, vascular system, their ontogeny, structure and functions. Plant cell structure, organisation, organelles, cytoskeleton, cell wall and membranes.

Development: Cell cycle, cell division, senescence, hormonal regulation of growth; life cycle of an angiosperm, pollination, fertilization, embryogenesis, seed formation, seed storage proteins, seed dormancy and germination. Concept of cellular totipotency, organogenesis and somatic embryogenesis, somaclonal variation, embryo culture, in vitro fertilization.

Physiology and Biochemistry: Plant water relations, transport of minerals and solutes, N2 metabolism, proteins and nucleic acid, respiration, photophysiology, photosynthesis, photorespiration; biosynthesis, mechanism of action and physiological effects of plant growth regulators.

Genetics: Principles of Mendelian inheritance, linkage, recombination and genetic mapping;

extrachromosomal inheritance; eukaryotic genome organization (chromatin structure) and regulation of gene expression, gene mutation, chromosome aberrations (numerical and structural), transposons.

Plant Breeding: Principles, methods - selection, hybridization, heterosis; male sterility, self and inter-specific incompatibility; haploidy; somatic cell hybridization; molecular marker-assisted selection; gene transfer methods viz. direct and vector-mediated, transgenic plants and their applications in agriculture.

Economic Botany: Economically important plants - cereals, pulses, plants yielding fiber, timber, sugar, beverages, oils, rubber, dyes, gums, drugs and narcotics - a general account.

Systematics: Systems of classification (non-phylogenetic vs. phylogenetic - outline), plant groups, molecular systematics.

Plant Pathology: Nature and classification of plant diseases, diseases of important crops caused by fungi, bacteria and viruses, and their control measures, mechanism(s) of pathogenesis and resistance, molecular detection of pathogens; plant-microbe beneficial interactions.

Ecology and Plant Geography: Ecosystems - types, dynamics, degradation, ecological succession; food chains; vegetation types of the world; pollution and global warming; speciation and extinction, conservation strategies, cryopreservation.

SECTION L. MICROBIOLOGY

Historical perspective - Discovery of the microbial world; Controversy over spontaneous generation; Role of microorganisms in transformation of organic matter and in the causation of diseases.

Methods in microbiology - Pure culture techniques; Theory and practice of sterilization; Principles of microbial nutrition; Construction of culture media; Enrichment culture techniques for isolation of chemoautotrophs, chemoheterotrophs and photosynthetic microorganisms.

Microbial evolution, systematics and taxonomy - Evolution of earth and earliest life forms; Primitive organisms and their metabolic strategies; New approaches to bacterial taxonomic classification including ribotyping; Nomenclature.

Microbial diversity - Bacteria, archea and their broad classification; Eukaryotic microbes, yeast, fungi, slime mold and protozoa; Viruses and their classification.

Microbial growth -The definition of growth, mathematical expression of growth, growth curve, measurement of growth and growth yields; Synchronous growth; Continuous culture.

Nutrition and metabolism - Overview of metabolism; Microbial nutrition; Energy classes of microorganisms; Culture media; Energetics, modes of ATP generation; ATP generation by heterotrophs; Fermentation; Glycolysis; Respiration; The citric acid cycle; Electron transport systems; Alternate modes of energy generation; Pathways (anabolism) in the biosynthesis of amino acids, purines, pyrimidines and fatty acids.

Metabolic diversity among microorganisms - Photosynthesis in microorganisms; Role of chlorophylls, carotenoids and phycobilins; Calvin cycle; Chemolithotrophy; Hydrogen- iron-nitrite-oxidizing bacteria; Nitrate and sulfate reduction; Methanogenesis and acetogenesis.

Prokaryotic cells: structure-function - Cells walls of eubacteria (peptidoglycan) and related molecules; Outer-membrane of gram-negative bacteria; Cell wall and cell membrane synthesis; Flagella and motility; Cell inclusions like endospores, gas vesicles.

Microbial diseases and host parasite relationships - Normal microflora of skin; Oral cavity;

Gastrointestinal tract; Entry of pathogens into the host; Infectious disease transmission; Respiratory infections caused by bacteria and viruses; Tuberculosis; Sexually transmitted diseases including AIDS; Diseases transmitted by animals (Rabies, plague), insects and ticks (rikettsias, Lyme disease, malaria); Food and water borne diseases; Public health and water quality; Pahtogenic fungi; Emerging and resurgent infectious diseases.

Chemotherapy/Antibiotics - Antimicrobial agents; Sulfa drugs; Antibiotics; Pencillins and cephalosporins; Broad-spectrum antibiotics; Antibiotics from prokaryotes; Antifungal antibiotics; Mode of action; Resistance to antibiotics.

Microbial genetics - Genes, mutation and mutagenesis - UV and chemical mutagnes; Types of mutations; Ames test for mutagenesis; Methods of genetic analysis. Bacterial genetic system - Transformation; Conjugation; Transduction; Recombination; Plasmids and Transposons; Bacterial genetic map with reference to E. coli. Viruses and their genetic system - Phage ? and its life cycle; RNA phages; RNA viruses; Retroviruses; Genetic systems of yeast and Neurospora; Extrachromosomal inheritance and mitochondrial genetics; Basic concept of genomics.

SECTION M. ZOOLOGY

Animal world: Animal diversity, distribution, systematic and classification of animals, the phylogenetic relationship.

Evolution: Origin of life, history of life on earth, evolutionary theories, natural selection, adaptation, speciation.

Genetics: Principles of inheritance, molecular basis of heredity, the genetic material, transmission of genetic material, mutations, cytoplasmic inheritance.

Biochemistry and Molecular Biology: Nucleic acids, proteins and other biological macromolecules. Replication, transcription and translation, regulation of gene expression, organization of genome, Kreb's cycle, glycolysis, enzyme catalysis, hormones and their action.

Cell Biology: Structure of cell, cellular organelles and their structure and function, cell cycle, cell division, cellular differentiation, chromosome and chromatin structure. Eukaryotic gene organisation and expression.

Animal Anatomy and Physiology: Comparative physiology, the respiratory system, circulatory system, digestive system, the nervous system, the excretory system, the endocrine system, the reproductive system, the skeletal system, osmoregulation.

Parasitology and Immunology: Nature of parasite, host-parasite relation, protozoan and helminthic parasites, the immune response, cellular and humoral immune response, evolution of the immune system.

Development Biology: Embryonic development, cellular differentiation, organogenesis, metamorphosis, genetic basis of development.

Ecology: The ecosystem, habitats the food chain, population dynamics, species diversity, zoogeography, biogeochemical cycles, conservation biology.

Animal Behaviour: Types of behaviours, courtship, mating and territoriality, instinct, learning and memory, social behaviour across the animal taxa, communication, pheromones, evolution of animal behaviour.

IT - INFORMATION TECHNOLOGY

ENGINEERING MATHEMATICS

Mathematical Logic: Propositional Logic; First Order Logic.

Probability: Conditional Probability; Mean, Median, Mode and Standard Deviation; Random Variables; Distributions; uniform, normal, exponential, Poisson, Binomial.

Set Theory & Algebra: Sets; Relations; Functions; Groups; Partial Orders; Lattice; Boolean Algebra.

Combinatorics: Permutations; Combinations; Counting; Summation; generating functions; recurrence relations; asymptotics.

Graph Theory: Connectivity; spanning trees; Cut vertices & edges; covering; matching; independent sets; Colouring; Planarity; Isomorphism.

Linear Algebra: Algebra of matrices, determinants, systems of linear equations, Eigen values and Eigen vectors.

Numerical Methods: LU decomposition for systems of linear equations; numerical solutions of non linear algebraic equations by Secant, Bisection and Newton-Raphson Methods; Numerical integration by trapezoidal and Simpson's rules.

Calculus: Limit, Continuity & differentiability, Mean value Theorems, Theorems of integral calculus, evaluation of definite & improper integrals, Partial derivatives, Total derivatives, maxima & minima.

FORMAL LANGUAGES AND AUTOMATA

Regular Languages: finite automata, regular expressions, regular grammar.

Context free languages: push down automata, context free grammars

COMPUTER HARDWARE

Digital Logic: Logic functions, minimization, design and synthesis of combinatorial and sequential circuits, number representation and computer arithmetic (fixed and floating point)

Computer organization: Machine instructions and addressing modes, ALU and data path, hardwired and microprogrammed control, memory interface, I/O interface (interrupt and DMA mode), serial communication interface, instruction pipelining, cache, main and secondary storage

SOFTWARE SYSTEMS

Data structures and Algorithms: the notion of abstract data types, stack, queue, list, set, string, tree, binary search tree, heap, graph, tree and graph traversals, connected components, spanning trees, shortest paths, hashing, sorting, searching, design techniques (greedy, dynamic, divide and conquer), asymptotic analysis (best, worst, average cases) of time and space, upper and lower bounds, intractability

Programming Methodology: C programming, program control (iteration, recursion, functions), scope, binding, parameter passing, elementary concepts of object oriented programming

Operating Systems (in the context of Unix): classical concepts (concurrency, synchronization, deadlock), processes, threads and interprocess communication, CPU scheduling, memory management, file systems, I/O systems, protection and security

Information Systems and Software Engineering: information gathering, requirement and feasibility analysis, data flow diagrams, process specifications, input/output design, process life cycle, planning and managing the project, design, coding, testing, implementation, maintenance.

Databases: relational model, database design, integrity constraints, normal forms, query languages (SQL), file structures (sequential, indexed), b-trees, transaction and concurrency control

Data Communication: data encoding and transmission, data link control, multiplexing, packet switching, LAN architecture, LAN systems (Ethernet, token ring), Network devices: switches, gateways, routers

Networks: ISO/OSI stack, sliding window protocols, routing protocols, TCP/UDP, application layer protocols & systems (http, smtp, dns, ftp), network security

Web technologies: three tier web based architecture; JSP, ASP, J2EE, .NET systems; html, XML

AG - AGRICULTURAL ENGINEERING

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

FARM MACHINERY AND POWER:

Sources of power on the farm-human, animal, mechanical, electrical, wind, solar and biomass; design and selection of machine elements - gears, pulleys, chains and sprockets and belts; overload safety devices used in farm machinery; measurement of force, torque, speed, displacement and acceleration on machine elements.

Soil tillage; forces acting on a tillage tool; hitch systems and hitching of tillage implements; functional requirements, principles of working, construction and operation of manual, animal and power operated equipment for tillage. sowing, planting, fertilizer application, inter-cultivation, spraying, mowing, chaff cutting, harvesting, threshing and transport; testing of agricultural machinery and equipment; calculation of performance parameters -field capacity, efficiency, application rate and losses; cost analysis of implements and tractors.

Thermodynamic principles of I.C. engines; I.C. engine cycles; engine components; fuels and combustion; lubricants and their properties; I.C. engine systems - fuel, cooling, lubrication, ignition, electrical, intake and exhaust; selection, operation, maintenance and repair of I.C. engines; power efficiencies and measurement; calculation of power, torque, fuel consumption, heat load and power losses.

Tractors and power tillers - type, selection, maintenance and repair; tractor clutches and brakes; power transmission systems - gear trains, differential, final drives and power take-off; mechanics of tractor chassis; traction theory; three point hitches- free link and restrained link operations; mechanical steering and hydraulic control systems used in tractors; human engineering and safety in tractor design; tractor tests and performance.

SOIL AND WATER CONSERVATION ENGINEERING:

Ideal and real fluids, properties of fluids; hydrostatic pressure and its measurement; hydrostatic forces on plane and curved surface; continuity equation; Bernoulli's theorem; laminar and turbulent flow in pipes, Darcy-Weisbach and Hazen-Williams equations, Moody's diagram; flow through orifices and notches; flow in open channels.

Engineering properties of soils, fundamental definitions and relationships; index properties of soils; permeability and seepage analysis; shear strength, Mohr's circle of stresses; active and passive earth pressures; stability of slopes.

Hydrological cycle; precipitation measurement, analysis of precipitation data; abstraction from precipitation; runoff; hydrograph analysis, unit hydrograph theory and application; stream flow measurement; flood routing, hydrological reservoir and channel routing.

Mechanics of soil erosion, factors affecting erosion; soil loss estimation; biological and engineering measures to control erosion, terraces and bunds; vegetative waterways; gully control structures, drop, drop inlet and chute spillways; farm ponds; earthen dams; principles of watershed management.

Water requirement of crops; consumptive use and evapo-transpiration; irrigation scheduling; irrigation efficiencies; design of prismatic and silt loaded channels; methods of irrigation water application; design and evaluation of irrigation methods; drainage coefficient; surface and subsurface drainage systems; leaching requirement and salinity control; irrigation and drainage water quality; classification of pumps; pump characteristics; pump selection; types of aquifer; evaluation of aquifer properties; well hydraulics; ground water recharge.

AGRICULTURAL PROCESSING AND FOOD ENGINEERING:

Steady state heat transfer in conduction, convection and radiation; transient heat transfer in simple geometry; condensation and boiling heat transfer; working principles of heat exchangers; diffusive and convective mass transfer; simultaneous heat and mass transfer in agricultural processing operations.

Material and energy balances in food processing systems; water activity, sorption and desorption isotherms; centrifugal separation of solids, liquids and gases; kinetics of microbial death - pasteurisation and sterilization of liquid foods; preservation of food by cooling and freezing; psychrometry - properties of air-vapour mixture; concentration and dehydration of liquid foods - evaporators, tray, drum and spray dryers.

Mechanics and energy requirement in size reduction of granular solids; particle size analysis for comminuted solids; size separation by screening; fluidisation of granular solids; cleaning and grading efficiency and effectiveness of grain cleaners; conditioning and hydrothermal treatments for grains; dehydration of food grains; processes and machines for processing of cereals, pulses and oilseeds; design considerations for grain silos.

AR - ARCHITECTURE AND PLANNING

City planning: Historical development of cities; principles of city planning; new towns; survey methods, site planning, planning regulations and building bye-laws.

Housing: Concept of shelter; housing policies and design; community planning; role of government agencies; finance and management.

Landscape Design: Principles of landscape design and site planning; history and landscape styles; landscape elements and materials; planting design.

Computer Aided Design: Application of computers in architecture and planning; understanding elements of hardware and software; computer graphics; programming languages - C and Visual Basic and usage of packages such as AutoCAD.

Environmental and Building Science: Elements of environmental science; ecological principles concerning environment; role of micro-climate in design; climatic control through design elements; thermal comfort; elements of solar architecture; principles of lighting and illumination; basic principles of architectural acoustics; air pollution, noise pollution and their control.

Visual and Urban Design: Principles of visual composition; proportion, scale, rhythm, symmetry, harmony, balance, form and colour; sense of place and space, division of space; focal point, vista, imageability, visual survey.

History of Architecture: Indian - Indus valley, Vedic, Buddhist, Indo-Aryan, Dravidian and Mughal periods; European - Egyptian, Greek, Roman, medieval and renaissance periods.

Development of Contemporary Architecture: Architectural developments and impacts on society since industrial revolution; influence of modern art on architecture; works of national and international architects; post modernism in architecture.

Building Services: Water supply, Sewerage and Drainage systems; Sanitary fittings and fixtures; principles of electrification of buildings; elevators, their standards and uses; air-conditioning systems; fire fighting systems.

Building Construction and Management: Building construction techniques, methods and details; building systems and prefabrication of building elements; principles of modular coordination; estimation, specification, valuation, professional practice; project management, PERT, CPM.

Materials and Structural Systems: Behavioural characteristics of all types of building materials e.g. mud, timber, bamboo, brick, concrete, steel, glass, FRP; principles of strength of materials; design of structural elements in wood, steel and RCC; elastic and limit state design; complex structural systems; principles of pre-stressing.

Planning Theory: Planning process; multilevel planning; comprehensive planning; central place theory; settlement pattern; land use and land utilization.

Techniques of Planning: Planning surveys; Preparation of urban and regional structure plans, development plans, action plans; site planning principles and design; statistical methods; application of remote sensing techniques in urban and regional planning.

Traffic and Transportation Planning: Principles of traffic engineering and transportation planning; methods of conducting surveys; design of roads, intersections and parking areas; hierarchy of roads and levels of services; traffic and transport management in urban areas; traffic safety and traffic laws; public transportation planning; modes of transportation.

Services and Amenities: Principles and design of water supply systems, sewerage systems, solid waste disposal systems, power supply and communication systems; Health, education, recreation and demography related standards at various levels of the settlements.

Development Administration and Management: Planning laws; development control and zoning regulations; laws relating to land acquisition; development enforcements, land ceiling; regional and urban plan preparations; planning and municipal administration; taxation, revenue resources and fiscal management; public participation and role of NGO.

CE - CIVIL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

STRUCTURAL ENGINEERING

Mechanics: Bending moments and shear forces in statically determinate beams; simple stress and strain: relationship; stress and strain in two dimensions, principal stresses, stress transformation, Mohr's circle; simple bending theory; flexural shear stress; thin-walled pressure vessels; uniform torsion.

Structural Analysis: Analysis of statically determinate trusses, arches and frames; displacements in statically determinate structures and analysis of statically indeterminate structures by force/energy methods; analysis by displacement methods (slope-deflection and moment-distribution methods); influence lines for determinate and indeterminate structures; basic concepts of matrix methods of structural analysis.

Concrete Structures: Basic working stress and limit states design concepts; analysis of ultimate load capacity and design of members subject to flexure, shear, compression and torsion (beams, columns and isolated footings); basic elements of prestressed concrete: analysis of beam sections at transfer and service loads.

Steel Structures: Analysis and design of tension and compression members, beams and beam-columns, column bases; connections - simple and eccentric, beam-column connections, plate girders and trusses; plastic analysis of beams and frames.

GEOTECHNICAL ENGINEERING

Soil Mechanics: Origin of soils; soil classification; three-phase system, fundamental definitions, relationship and inter-relationships; permeability and seepage; effective stress principle: consolidation, compaction; shear strength.

Foundation Engineering: Sub-surface investigation - scope, drilling bore holes, sampling, penetrometer tests, plate load test; earth pressure theories, effect of water table, layered soils; stability of slopes - infinite slopes, finite slopes; foundation types - foundation design requirements; shallow foundations; bearing capacity, effect of shape, water table and other factors, stress distribution, settlement analysis in sands and clays; deep foundations - pile types, dynamic and static formulae, load capacity of piles in sands and clays.

WATER RESOURCES ENGINEERING

Fluid Mechanics and Hydraulics: Hydrostatics, applications of Bernoulli equation, laminar and turbulent flow in pipes, pipe networks; concept of boundary layer and its growth; uniform flow, critical flow and gradually varied flow in channels, specific energy concept, hydraulic jump; forces on immersed bodies; flow measurement in channels; tanks and pipes; dimensional analysis and hydraulic modeling. Applications of momentum equation, potential flow, kinematics of flow; velocity triangles and specific speed of pumps and turbines.

Hydrology: Hydrologic cycle; rainfall; evaporation infiltration, unit hydrographs, flood estimation, reservoir design, reservoir and channel routing, well hydraulics.

Irrigation: Duty, delta, estimation of evapo-transpiration; crop water requirements; design of lined and unlined canals; waterways; head works, gravity dams and Ogee spillways. Designs of weirs on permeable foundation, irrigation methods.

ENVIRONMENTAL ENGINEERING

Water requirements; quality and standards, basic unit processes and operations for water treatment, distribution of water. Sewage and sewerage treatment: quantity and characteristic of waste water sewerage; primary and secondary treatment of waste water; sludge disposal; effluent discharge standards.

TRANSPORTATION ENGINEERING

Highway planning; geometric design of highways; testing and specifications of paving materials; design of flexible and rigid pavements.

CH - CHEMICAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

CHEMICAL ENGINEERING

Process Calculations and Thermodynamics: Laws of conservation of mass and energy; use of tie components; recycle, bypass and purge calculations; degree of freedom analysis.

First and Second laws of thermodynamics and their applications; equations of state and thermodynamic properties of real systems; phase equilibria; fugacity, excess properties and correlations of activity coefficients; chemical reaction equilibria.

Fluid Mechanics and Mechanical Operations: Fluid statics, Newtonian and non-Newtonian fluids, Bernoulli equation, Macroscopic friction factors, energy balance, dimensional analysis, shell balances, flow through pipeline systems, flow meters, pumps and compressors, packed and fluidized beds, elementary boundary layer theory, size reduction and size separation; free and hindered settling; centrifuge and cyclones; thickening and classification, filtration, mixing and agitation; conveying of solids.

Heat Transfer: Conduction, convection and radiation, heat transfer coefficients, steady and unsteady heat conduction, boiling, condensation and evaporation; types of heat exchangers and evaporators and their design.

Mass Transfer: Fick's law, molecular diffusion in fluids, mass transfer coefficients, film, penetration and surface renewal theories; momentum, heat and mass transfer analogies; stagewise and continuous contacting and stage efficiencies; HTU & NTU concepts design and operation of equipment for distillation, absorption, leaching, liquid-liquid extraction, crystallization, drying, humidification, dehumidification and adsorption.

Chemical Reaction Engineering: Theories of reaction rates; kinetics of homogeneous reactions, interpretation of kinetic data, single and multiple reactions in ideal reactors, non-ideal reactors; residence time; non-isothermal reactors; kinetics of heterogeneous catalytic reactions; diffusion effects in catalysis.

Instrumentation and Process Control: Measurement of process variables; sensors, transducers and their dynamics, dynamics of simple systems, dynamics such as CSTRs, transfer functions and responses of simple systems, process reaction curve, controller modes (P, PI, and PID); control valves; analysis of closed loop systems including stability, frequency response (including Bode plots) and controller tuning, cascade, feed forward control.

Plant Design and Economics: Design and sizing of chemical engineering equipment such as compressors, heat exchangers, multistage contactors; principles of process economics and cost estimation including total annualized cost, cost indexes, rate of return, payback period, discounted cash flow, optimization in Design.

Chemical Technology: Inorganic chemical industries; sulfuric acid, NaOH, fertilizers (Ammonia, Urea, SSP and TSP); natural products industries (Pulp and Paper, Sugar, Oil, and Fats); petroleum refining and petrochemicals; polymerization industries; polyethylene, polypropylene, PVC and polyester synthetic fibers.

CS - COMPUTER SCIENCE AND ENGINEERING

ENGINEERING MATHEMATICS

Mathematical Logic: Propositional Logic; First Order Logic.

Probability: Conditional Probability; Mean, Median, Mode and Standard Deviation; Random Variables; Distributions; uniform, normal, exponential, Poisson, Binomial.

Set Theory & Algebra: Sets; Relations; Functions; Groups; Partial Orders; Lattice; Boolean Algebra.

Combinatorics: Permutations; Combinations; Counting; Summation; generating functions; recurrence relations; asymptotics.

Graph Theory: Connectivity; spanning trees; Cut vertices & edges; covering; matching; independent sets; Colouring; Planarity; Isomorphism.

Linear Algebra: Algebra of matrices, determinants, systems of linear equations, Eigen values and Eigen vectors.

Numerical Methods: LU decomposition for systems of linear equations; numerical solutions of non linear algebraic equations by Secant, Bisection and Newton-Raphson Methods; Numerical integration by trapezoidal and Simpson's rules.

Calculus: Limit, Continuity & differentiability, Mean value Theorems, Theorems of integral calculus, evaluation of definite & improper integrals, Partial derivatives, Total derivatives, maxima & minima.

THEORY OF COMPUTATION

Formal Languages and Automata Theory: Regular languages and finite automata, Context free languages and Push-down automata, Recursively enumerable sets and Turing machines, Un-decidability;

Analysis of Algorithms and Computational Complexity: Asymptotic analysis (best, worst, average case) of time and space, Upper and lower bounds on the complexity of specific problems, NP-completeness.

COMPUTER HARDWARE

Digital Logic: Logic functions, Minimization, Design and synthesis of Combinational and Sequential circuits; Number representation and Computer Arithmetic (fixed and floating point);

Computer Organization: Machine instructions and addressing modes, ALU and Data-path, hardwired and micro-programmed control, Memory interface, I/O interface (Interrupt and DMA mode), Serial communication interface, Instruction pipelining, Cache, main and secondary storage.

SOFTWARE SYSTEMS

Data structures: Notion of abstract data types, Stack, Queue, List, Set, String, Tree, Binary search tree, Heap, Graph;

Programming Methodology: C programming, Program control (iteration, recursion, Functions), Scope, Binding, Parameter passing, Elementary concepts of Object oriented, Functional and Logic Programming;

Algorithms for problem solving: Tree and graph traversals, Connected components, Spanning trees, Shortest paths; Hashing, Sorting, Searching; Design techniques (Greedy, Dynamic Programming, Divide-and-conquer);

Compiler Design: Lexical analysis, Parsing, Syntax directed translation, Runtime environment, Code generation, Linking (static and dynamic); Operating Systems: Classical concepts (concurrency, synchronization, deadlock), Processes, threads and Inter-process communication, CPU scheduling, Memory management, File systems, I/O systems, Protection and security.

Databases: Relational model (ER-model, relational algebra, tuple calculus), Database design (integrity constraints, normal forms), Query languages (SQL), File structures (sequential files, indexing, B+ trees), Transactions and concurrency control;

Computer Networks: ISO/OSI stack, sliding window protocol, LAN Technologies (Ethernet, Token ring), TCP/UDP, IP, Basic concepts of switches, gateways, and routers.

CH - CHEMISTRY

PHYSICAL CHEMISTRY

Structure: Quantum theory - principles and techniques; applications to particle in a box, harmonic oscillator, rigid rotor and hydrogen atom; valence bond and molecular orbital theories and Huckel approximation, approximate techniques: variation and perturbation; symmetry, point groups; rotational, vibrational, electronic, NMR and ESR spectroscopy.

Equilibrium: First law of thermodynamics, heat, energy and work; second law of thermodynamics and entropy; third law and absolute entropy; free energy; partial molar quantities; ideal and non-ideal solutions; phase transformation: phase rule and phase diagrams- one, two, and three component systems; activity, activity coefficient, fugacity and fugacity coefficient ; chemical equilibrium, response of chemical equilibrium to temperature and pressure; colligative properties; kinetic theory of gases; thermodynamics of electrochemical cells; standard electrode potentials: applications - corrosion and energy conversion; molecular partition function (translational, rotational, vibrational and electronic).

Kinetics: Rates of chemical reactions, theories of reaction rates, collision and transition state theory; temperature dependence of chemical reactions; elementary reactions, consecutive elementary reactions; steady state approximation, kinetics of photochemical reactions and free radical polymerization, homogenous and heterogeneous catalysis.

INORGANIC CHEMISTRY

Non-Transition Elements: General characteristics, structure and reactions of simple and industrially important compounds, boranes, carboranes, silicates, silicones, diamond and graphite; hydrides, oxides and oxoacids of N, P, S and halogens; boron nitride, borazines and phosphazenes; xenon compounds. Shapes of molecules, hard-soft acid base concept.

Transition Elements: General characteristics of d and f block elements; coordination chemistry: structure and isomerism, stability, theories of metal-ligand bonding (CFT and LFT), electronic spectra and magnetic properties of transition metal complexes and lanthanides; metal carbonyls, metal-metal bonds and metal atom clusters, metallocenes; transition metal complexes with bonds to hydrogen, alkyls, alkenes, and arenes; metal carbenes; use of organometallic compounds as catalysts in organic synthesis; mechanisms of substitution and electron transfer reactions of coordination complexes. Role of metals with special reference to Na, K, Mg, Ca, Fe, Co, Zn, and Mo in biological systems.

Solids: Crystal systems and lattices, Miller planes, crystal packing, crystal defects; Bragg's Law; ionic crystals, band theory, metals and semiconductors. Spinels.

Instrumental methods of analysis: atomic absorption, UV-visible spectrometry, chromatographic and electro-analytical methods.

ORGANIC CHEMISTRY

Synthesis, reactions and mechanisms involving the following: Alkenes, alkynes, arenes, alcohols, phenols, aldehydes, ketones, carboxylic acids and their derivatives; halides, nitro compounds and amines; stereochemical and conformational effects on reactivity and specificity; reactions with diborane and peracids. Michael reaction, Robinson annulation, reactivity umpolung, acyl anion equivalents; molecular rearrangements involving electron deficient atoms.

Photochemistry: Basic principles, photochemistry of olefins, carbonyl compounds, arenes, photo oxidation and reduction.

Pericyclic reactions: Cycloadditions, electrocyclic reactions, sigmatropic reactions; Woodward-Hoffmann rules.

Heterocycles: Structural properties and reactions of furan, pyrrole, thiophene, pyridine, indole.

Biomolecules: Structure, properties and reactions of mono- and di-saccharides, physico-chemical properties of amino acids, structural features of proteins and nucleic acids.

Spectroscopy: Principles and applications of IR, UV-visible, NMR and mass spectrometry in the determination of structures of organic compounds.

EC - ELECTRONICS AND COMMUNICATION ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix Algebra, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Mean value theorems, Theorems of integral calculus, Evaluation of definite and improper integrals, Partial Derivatives, Maxima and minima, Multiple integrals, Fourier series. Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equation (linear and nonlinear), Higher order linear differential equations with constant coefficients, Method of variation of parameters, Cauchy's and Euler's equations, Initial and boundary value problems, Partial Differential Equations and variable separable method.

Complex variables: Analytic functions, Cauchy's integral theorem and integral formula, Taylor's and Laurent' series, Residue theorem, solution integrals.

Probability and Statistics: Sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Discrete and continuous distributions, Poisson, Normal and Binomial distribution, Correlation and regression analysis.

Numerical Methods: Solutions of non-linear algebraic equations, single and multi-step methods for differential equations.

Transform Theory: Fourier transform, Laplace transform, Z-transform.

ELECTRONICS & COMMUNICATION ENGINEERING

Networks: Network graphs: matrices associated with graphs; incidence, fundamental cut set and fundamental circuit matrices. Solution methods: nodal and mesh analysis. Network theorems: superposition, Thevenin and Norton's maximum power transfer, Wye-Delta transformation. Steady state sinusoidal analysis using phasors. Linear constant coefficient differential equations; time domain analysis of simple RLC circuits, Solution of network equations using Laplace transform: frequency domain analysis of RLC circuits. 2-port network parameters: driving point and transfer functions. State equations for networks.

Electronic Devices: Energy bands in silicon, intrinsic and extrinsic silicon. Carrier transport in silicon: diffusion current, drift current, mobility, resistivity. Generation and recombination of carriers. p-n junction diode, Zener diode, tunnel diode, BJT, JFET, MOS capacitor, MOSFET, LED, p-I-n and avalanche photo diode, LASERs. Device technology: integrated circuits fabrication process, oxidation, diffusion, ion implantation, photolithography, n-tub, p-tub and twin-tub CMOS process.

Analog Circuits: Equivalent circuits (large and small-signal) of diodes, BJTs, JFETs, and MOSFETs. Simple diode circuits, clipping, clamping, rectifier. Biasing and bias stability of transistor and FET amplifiers. Amplifiers: single-and multi-stage, differential, operational, feedback and power. Analysis of amplifiers; frequency response of amplifiers. Simple op-amp circuits. Filters. Sinusoidal oscillators; criterion for oscillation; single-transistor and op-amp configurations. Function generators and wave-shaping circuits. Power supplies.

Digital circuits: Boolean algebra, minimization of Boolean functions; logic gates digital IC families (DTL, TTL, ECL, MOS, CMOS). Combinational circuits: arithmetic circuits, code converters, multiplexers and decoders. Sequential circuits: latches and flip-flops, counters and shift-registers. Sample and hold circuits, ADCs, DACs. Semiconductor memories. Microprocessor(8085): architecture, programming, memory and I/O interfacing.

Signals and Systems: Definitions and properties of Laplace transform, continuous-time and discrete-time Fourier series, continuous-time and discrete-time Fourier Transform, z-transform. Sampling theorems. Linear Time-Invariant (LTI) Systems: definitions and properties; casuality, stability, impulse response, convolution, poles and zeros frequency response, group delay, phase delay. Signal transmission through LTI systems. Random signals and noise: probability, random variables, probability density function, autocorrelation, power spectral density.

Controls Systems: Basic control system components; block diagrammatic description, reduction of block diagrams. Open loop and closed loop (feedback) systems and stability analysis of these systems. Signal flow graphs and their use in determining transfer functions of systems; transient and steady state analysis of LTI control systems and frequency response. Tools and techniques for LTI control system analysis: root loci, Routh-Hurwitz criterion, Bode and Nyquist plots. Control system compensators: elements of lead and lag compensation, elements of Proportional-Integral-Derivative(PID) control. State variable representation and solution of state equation of LTI control systems.

Communications: Analog communication systems: amplitude and angle modulation and demodulation systems, spectral analysis of these operations, superheterodyne receivers; elements of hardware, realizations of analog communication systems; signal-to-noise ratio (SNR) calculations for amplitude modulation (AM) and frequency modulation (FM) for low noise conditions. Digital communication systems: pulse code modulation (PCM), differential pulse code modulation (DPCM), delta modulation (DM); digital modulation schemes-amplitude, phase and frequency shift keying schemes (ASK, PSK, FSK), matched filter receivers, bandwith consideration and probability of error calculations for these schemes.

Electromagnetics: Elements of vector calculus: divergence and curl; Gauss' and Stokes' theorems, Maxwell's equations: differential and integral forms. Wave equation, Poynting vector. Plane waves: propagation through various media; reflection and refraction; phase and group velocity; skin depth. Transmission lines: characteristic impedance; impedance transformation; Smith chart; impedance matching; pulse excitation. Waveguides: modes in rectangular waveguides; boundary conditions; cut-off frequencies; dispersion relations. Antennas: Dipole antennas; antenna arrays; radiation pattern; reciprocity theorem, antenna gain.

EE - ELECTRICAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix Algebra, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Mean value theorems, Theorems of integral calculus, Evaluation of definite and improper integrals, Partial Derivatives, Maxima and minima, Multiple integrals, Fourier series. Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equation (linear and nonlinear), Higher order linear differential equations with constant coefficients, Method of variation of parameters, Cauchy's and Euler's equations, Initial and boundary value problems, Partial Differential Equations and variable separable method.

Complex variables: Analytic functions, Cauchy's integral theorem and integral formula, Taylor's and Laurent' series, Residue theorem, solution integrals.

Probability and Statistics: Sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Discrete and continuous distributions, Poisson, Normal and Binomial distribution, Correlation and regression analysis.

Numerical Methods: Solutions of non-linear algebraic equations, single and multi-step methods for differential equations.

Transform Theory: Fourier transform, Laplace transform, Z-transform.

ELECTRICAL ENGINEERING

Electrical Circuits and Fields: Network graph, KCL, KVL, node/ cut set, mesh/ tie set analysis, transient response of d.c. and a.c. networks; sinusoidal steady-state analysis; resonance in electrical circuits; concepts of ideal voltage and current sources, network theorems, driving point, immittance and transfer functions of two port networks, elementary concepts of filters; three phase circuits; Fourier series and its application; Gauss theorem, electric field intensity and potential due to point, line, plane and spherical charge distribution, dielectrics, capacitance calculations for simple configurations; Ampere's and Biot-Savart's law, inductance calculations for simple configurations.

Electrical Machines: Single phase transformer - equivalent circuit, phasor diagram, tests, regulation and efficiency; three phase transformers - connections, parallel operation; auto transformer and three-winding transformer; principles of energy conversion, windings of rotating machines: D. C. generators and motors - characteristics, starting and speed control, armature reaction and commutation; three phase induction motors-performance characteristics, starting and speed control; single-phase induction motors; synchronous generators-performance, regulation, parallel operation; synchronous motors - starting, characteristics, applications, synchronous condensers; fractional horse power motors; permanent magnet and stepper motors.

Power Systems: Electric power generation - thermal, hydro, nuclear; transmission line parameters; steady-state performance of overhead transmission lines and cables and surge propagation; distribution systems, insulators, bundle conductors, corona and radio interference effects; per-unit quantities; bus admittance and impedance matrices; load flow; voltage control and power factor correction; economic operation; symmetrical components, analysis of symmetrical and unsymmetrical faults; principles of over current, differential and distance protections; concept of solid state relays and digital protection; circuit breakers; concept of system stability-swing curves and equal area criterion; basic concepts of HVDC transmission.

Control Systems: Principles of feedback; transfer function; block diagrams: steady-state errors; stability-Routh and Nyquist criteria; Bode plots; compensation; root loci; elementary state variable formulation; state transition matrix and response for Linear Time Invariant systems.

Electrical and Electronic Measurements: Bridges and potentiometers, PMMC, moving iron, dynamometer and induction type instruments; measurement of voltage, current, power, energy and power factor; instrument transformers; digital voltmeters and multimeters; phase, time and frequency measurement; Q-meter, oscilloscopes, potentiometric recorders, error analysis.

Analog and Digital Electronics: Characteristics of diodes, BJT, FET, SCR; amplifiers-biasing, equivalent circuit and frequency response; oscillators and feedback amplifiers, operational amplifiers- characteristics and applications; simple active filters; VCOs and timers; combinational and sequential logic circuits, multiplexer, Schmitt trigger, multivibrators, sample and hold circuits, A/D and D/A converters; microprocessors and their applications.

Power Electronics and Electric Drives: Semiconductor power devices-diodes, transistors, thyristors, triacs, GTOs, MOSFETs and IGBTs - static characteristics and principles of operation; triggering circuits; phase control rectifiers; bridge converters-fully controlled and half controlled; principles of choppers and inverters, basic concepts of adjustable speed dc and ac drives.

GG - GEOLOGY AND GEOPHYSICS

PART - I

Earth and planetary system; size, shape, internal structure and composition of the earth; atmosphere and greenhouse effect; isostasy; elements of seismology; continents and continental processes; physical oceanography; palaeomagnetism, continental drift plate tectonics, geothermal energy.

Weathering; soil formation; action of river, wind and glacier; oceans and oceanic features; earthquakes, volcanoes, orogeny and mountain building; elements of structural geology; crystallography; classification, composition and properties of minerals and rocks; engineering properties of rocks and soils, role of geology in the construction of engineering structures.

Processes of ore formation, occurrence and distribution of ores on land and on ocean floor; coal and petroleum resources in India; ground water geology including well hydraulics, geological time scale and geochronology; stratigraphic principles and stratigraphy of India; basics concepts of gravity, magnetic and electrical prospecting for ores and ground water.

PART - IIA: GEOLOGY

Crystal symmetry, forms, twinning; crystal chemistry; optical mineralogy, classification of minerals, diagnostic properties of rock minerals.

Mineralogy, structure, texture and classification of igneous, sedimentary and metamorphic rock, their origin and evolution; application of thermodynamics; structure and petrology of sedimentary rocks; sedimentary processes and environments, sedimentary facies, basin studies; basement cover relationship;

Primary and secondary structures; geometry and genesis of folds, faults, joints, unconformities, cleavage, schistosity and lineation; methods of projection. Tectonites and their significance; shear zone; superposed folding.

Morphology, classification and geological significance of important invertebrates, vertebrates, microfossils and palaeoflora; stratigraphic principles and Indian stratigraphy; geomorphic processes and agents; development and evolution of landforms; slope and drainage; processes on deep oceanic and near-shore regions; quantitative and applied geomorphology; air photo interpretation and remote sensing; chemical and optical properties of ore minerals; formation and localization of ore deposits; prospecting and exploration of economic minerals; coal and petroleum geology; origin and distribution of mineral and fuel deposits in India; ore dressing and mineral economics.

Cosmic abundance; meteorites; geochemical evolution of the earth; geochemical cycles; distribution of major, minor and trace elements; isotope geochemistry; geochemistry of waters including solution equilibria and water rock interaction.

Engineering properties of rocks and soils; rocks as construction material; geology of dams, tunnels and excavation sites; natural hazards; the fly ash problem; ground water geology and exploration; water quality; impact of human activity; Remote sensing techniques for the interpretation of landforms and resource management.

PART - II B: GEOPHYSICS

The earth as a planet; different motions of the earth; gravity filed of the earth and its shape; geochronology; isostasy, seismology and interior of the earth; variation of density, velocity, pressure, temperature, electrical and magnetic properties inside the earth; earthquakes-causes and measurements; zonation and seismic hazards; geomagnetic field, palaeomagnetism; oceanic and continental lithosphere; plate tectonics; heat flow; upper and lower atmospheric phenomena.

Theories of scalar and vector potential fields; Laplace, Maxwell and Helmholtz equations for solution of different types of boundary value problems for Cartesian, cylindrical and spherical polar coordinates; Green's theorem; Image theory; integral equations and conformal transformations in potential theory; Eikonal equation and ray theory.

'G' and 'g' units of measurement, density of rocks, gravimeters, preparation, analysis and interpretation of gravity maps; derivative maps, analytical continuation; gravity anomaly type curves; calculation of mass.

Earth's magnetic field, units of measurement, magnetic susceptibility of rocks, magnetometers, corrections, preparation of magnetic maps, magnetic anomaly type curve, analytical continuation, interpretation and application; magnetic well logging.

Conduction of electricity through rocks, electrical conductivities of metals, metallic, non-metallic and rock forming minerals, D.C. resistivity units and methods of measurement, electrode configuration for sounding and profiling, application of filter theory, interpretation of resistivity field data, application; self potential origin, classification, field measurement, interpretation of induced polarization time frequency, phase domain; IP units and methods of measurement, interpretation and application; ground-water exploration.

Origin of electromagnetic field elliptic polarization, methods of measurement for different source-receiver configuration components in EM measurements, interpretation and applications; earth's natural electromagnetic field, tellurics, magneto-tellurics; geomagnetic depth sounding principles, methods of measurement, processing of data and interpretation.

Seismic methods of prospecting: Reflection, refraction and CDP surveys; land and marine seismic sources, generation and propagation of elastic waves, velocity increasing with depth, geophones, hydrophones, recording instruments (DFS), digital formats, field layouts, seismic noises and noise profile analysis, optimum geophone grouping, noise cancellation by shot and geophone arrays, 2D and 3D seismic data acquisition and processing, CDP stacking charts, binning, filtering, dip-moveout, static and dynamic corrections, deconvolution, migration, signal processing, Fourier and Hilbert transforms, attribute analysis, bright and dim spots, seismic stratigraphy, high resolution seismics, VSP.

Principles and techniques of geophysical well-logging, SP, resistivity, induction, micro gamma ray, neutron, density, sonic, temperature, dip meter, caliper, nuclear magnetic, cement bond logging. Quantitative evaluation of formations from well logs; well hydraulics and application of geophysical methods for groundwater study; application of bore hole geophysics in ground water, mineral and oil exploration. Remote sensing techniques and application of remote sensing methods in geophysics.

IN - INSTRUMENTATION ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix Algebra, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Mean value theorems, Theorems of integral calculus, Evaluation of definite and improper integrals, Partial Derivatives, Maxima and minima, Multiple integrals, Fourier series. Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equation (linear and nonlinear), Higher order linear differential equations with constant coefficients, Method of variation of parameters, Cauchy's and Euler's equations, Initial and boundary value problems, Partial Differential Equations and variable separable method.

Complex variables: Analytic functions, Cauchy's integral theorem and integral formula, Taylor's and Laurent' series, Residue theorem, solution integrals.

Probability and Statistics: Sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Discrete and continuous distributions, Poisson, Normal and Binomial distribution, Correlation and regression analysis.

Numerical Methods: Solutions of non-linear algebraic equations, single and multi-step methods for differential equations.

Transform Theory: Fourier transform, Laplace transform, Z-transform.

INSTRUMENTATION ENGINEERING

Measurement Basics and Metrology: Static and dynamic characteristics of measurement systems. Standards and calibration. Error and uncertainty analysis, statistical analysis of data, and curve fitting. Linear and angular measurements; Measurement of straightness, flatness, roundness and roughness.

Transducers, Mechanical Measurements and Industrial Instrumentation: Transducers - elastic, resistive, inductive, capacitive, thermo-electric, piezoelectric, photoelectric, electro-mechanical, electro-chemical, and ultrasonic. Measurement of displacement, velocity (linear and rotational), acceleration, shock, vibration, force, torque, power, strain, stress, pressure, flow, temperature, humidity, viscosity, and density. energy storing elements, suspension systems and dampers.

Analog Electronics: Characteristics of diodes, BJTs, JFETs and MOSFETs; Diode circuits; Amplifiers: single and multi-stage, feedback; Frequency response; Operational amplifiers - design, characteristic, linear and non-linear applications: difference amplifiers; instrumentation amplifiers; precision rectifiers, I-to-V converters, active filters, oscillators, comparators, signal generators, wave shaping circuits.

Digital Electronics: Combinational logic circuits, minimization of Boolean functions; IC families (TTL, MOS, CMOS), arithmetic circuits, multiplexer and decoders. Sequential circuits: flip-flops, counters, shift registers. Schmitt trigger, timers, and multivibrators. Analog switches, multiplexers, S/H circuits. Analog-to-digital and digital-to-analog converters. Basics of computer organization and architecture. 8-bit microprocessor (8085), applications, memory, I/O interfacing, and microcontrollers.

Signals and Systems: Vectors and matrices; Fourier series; Fourier transforms; Ordinary differential equations. Impulse and frequency responses of first and second order systems. Laplace transform and transfer function, convolution and correlation. Amplitude and frequency modulations and demodulations. Discrete time systems, difference equations, impulse and frequency responses; Z-transforms and transfer functions; IIR and FIR filters.

Electrical and Electronic Measurements: Measurement of R, L and C; bridges and potentiometers. Measurement of voltage, current, power, power factor, and energy; Instrument transformers; Q meter, waveform analyzers. Digital volt-meters and multi-meters.

Time, phase and frequency measurements; Oscilloscope. Noise and interference in instrumentation.

Control Systems & Process Control: Principles of feedback; transfer function, signal flow graphs. Stability criteria, Bode plots, root-loci, Routh and Nyquist criteria. Compensation techniques; State space analysis. System components: mechanical, hydraulic, pneumatic, electrical and electronic; Servos and synchros; Stepper motors. On-off, cascade, P, PI, PID and feed-forward controls. Controller tuning and general frequency response.

Analytical, Optical and Biomedical Instrumentation: Principles of spectrometry, UV, visible, IR mass spectrometry, X-ray methods; nuclear radiation measurements, gas, solid and semi conductor lasers and their characteristics, interferometers, basics of fibre optics, transducers in biomedical applications, cardiovascular system measurements, instrumentation for clinical laboratory.

MA - MATHEMATICS

Linear Algebra: Finite dimensional vector spaces. Linear transformations and their matrix representations, rank; systems of linear equations, eigenvalues and eigenvectors, minimal polynomial, Cayley-Hamilton theorem, diagonalisation, Hermitian, Skew-Hermitian and unitary matrices. Finite dimensional inner product spaces, self-adjoint and Normal linear operators, spectral theorem, Quadratic forms.

Complex Analysis: Analytic functions, conformal mappings, bilinear transformations, complex integration: Cauchy's integral theorem and formula, Liouville's theorem, maximum modulus principle, Taylor and Laurent's series, residue theorem and applications for evaluating real integrals.

Real Analysis: Sequences and series of functions, uniform convergence, power series, Fourier series, functions of several variables, maxima, minima, multiple integrals, line, surface and volume integrals, theorems of Green, Stokes and Gauss; metric spaces, completeness, Weierstrass approximation theorem, compactness. Lebesgue measure, measurable functions; Lebesgue integral, Fatou's lemma, dominated convergence theorem.

Ordinary Differential Equations: First order ordinary differential equations, existence and uniqueness theorems, systems of linear first order ordinary differential equations, linear ordinary differential equations of higher order with constant coefficients; linear second order ordinary differential equations with variable coefficients, method of Laplace transforms for solving ordinary differential equations, series solutions; Legendre and Bessel functions and their orthogonality, Sturm Liouville system, Greeen's functions.

Algebra: Normal subgroups and homomorphisms theorems, automorphisms. Group actions, sylow's theorems and their applications groups of order less than or equal to 20, Finite p-groups. Euclidean domains, Principal ideal domains and unique factorizations domains. Prime ideals and maximal ideals in commutative rings.

Functional Analysis: Banach spaces, Hahn-Banach theorems, open mapping and closed graph theorems, principle of uniform boundedness; Hilbert spaces, orthonormal sets, Riesz representation theorem, self-adjoint, unitary and normal linear operators on Hilbert Spaces.

Numerical Analysis: Numerical solution of algebraic and transcendental equations; bisection, secant method, Newton-Raphson method, fixed point iteration, interpolation: existence and error of polynomial interpolation, Lagrange, Newton, Hermite(osculatory)interpolations; numerical differentiation and integration, Trapezoidal and Simpson rules; Gaussian quadrature; (Gauss-Legendre and Gauss-Chebyshev), method of undetermined parameters, least square and orthonormal polynomial approximation; numerical solution of systems of linear equations: direct and iterative methods, (Jacobi Gauss-Seidel and SOR) with convergence; matrix eigenvalue problems: Jacobi and Given's methods, numerical solution of ordinary differential equations: initial value problems, Taylor series method, Runge-Kutta methods, predictor-corrector methods; convergence and stability.

Partial Differential Equations: Linear and quasilinear first order partial differential equations, method of characteristics; second order linear equations in two variables and their classification; Cauchy, Dirichlet and Neumann problems, Green's functions; solutions of Laplace, wave and diffusion equations in two variables Fourier series and transform methods of solutions of the above equations and applications to physical problems.

Mechanics: Forces in three dimensions, Poinsot central axis, virtual work, Lagrange's equations for holonomic systems, theory of small oscillations, Hamiltonian equations;

Topology: Basic concepts of topology, product topology, connectedness, compactness, countability and separation axioms, Urysohn's Lemma, Tietze extension theorem, metrization theorems, Tychonoff theorem on compactness of product spaces.

Probability and Statistics: Probability space, conditional probability, Bayes' theorem, independence, Random variables, joint and conditional distributions, standard probability distributions and their properties, expectation, conditional expectation, moments. Weak and strong law of large numbers, central limit theorem. Sampling distributions, UMVU estimators, sufficiency and consistency, maximum likelihood estimators. Testing of hypotheses, Neyman-Pearson tests, monotone likelihood ratio, likelihood ratio tests, standard parametric tests based on normal, X2 ,t, F-distributions. Linear regression and test for linearity of regression. Interval estimation.

Linear Programming: Linear programming problem and its formulation, convex sets their properties, graphical method, basic feasible solution, simplex method, big-M and two phase methods, infeasible and unbounded LPP's, alternate optima. Dual problem and duality theorems, dual simplex method and its application in post optimality analysis, interpretation of dual variables. Balanced and unbalanced transportation problems, unimodular property and u-v method for solving transportation problems. Hungarian method for solving assignment problems.

Calculus of Variations and Integral Equations: Variational problems with fixed boundaries; sufficient conditions for extremum, Linear integral equations of Fredholm and Volterra type, their iterative solutions. Fredholm alternative.

ME - MECHANICAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

APPLIED MECHANICS AND DESIGN

Engineering Mechanics: Equivalent force systems, free-body concepts, equations of equilibrium, trusses and frames, virtual work and minimum potential energy. Kinematics and dynamics of particles and rigid bodies, impulse and momentum (linear and angular), energy methods, central force motion.

Strength of Materials: Stress and strain, stress-strain relationship and elastic constants, Mohr's circle for plane stress and plane strain, shear force and bending moment diagrams, bending and shear stresses, deflection of beams, torsion of circular shafts, thin and thick cylinders, Euler's theory of columns, strain energy methods, thermal stresses.

Theory of Machines: Displacement, velocity and acceleration, analysis of plane mechanisms, dynamic analysis of slider-crank mechanism, planar cams and followers, gear tooth profiles, kinematics of gears, governors and flywheels, balancing of reciprocating and rotating masses.

Vibrations: Free and forced vibration of single degree freedom systems, effect of damping, vibration isolation, resonance, critical speed of rotors.

Design of Machine Elements: Design for static and dynamic loading, failure theories, fatigue strength; design of bolted, riveted and welded joints; design of shafts and keys; design of spur gears, rolling and sliding contact bearings; brakes and clutches; belt, rope and chain drives.

FLUID MECHANICS AND THERMAL SCIENCES

Fluid Mechanics: Fluid properties, fluid statics, manometry, buoyancy; control-volume analysis of mass, momentum and energy; fluid acceleration; differential equations of continuity and momentum; Bernoulli's equation; viscous flow of incompressible fluids; boundary layer; elementary turbulent flow; flow through pipes, head losses in pipes, bends etc.

Heat-Transfer: Modes of heat transfer; one dimensional heat conduction, resistance concept, electrical analogy, unsteady heat conduction, fins; dimensionless parameters in free and forced convective heat transfer, various correlations for heat transfer in flow over flat plates and through pipes; thermal boundary layer; effect of turbulence; radiative heat transfer, black and grey surfaces, shape factors, network analysis; heat exchanger performance, LMTD and NTU methods.

Thermodynamics: Zeroth, First and Second laws of thermodynamics; thermodynamic system and processes; irreversibility and availability; behaviour of ideal and real gases, properties of pure substances, calculation of work and heat in ideal processes; analysis of thermodynamic cycles related to energy conversion; Carnot, Rankine, Otto, Diesel, Brayton and vapour compression cycles.

Power Plant Engineering: Steam generators; steam power cycles; steam turbines; impulse and reaction principles, velocity diagrams, pressure and velocity compounding; reheating and reheat factor; condensers and feed heaters.

I.C. Engines: Requirements and suitability of fuels in IC engines, fuel ratings, fuel-air mixture requirements; normal combustion in SI and CI engines; engine performance calculations.

Refrigeration and air-conditioning: Refrigerant compressors, expansion devices, condensers and evaporators; properties of moist air, psychrometric chart, basic psychometric processes.

Turbomachinery: Components of gas turbines; compression processes, centrifugal and axial flow compressors; axial flow turbines, elementary theory; hydraulic turbines; Euler-turbine equation; specific speed, Pelton-wheel, Francis and Kaplan turbines; centrifugal pumps.

MANUFACTURING AND INDUSTRIAL ENGINEERING

Engineering Materials: Structure and properties of engineering materials and their applications, heat treatment.

Metal Casting: Casting processes (expendable and non-expendable) -pattern, moulds and cores, heating and pouring, solidification and cooling, gating design, design considerations, defects.

Forming Processes: Stress-strain diagrams for ductile and brittle material, Plastic deformation and yield criteria, fundamentals of hot and cold working processes, Bulk metal forming processes (forging, rolling, extrusion, drawing), sheet metal working processes (punching, blanking, bending, deep drawing, coining, spinning, load estimation using homogeneous deformation methods, defects). processing of powder metals- atomization, compaction, sintering, secondary and finishing operations. forming and shaping of plastics- extrusion, injection moulding.

Joining Processes: Physics of welding, fusion and non-fusion welding processes, brazing and soldering, adhesive bonding, design considerations in welding, weld quality defects.

Machining and Machine Tool Operations: Mechanics of machining, single and multi-point cutting tools, tool geometry and materials, tool life and wear, cutting fluids, machinability, economics of machining, non-traditional machining processes.

Metrology and Inspection: Limits, fits and tolerances, linear and angular measurements, comparators, gauge design, interferometry, form and finish measurement, measurement of screw threads, alignment and testing methods.

Tool Engineering: Principles of work holding, design of jigs and fixtures.

Computer Integrated Manufacturing: Basic concepts of CAD, CAM and their integration tools.

Manufacturing Analysis: Part-print analysis, tolerance analysis in manufacturing and assembly, time and cost analysis.

Work-Study: Method study, work measurement, time study, work sampling, job evaluation, merit rating.

Production Planning and Control: Forecasting models, aggregate production planning, master scheduling, materials requirements planning.

Inventory Control: Deterministic and probabilistic models, safety stock inventory control systems.

Operations Research: Linear programming, simplex and duplex method, transportation, assignment, network flow models, simple queuing models, PERT and CPM

MN - MINING ENGINEERING

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima;

Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

MINING ENGINEERING

Mechanics: Equivalent force systems, equations of equilibrium, two dimensional frames and trusses, free body diagrams, friction forces, particle kinematics and dynamics.

Mine Development, Geomechanics and Strata Control: Drivages for underground mine development, drilling methods and machines, explosives, blasting devices and practices, shaft sinking. Physico-mechanical properties of rocks, rock mass classification, ground control instrumentation and stress measurement techniques, theories of rock failure, ground vibrations, stress distribution around mine openings, subsidence, design of supports in roadways and workings, stability of open pits, slopes.

Mining Methods and Machinery: Surface mining - layout, development, loading, transportation and mechanization, continuous surface mining systems. Underground coal mining - bord and pillar system, longwall mining, thick seam mining methods. Underground metal mining: different stoping methods, stope mechanization, ore handling systems, mine filling. Generation and transmission of mechanical, hydraulic, and pneumatic power. Materials handling - haulages, conveyors, ropeways, face and development machinery, hoisting systems, and pumps.

Ventilation, Underground Hazards and Surface Environment: Underground atmosphere, heat load sources and thermal environment, air cooling, mechanics of air flow distribution, natural and mechanical ventilation, mine fans and their usage, auxiliary ventilation. Subsurface hazards from fires, explosions, gases, dust, and inundation, rescue apparatus and practices, safety in mines, accident analysis, noise, mine lighting. Air and water pollution: causes, dispersion, quality standards, and control.

Surveying, Mine Planning and Systems Engineering: Fundamentals of engineering surveying, Levels and levelling, Theodolite, tacheometry, triangulation, contouring, errors and adjustments, correlation, underground surveying, curves, photogrammetry, field astronomy, GPS fundamentals. Principles of planning - Sampling methods and practices, reserve estimation techniques, basics of geostatistics, optimization of facility location, cash flow concepts and mine valuation, open pit design. Work study, concepts of reliability, reliability of series and parallel systems. Linear programming, transportation and assignment problems, queueing, network analysis, inventory control.

MT - METALLURGICAL ENGINEERING

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima;

Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

METALLURGICAL ENGINEERING

Thermodynamics and Rate Processes: Laws of thermodynamics, activity, equilibrium constant, applications to metallurgical systems, solutions, phase equilibria, basic kinetic laws, order of reactions, rate constants and rate limiting steps principles of electro chemistry, aqueous, corrosion and protection of metals, oxidation and high temperature corrosion - characterization and control; momentum transfer - concepts of viscosity, shell balances, Bernoulli's equation; heat transfer - conduction, convection and heat transfer coefficient relations, radiation, mass transfer - diffusion and Fick's laws.

Extractive Metallurgy: Flotation, gravity and other methods of mineral processing; agglomeration, pyro-hydro-and electro-metallurgical processes; material and energy balances; principles and processes for the extraction of non-ferrous metals - aluminium, copper, zinc, lead, magnesium, nickel, titanium and other rare metals; iron and steel making - principles, blast furnace, direct reduction processes, primary and secondary steel making, deoxidation and inclusion in steel; ingot and continuous casting; stainless steel making, design of furnaces; fuels and refractories.

Physical Metallurgy: Crystal structure and bonding characteristics of metals, alloys, ceramics and polymers; solid solutions; solidification; phase transformation and binary phase diagrams; principles of heat treatment of steels, aluminum alloys and cast irons; recovery, recrystallization and grain growth; industrially important ferrous and non-ferrous alloys; elements of X-ray and electron diffraction; principles of scanning and transmission electron microscopy; elements of ceramics, composites and electronic materials; electronic basis of thermal, optical, electrical and magnetic properties of materials.

Mechanical Metallurgy: Elements of elasticity and plasticity; defects in crystals; elements of dislocation theory - types of dislocations, slip and twinning, stress fields of dislocations, dislocation interactions and reactions, methods of seeing dislocations; strengthening mechanisms; tensile, fatigue and creep behaviour; superplasticity; fracture - Griffith theory, ductile to brittle transition, fracture toughness; failure analysis; mechanical testing - tension, compression, torsion, hardness, impact, creep, fatigue, fracture toughness and formability tests.

Manufacturing Processes: Metal casting - patterns, moulds, melting, gating, feeding and casting processes, defects and castings, hot and cold working of metals; Metal forming - fundamentals of metal forming, rolling wire drawing, extrusion, forming, sheet metal forming processes, defects in forming; Metal joining - soldering, brazing and welding, common welding processes, welding metallurgy, problems associated with welding of steels and aluminium alloys, defects in welding, powder metallurgy; NDT methods - ultrasonic, radiography, eddy current, acoustic emission and magnetic.

PH - PHYSICS

Mathematical Physics: Linear vector space, matrices; vector calculus; linear differential equations; elements of complex analysis; Laplace transforms, Fourier analysis, elementary ideas about tensors.

Classical Mechanics: Conservation laws; central forces; collisions and scattering in laboratory and centre of mass reference frames; mechanics of system of particles; rigid body dynamics; moment of inertia tensor; noninertial frames and pseudo forces; variational principle; Lagrange's and Hamilton's formalisms; equation of motion, cyclic coordinates, Poisson bracket; periodic motion, small oscillations, normal modes; wave equation and wave propagation; special theory of relativity - Lorentz transformations, relativistic kinematics, mass-energy equivalence.

Electromagnetic Theory: Laplace and Poisson equations; conductors and dielectrics; boundary value problems; Ampere's and Biot-Savart's laws; Faraday's law; Maxwell's equations; scalar and vector potentials; Coulomb and Lorentz gauges; boundary conditions at interfaces; electromagnetic waves; interference, diffraction and polarization; radiation from moving charges.

Quantum Mechanics: Physical basis of quantum mechanics; uncertainty principle; Schrodinger equation; one and three dimensional potential problems; Particle in a box, harmonic oscillator, hydrogen atom; linear vectors and operators in Hilbert space; angular momentum and spin; addition of angular momentum; time independent perturbation theory; elementary scattering theory.

Atomic and Molecular Physics: Spectra of one-and many-electron atoms; LS and jj coupling; hyperfine structure; Zeeman and Stark effects; electric dipole transitions and selection rules; X-ray spectra; rotational and vibrational spectra of diatomic molecules; electronic transition in diatomic molecules, Franck-Condon principle; Raman effect; NMR and ESR; lasers.

Thermodynamics and Statistical Physics: Laws of thermodynamics; macrostates, phase space; probability ensembles; partition function, free energy, calculation of thermodynamic quantities; classical and quantum statistics; degenerate Fermi gas; black body radiation and Planck's distribution law; Bose-Einstein condensation; first and second order phase transitions, critical point.

Solid State Physics: Elements of crystallography; diffraction methods for structure determination; bonding in solids; elastic properties of solids; defects in crystals; lattice vibrations and thermal properties of solids; free electron theory; band theory of solids; metals, semiconductors and insulators; transport properties; optical, dielectric and magnetic properties of solids; elements of superconductivity.

Nuclear and Particle Physics: Rutheford scattering; basic properties of nuclei; radioactive decay; nuclear forces; two nucleon problem; nuclear reactions; conservation laws; fission and fusion; nuclear models; particle accelerators, detectors; elementary particles; photons, baryons, mesons and leptons; Quark model.

Electronics: Network analysis; semiconductor devices; bipolar transistors; FETs; power supplies, amplifier, oscillators; operational amplifiers; elements of digital electronics; logic circuits.

PI - PRODUCTION AND INDUSTRIAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

GENERAL ENGINEERING:

Engineering Materials: Structure and properties of engineering materials and their applications; effect of strain, strain rate and temperature on mechanical properties of metals and alloys; heat treatment of metals and alloys.

Applied Mechanics: Engineering mechanics - equivalent force systems, free body concepts, equations of equilibrium, virtual work and minimum potential energy; strength of materials-stress, strain and their relationship, Mohr's circle, deflection of beams, bending and shear stress, Euler's theory of columns.

Theory of Machines and Design: Analysis of planar mechanisms, plane cams and followers; governers and fly wheels; design of elements-failure theories; design of bolted, riveted and welded joints; design of shafts, keys, belt drives, brakes and clutches.

Thermal Engineering: Fluid machines - fluid statics, Bernoulli's equation, flow through pipes, equations of continuity and momentum; Thermodynamics - zeroth, First and Second laws of thermodynamics, thermodynamic system and processes, calculation of work and heat for systems and control volumes; Heat transfer - fundamentals of conduction, convection and radiation.

PRODUCTION ENGINEERING

Metal Casting: Casting processes; patterns-materials; allowances; moulds and cores - materials, making and testing; melting and founding of cast iron, steels and nonferrous metals and alloys; solidification; design of casting, gating and risering; casting defects and inspection.

Metal working: Stress-strain in elastic and plastic deformation; deformation mechanisms; hot and cold working-forging, rolling, extrusion, wire and tube drawing; sheet metal working; analysis of rolling, forging, extrusion and wire /rod drawing; metal working defects, high energy rate forming processes-explosive, magnetic, electro and electrohydraulic.

Metal Joining Processes: Welding processes - gas shielded metal arc, TIG, MIG, submerged arc, electroslag, thermit, resistance, pressure and forge welding; thermal cutting; other joining processes - soldering, brazing, braze welding; welding codes, welding symbols, design of welded joints, defects and inspection; introduction to modern welding processes - friction, ultrasonic, explosive, electron beam, laser and plasma.

Machining and Machine Tool Operations: Machining processes-turning, drilling, boring, milling, shaping, planing, sawing, gear cutting, thread production, broaching, grinding, lapping, honing super finishing; mechanics of cutting- Merchant's analysis, geometry of cutting tools, cutting forces, power requirements; selection of process parameters; tool materials, tool wear and tool life, cutting fluids, machinability; nontraditional machining processes and hybrid processes- EDM, CHM, ECM, USM, LBM, EBM, AJM, PAM AND WJM; economics of machining.

Metrology and Inspection: Limits and fits, linear and angular measurements by mechanical and optical methods, comparators; design of limit gauges; interferometry; measurement of straightness, flatness, roundness, squareness and symmetry; surface finish measurement; inspection of screw threads and gears; alignment testing.

Powder Metallurgy and Processing of Plastics: Production of powders, compaction, sintering; Polymers and composites; injection, compression and blow molding, extrusion, calendaring and thermoforming; molding of composites.

Tool Engineering: Work-holding-location and clamping; principles and methods; design of jigs and fixtures; design of press working tools, forging dies.

Manufacturing Analysis: Sources of errors in manufacturing; process capability; part-print analysis; tolerance analysis in manufacturing and assembly; process planning; parameter selection and comparison of production alternatives; time and cost analysis; Issues in choosing manufacturing technologies and strategies.

Computer Integrated Manufacturing: Basic concepts of CAD, CAM, CAPP, group technology, NC, CNC, DNC, FMS, Robotics and CIM.

INDUSTRIAL ENGINEERING

Product Design and Development: Principles of good product design, component and tolerance design; efficiency, quality and cost considerations; product life cycle; standardization, simplification, diversification, value analysis, concurrent engineering.

Engineering Economy and Costing: Financial statements; elementary cost accounting, methods of depreciation; break-even analysis, techniques for evaluation of capital investments.

Work System Design: Taylor's scientific management, Gilbreths's contributions; productivity concepts and measurements; method study, micro-motion study, principles of motion economy; human factors engineering, ergonomics; work measurement - time study, PMTS, work sampling; job evaluation, merit rating, wage administration, incentive systems; business process reengineering.

Logistics and Facility Design: Facility location factors, evaluation of alternatives, types of plant layout, evaluation; computer aided layout; assembly line balancing; material handling systems; supply chain management.

Production Planning and Inventory Control: Inventory Function costs, classifications - deterministic and probabilistic models; quantity discount; safety stock; inventory control system; Forecasting techniques - causal and time series models, moving average, exponential smoothing; trend and seasonality; aggregate production planning; master scheduling; bill of materials and material requirement planning; order control and flow control, routing, scheduling and priority dispatching; JIT; Kanban PULL systems; bottleneck scheduling and theory of constraints.

Operation Research: Linear programming - problem formulation, simplex method, duality and sensitivity analysis; transportation; assignment; network flow models, constrained optimization and Lagrange multipliers; simple queuing models; dynamic programming; simulation; PERT and CPM, time-cost trade-off, resource leveling.

Quality Control: Taguchi method; design of experiments; quality costs, statistical quality assurance, process control charts, acceptance sampling, zero defects; quality circles, total quality management.

Reliability and Maintenance: Reliability, availability and maintainability; probabilistic failure and repair times; system reliability; preventive maintenance and replacement, TPM.

Management Information System: Value of information; information storage and retrieval system - database and data structures; interactive systems; knowledge based systems.

Intellectual Property System: Definition of intellectual property, importance of IPR; TRIPS, and its implications, WIPO and Global IP structure, and IPS in India; patent, copyright, industrial design and trademark; meanings, rules and procedures, terms, infringements and remedies.

PY - PHARMACEUTICAL SCIENCES

Natural Products: Pharmacognosy & Phytochemistry - Chemistry, tests, isolation, characterization and estimation of phytopharmaceuticals belonging to the group of Alkaloids, Glycosides, Terpenoids, Steroids, Bioflavanoids, Purines, Guggul lipids. Pharmacognosy of crude drugs which contain the above constituents. Standardisation of raw materials and herbal products. WHO guide lines. Quantitative microscopy including modern techniques used for evaluation. Biotechnological principles and techniques for plant development Tissue culture.

Pharmacology: General pharmacological principles including Toxicology. Drug interaction. Pharmacology of drugs acting on Central nervous system, Cardiovascular system, Autonomic nervous system, Gastro intestinal system and Respiratory system. Pharmacology of Autocoids, Hormones, Chemotherapeutic agents including anticancer drugs. Bioassays. Immuno Pharmacology.

Medicinal Chemistry: Structure, nomenclature, classification, synthesis, SAR and metabolism of the following category of drugs which are official in Indian Pharmacopoeia and British Pharmacopoeia Hypnotics and Sedatives, Analgesics, NSAIDS, Neuroleptics, Antidepressants, Anxiolytics, Anticonvulsants, Antihistaminics, Local anaesthetics, Cardio Vascular drugs - Antianginal agents Vasodilators, Adrenergic & cholinergic drugs, Cardiotonic agents, Diuretics, Antihypertensive drugs, Hypoglycemic agents, Antilipedmic agents, Coagulants, Anticoagulants, Antiplatelet agents. Chemotherapeutic agents - Antibiotics, Antibacterials, Sulphadrugs. Antiproliozoal drugs, Antiviral, Antitubercular, Antimalarial, Anticancer, Antiamoebic drugs. Diagnostic agents. Preparation and storage and uses of official Radiopharmaceuticals. Vitamins and Hormones.

Pharmaceutics: Development, manufacturing standards, labeling, packing as per the pharmacopoeal requirements, Storage of different dosage forms and new drug delivery systems. Biopharmaceutics and Pharmacokinetics and their importance in formulation. Formulation and preparation of cosmetics - lipstick, shampoo, creams, nail preparations and dentifrices. Pharmaceutical calculations.

Pharmaceutical Jurisprudence: Legal aspects of manufacture, storage, sale of drugs. D and C act and rules. Pharmacy act.

Pharmaceutical Analysis: Principles, instrumentation and applications of the following. Absorption spectroscopy (UV, visible & IR), Fluorimetry, Flame photometry, Potentiometry, Conductometry and Plarography. Pharmacopoeial assays. Principles of NMR, ESR, Mass spectroscopy, X-ray diffraction analysis and different chromatographic methods.

Biochemistry and Clinical Pharmacy: Biochemical role of hormones, Vitamins, Enzymes, Nucleic acids. Bioenergetics. General principles of immunology. Immunological techniques. Adverse drug interaction.

Microbiology: Principles and methods of microbiological assays of the Pharmacopoeia. Methods of preparation of official sera and vaccines. Serological and diagnostic tests. Applications of microorganisms in Bio Conversions and in Pharmaceutical industry.

TF - TEXTILE ENGINEERING AND FIBRE SCIENCE

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

TEXTILE ENGINEERING & FIBRE SCIENCE

Textile Fibres: Classification of textile fibres according to their nature and origin; general characteristics of textile fibres-their chemical and physical structures and their properties; essential characteristics of fibre forming polymers; uses of natural and man-made fibres; physical and chemical methods of fibre and blend identification and blend analysis.

Melt Spinning processes with special reference to polyamide and polyester fibres; wet and dry spinning of viscose and acrylic fibres; post spinning operations-drawing, heat setting, texturing- false twist and air-jet, tow-to-top conversion. Methods of investigating fibre structure e.g. X-ray diffraction, birefringence, optical and electron microscopy, I.R. absorption, thermal methods; structure and morphology and principal natural and man-made fibres, mechanical properties of fibres, moisture sorption in fibres; fibre structure and property correlation.

Textile Testing: Sampling techniques, sample size and sampling errors; measurement of fibre length, fineness, crimp, strength and reflectance; measurement of cotton fibre maturity ad trash content; HVI and AFIS for fibre testing. Measurement of yarn count, twist and hairiness; tensile testing of fibres, yarn and fabrics; evenness testing of slivers, rovings and yarns; testing equipment for measurement test methods of fabric properties like thickness, compressibility, air permeability, drape, crease recovery, tear strength bursting strength and abrasion resistance. Correlation analysis, significance tests and analysis of variance; frequency distributions and control charts.

Yarn Manufacture and Yarn Structure: Modern methods of opening, cleaning and blending of fibrous materials; the technology of carding with particular reference to modern developments; causes of irregularity introduced by drafting, the development of modern drafting systems; principles and techniques of preparing material for combing; recent development in combers; functions and synchronization of various mechanisms concerned with roving production; forces acting on yarn and traveller, ring and traveller designs; causes of end breakages; properties of doubles yarns; new methods of yarn production such as rotor spinning, air jet spinning and friction spinning.

Yarn diameter; specific volume, packing coefficient; twist-strength relationship; fibre orientation in yarn; fibre migration.

Fabric Manufacture and Fabric Structure: Principles of cheese and cone winding processes and machines; random and precision winding; package faults and their remedies; yarn clearers and tensioners; different systems of yarn splicing; features of modern cone winding machines; different types of warping creels; features of modern beam and sectional warping machines; different sizing systems, sizing of spun and filament yarns, modern sizing machines; principles of pirn winding processes and machines; primary and secondary motions of loom, effect of their settings and timings on fabric formation, fabric appearance and weaving performance; dobby and jacquard shedding; mechanics of weft insertion with shuttle; warp and weft stop motions, warp protection, weft replenishment; functional principles of weft insertion systems of shuttleless weaving machines, principles of multiphase and circular looms. Principles of weft and warp knitting; basic weft and warp knitted structures; classification, production and areas of application of nonwoven fabrics.

Basic woven fabric constructions and their derivatives; crepe, cord, terry, gauze, lino and double cloth constructions.

Peirce's equations for fabric geometry; thickness, cover and maximum sett of woven fabrics

Textile Chemical Processing: Preparatory processes for natural-and and their blends; mercerization of cotton; machines for yarn and fabric mercerization.

Dyeing and printing of natural- and synthetic- fibre fabrics and their blends with different dye classes; dyeing and printing machines; styles of printing; fastness properties of dyed and printed textile materials.

Finishing of textile materials, wash and wear, durable press, soil release, water repellent, flame retardant and antistatic finishes; shrink-resistance finish for wool; heat setting of synthetic-fibre fabrics, finishing machines; energy efficient processes; pollution control.

XE - ENGINERING SCIENCES

The syllabi of the sections of this paper are as follows:

SECTION A. ENGINEERING MATHEMATICS (Compulsory)

Linear Algebra : Determinates, algebra of matrices, rank, inverse, system of linear equations, symmetric, skew-symmetric and orthogonal matrices. Hermitian, skew-hermitian and unitary matrices. eigenvalues and eigenvectors, diagonalisation of matrices, Cayley-Hamiltonian, quadratic forms.

Calculus : Functions of single variables, limit, continuity and differentiability, Mean value theorems, Intermediate forms and L'Hospital rule, Maxima and minima, Taylor's series, Fundamental and mean value-theorems of integral calculus. Evaluation of definite and improper integrals, Beta and Gamma functions, Functions of two variables, limit, continuity, partial derivatives, Euler's theorem for homogeneous functions, total derivatives, maxima and minima, Lagrange method of multipliers, double and triple integrals and their applications, sequence and series, tests for convergence, power series, Fourier Series, Fourier integrals.

Complex variable: Analytic functions, Cauchy's integral theorem and integral formula without proof. Taylor's and Laurent' series, Residue theorem (without proof) with application to the evaluation of real integarls.

Vector Calculus: Gradient, divergence and curl, vector identities, directional derivatives, line, surface and volume integrals, Stokes, Gauss and Green's theorems (without proofs) with applications.

Ordinary Differential Equations: First order equation (linear and nonlinear), higher order linear differential equations with constant coefficients, method of variation of paramaters, Cauchy's and Euler's equations, initial and boundary value problems, power series solutions, Legendre polynomials and Bessel's functions of the first kind.

Partial Differential Equations: Variables separable method, solutions of one dimensional heat, wave and Laplace equations.

Probability and Statistics: Definitions of probability and simple theorems, conditional probability, mean, mode and standard deviation, random variables, discrete and continuous distributions, Poisson, normal and Binomial distribution, correlation and regression

Numerical Methods: L-U decomposition for systems of linear equations,Newton-Raphson method, numerical integration(trapezoidal and Simpson's rule), numerical methods for first order differential equation (Euler method)

SECTION B. COMPUTATIONAL SCIENCE

Numerical Methods: Truncation errors, round off errors and their propagation; Interpolation; Lagrange, Newton's forward, backward and divided difference formulas, least square curve fitting, solution of non-linear equations of one variables using bisection, false position, secant and Newton Raphson methods; Rate of convergence of these methods, general iterative methods. Simple and multiple roots of polynomials. Solutions of system of linear algebraic equations using Gauss elimination methods, Jacobi and Gauss-Seidel iterative methods and their rate of convergence; ill conditioned and well conditioned system. eigen values and eigen vectors using power methods. Numerical integration using trapezoidal, Simpson's rule and other quadrature formulas. Numerical Differentiation. Solution of boundary value problems. Solution of initial value problems of ordinary differential equations using Euler's method, predictor corrector and Runge Kutta method.

Programming : Elementary concepts and terminology of a computer system and system software, Fortran77 and C programming.

Fortran : Program organization, arithmetic statements, transfer of control, Do loops, subscripted variables, functions and subroutines.

C language : Basic data types and declarations, flow of control- iterative statement, conditional statement, unconditional branching, arrays, functions and procedures.

SECTION C. ELECTRICAL SCIENCES

Electric Circuits: Ideal voltage and current sources; RLC circuits, steady state and transient analysis of DC circuits, network theorems; alternating currents and voltages, single-phase AC circuits, resonance; three-phase circuits.

Magnetic circuits: Mmf and flux, and their relationship with voltage and current; transformer, equivalent circuit of a practical transformer, three-phase transformer connections.

Electrical machines: Principle of operation, characteristics, efficiency and regulation of DC and synchronous machines; equivalent circuit and performance of three-phase and single-phase induction motors.

Electronic Circuits: Characteristics of p-n junction diodes, zener diodes, bipolar junction transistors (BJT) and junction field effect transistors (JFET); MOSFET's structure, characteristics, and operations; rectifiers, filters, and regulated power supplies; biasing circuits, different configurations of transistor amplifiers, class A, B and C of power amplifiers; linear applications of operational amplifiers; oscillators; tuned and phase shift types.

Digital circuits: Number systems, Boolean algebra; logic gates, combinational circuits, flip-flops (RS, JK, D and T) counters.

Measuring instruments: Moving coil, moving iron, and dynamometer type instruments; shunts, instrument transformers, cathode ray oscilloscopes; D/A and A/D converters.

SECTION D. FLUID MECHANICS

Fluid Properties: Relation between stress and strain rate for Newtonian fluids

Hydrostatics, buoyancy, manometry

Concept of local and convective accelerations; control volume analysis for mass, momentum and energy conservation.

Differential equations of continuity and momentum (Euler's equation of motion); concept of fluid rotation, stream function, potential function; Bernoulli's equation and its applications.

Qualitative ideas of boundary layers and its separation; streamlined and bluff bodies; drag and lift forces.

Fully-developed pipe flow; laminar and turbulent flows; friction factor; Darcy Weisbach relation; Moody's friction chart; losses in pipe fittings; flow measurements using venturimeter and orifice plates.

Dimensional analysis; similitude and concept of dynamic similarity; importance of dimensionless numbers in model studies.

SECTION E. MATERIALS SCIENCE

Atomic structure and bonding in materials: metals, ceramics and polymers.

Structure of materials: Crystal systems, unit cells and space lattice; determination of structures of simple crystals by X-ray diffraction; Miller indices for planes and directions. Packing geometry in metallic, ionic and covalent solids.

Concept of amorphous, single and polycrystalline structures and their effects on properties of materials.

Imperfections in crystalline solids and their role in influencing various properties.

Fick´s laws of diffusion and applications of diffusion in sintering, doping of semiconductors and surface hardening of metals.

Alloys: solid solution and solubility limit. Binary phase diagram, intermediate phases and intermetallic compounds; iron-iron carbide phase diagram. Phase transformation in steels. Cold and hot working of metals, recovery, recrystallization and grain growth.

Properties and applications of ferrous and nonferrous alloys.

Structure, properties, processing and applications of traditional and advanced ceramics.

Polymers: classification, polymerization, structure and properties, additives for polymer products, processing and application.

Composites: properties and application of various composites.

Corrosion and environmental degradation of materials (metals, ceramics and polymers).

Mechanical properties of materials: Stress-strain diagrams of metallic, ceramic and polymeric materials, modulus of elasticity, yield strength, plastic deformation and toughness, tensile strength and elongation at break; viscoelasticity, hardness, impact strength. ductile and brittle fracture. creep and fatigue properties of materials.

Heat capacity, thermal conductivity, thermal expansion of materials.

Concept of energy band diagram for materials; conductors, semiconductors and insulators in terms of energy bands. Electrical conductivity, effect of temperature on conductivity in materials, intrinsic and extrinsic semiconductors, dielectric properties of materials.

Refraction, reflection, absorption and transmission of electromagnetic radiation in solids.

Origin of magnetism in metallic and ceramic materials, paramagnetism, diamagnetism, antiferromagnetism, ferromagnetism, ferrimagnetism in materials and magnetic hysteresis.

Advanced materials: Smart materials exhibiting ferroelectric, piezoelectric, optoelectronic, semiconducting behaviour; lasers and optical fibers; photoconductivity and superconductivity in materials.

SECTION F. SOLID MECHANICS

Equivalent force systems; free-body diagrams; equilibrium equations; analysis of determinate and indeterminate trusses and frames; friction.

Simple relative motion of particles; force as function of position, time and speed; force acting on a body in motion; laws of motion; law of conservation of energy; law of conservation of momentum

Stresses and strains; principal stresses and strains; Mohr's circle; generalized Hooke's Law; equilibrium equations; compatibility conditions; yield criteria.

Axial, shear and bending moment diagrams; axial, shear and bending stresses; deflection (for symmetric bending); torsion in circular shafts; thin cylinders; energy methods (Castigliano's Theorems); Euler buckling.

SECTION G. THERMODYNAMICS

Basic Concepts: Continuum, macroscopic approach, thermodynamic system (closed and open or control volume); thermodynamic properties and equilibrium; state of a system, state diagram, path and process; different modes of work; Zeroth law of thermodynamics; concept of temperature; heat.

First Law of Thermodynamics: Energy, enthalpy, specific heats, first law applied to systems and control volumes, steady and unsteady flow analysis.

Second Law of Thermodynamics: Kelvin-Planck and Clausius statements, reversible and irreversible processes, Carnot theorems, thermodynamic temperature scale, Clausius inequality and concept of entropy, principle of increase of entropy; availability and irreversibility.

Properties of Pure Substances: Thermodynamic properties of pure substances in solid, liquid and vapour phases, P-V-T behaviour of simple compressible substances, phase rule, thermodynamic property tables and charts, ideal and real gases, equations of state, compressibility chart.

Thermodynamic Relations: T-ds relations, Maxwell equations, Joule-Thomson coefficient, coefficient of volume expansion, adiabatic and isothermal compressibilities, Clapeyron equation.

Ideal Gas Mixtures: Dalton's and Amagat's laws, calculations of properties, air-water vapour mixtures.

XL - LIFE SCIENCES

The syllabi of the Sections of this paper are as follows:

SECTION H. CHEMISTRY (Compulsory)

Atomic structure and periodicity: Quantum chemistry; Planck's quantum theory, wave particle duality, uncertainty principle, quantum mechanical model of hydrogen atom; electronic configuration of atoms; periodic table and periodic properties; ionization energy, election affinity, electronegativity, atomic size.

Structure and bonding: Ionic and covalent bonding M.O. and V.B. approaches for diatomic molecules, VSEPR theory and shape of molecules, hybridisation, resonance, dipole moment, structure parameters such as bond length, bond angle and bond energy, hydrogen bonding, van der Waals interactions. Ionic solids; ionic radii, lattice energy (Born-Haber Cycle).

s.p. and d Block Elements: Oxides, halides and hydrides of alkali and alkaline earth metals, B, Al, S, N, P and S, silicones, general characteristics of 3d elements, coordination complexes: valence bond and crystal field theory, color, geometry and magnetic properties.

Chemical Equilibria: Colligative properties of solutions, ionic equilibria in solution, solubility product, common ion effect, hydrolysis of salts, pH, buffer and their applications in chemical analysis.

Electrochemistry: Conductance, Kohlrausch law, Half Cell potentials, emf, Nernst equation, galvanic cells, thermodynamic aspects and their applications.

Reaction Kinetics: Rate constant, order of reaction, molecularity, activation energy, zero, first and second order kinetics, equilibrium constants (Kc, Kp and Kx) for homogeneous reactions, catalysis and elementary enzyme reactions.

Thermodynamics: First law, reversible and irreversible processes, internal energy, enthalpy, Kirchoff's equation, heat of reaction, Hess law, heat of formation, Second law, entropy, free energy, and work function. Gibbs-Helmholtz equation, Clausius-Clapeyron equation, free energy change and equilibrium constant, Troutons rule, Third law of thermodynamics.

Mechanistic Basis of Organic Reactions: Elementary treatment of SN1, SN2, E1 and E2 reactions, Hoffmann and Saytzeff rules, Addition reactions, Markonikoff rule and Kharash effect, Diels-Alder reaction, aromatic electrophilic substitution, orientation effect as exemplified by various functional groups.

Structure-Reactivity Correlations: Acids and bases, electronic and steric effects, optical and geometrical isomerism, tautomerism, concept of aromaticity

SECTION I. BIOCHEMISTRY

Organization of life. Importance of water. Cell structure and organelles. Structure and function of biomolecules: Carbohydrates, Lipids, Proteins and Nucleic acids. Biochemical separation techniques. Spectroscopic methods; UV-visible and fluorescence. Protein structure, folding and function: Myoglobin, Hemoglobin, Lysozyme, ribonuclease A, Carboxypeptidase and Chymotrypsin. Enzyme kinetics and regulation, Coenzymes.

Metabolism and bioenergitics. Generation and utilization of ATP. Photosynthesis. Major metabolic pathways and their regulation. Biological membranes. Transport across membranes. Signal transduction; hormones and neurotransmitters.

DNA replication, transcription and translation. Biochemical regulation of gene expression. Recombinant DNA technology and applications. Genomics and Proteomics.

The immune system. Active and passive immunity. Complement system. Antobody structure, function and diversity. Cells of the immune system: T, B and macrophages. T and B cell activation. Major histocompatibilty complex. T cell receptor. Immunological techniques: Immunodiffusion, immunoelectrophoresis, RIA and ELISA.

SECTION J. BIOTECHNOLOGY

Recombinant DNA technology for the production of therapeutic proteins. Micro array technology. Heterologous protein expression systems in bacteria, yeast etc.

Architecture of plant genome; plant tissue culture techniques; methods of gene transfer into plant cells; manipulation of phenotypic traits in plants; plant cell fermentations and production of secondary metabolites using suspension/ immobilized cell culture; methods for plant micro propagation; crop improvement and development of transgenic plants. Expression of animal proteins in plants.

Animal cell metabolism and regulation; cell cycle; primary cell culture; nutritional requirements for animal cell culture; techniques for the mass culture of animal cell lines; production of vaccines; growth hormones and interferons using animal cell culture; cytokines-production and therapeutic uses; hybridoma technology; vectors for gene transfer and expression in animal cells. Transgenic animals and molecular pharming.

Microbial production of industrial enzymes; methods for immobilization of enzymes; kinetics of soluble and immobilized enzymes; application of soluble and immobilized enzymes; enzyme-based sensors.

Microbial growth kinetics; batch, fed batch and continuous culture of microbial cells; media for industrial fermentations; sterilization of air and media; design features and operation of stirred tank, air-lift and fluidized bed reactors; aeration and agitation in aerobic fermentations; recovery and purification of fermentation products- filtration, centrifugation, cell disintegration, solvent extraction and chromatographic separations; industrial fermentations for the production of ethanol, citric acid, lysine, penicillin and other biomolecules; simple calculations based on material and energy balance of fermentation processes; application of microbes in the management of domestic and industrial wastes.

SECTION K. BOTANY

Anatomy: Roots, stem and leaves of land plants, meristems, vascular system, their ontogeny, structure and functions. Plant cell structure, organisation, organelles, cytoskeleton, cell wall and membranes.

Development: Cell cycle, cell division, senescence, hormonal regulation of growth; life cycle of an angiosperm, pollination, fertilization, embryogenesis, seed formation, seed storage proteins, seed dormancy and germination. Concept of cellular totipotency, organogenesis and somatic embryogenesis, somaclonal variation, embryo culture, in vitro fertilization.

Physiology and Biochemistry: Plant water relations, transport of minerals and solutes, N2 metabolism, proteins and nucleic acid, respiration, photophysiology, photosynthesis, photorespiration; biosynthesis, mechanism of action and physiological effects of plant growth regulators.

Genetics: Principles of Mendelian inheritance, linkage, recombination and genetic mapping; extrachromosomal inheritance; eukaryotic genome organization (chromatin structure) and regulation of gene expression, gene mutation, chromosome aberrations (numerical and structural), transposons.

Plant Breeding: Principles, methods - selection, hybridization, heterosis; male sterility, self and inter-specific incompatibility; haploidy; somatic cell hybridization; molecular marker-assisted selection; gene transfer methods viz. direct and vector-mediated, transgenic plants and their applications in agriculture.

Economic Botany: Economically important plants - cereals, pulses, plants yielding fiber, timber, sugar, beverages, oils, rubber, dyes, gums, drugs and narcotics - a general account.

Systematics: Systems of classification (non-phylogenetic vs. phylogenetic - outline), plant groups, molecular systematics.

Plant Pathology: Nature and classification of plant diseases, diseases of important crops caused by fungi, bacteria and viruses, and their control measures, mechanism(s) of pathogenesis and resistance, molecular detection of pathogens; plant-microbe beneficial interactions.

Ecology and Plant Geography: Ecosystems - types, dynamics, degradation, ecological succession; food chains; vegetation types of the world; pollution and global warming; speciation and extinction, conservation strategies, cryopreservation.

SECTION L. MICROBIOLOGY

Historical perspective - Discovery of the microbial world; Controversy over spontaneous generation; Role of microorganisms in transformation of organic matter and in the causation of diseases.

Methods in microbiology - Pure culture techniques; Theory and practice of sterilization; Principles of microbial nutrition; Construction of culture media; Enrichment culture techniques for isolation of chemoautotrophs, chemoheterotrophs and photosynthetic microorganisms.

Microbial evolution, systematics and taxonomy - Evolution of earth and earliest life forms; Primitive organisms and their metabolic strategies; New approaches to bacterial taxonomic classification including ribotyping; Nomenclature.

Microbial diversity - Bacteria, archea and their broad classification; Eukaryotic microbes, yeast, fungi, slime mold and protozoa; Viruses and their classification.

Microbial growth -The definition of growth, mathematical expression of growth, growth curve, measurement of growth and growth yields; Synchronous growth; Continuous culture.

Nutrition and metabolism - Overview of metabolism; Microbial nutrition; Energy classes of microorganisms; Culture media; Energetics, modes of ATP generation; ATP generation by heterotrophs; Fermentation; Glycolysis; Respiration; The citric acid cycle; Electron transport systems; Alternate modes of energy generation; Pathways (anabolism) in the biosynthesis of amino acids, purines, pyrimidines and fatty acids.

Metabolic diversity among microorganisms - Photosynthesis in microorganisms; Role of chlorophylls, carotenoids and phycobilins; Calvin cycle; Chemolithotrophy; Hydrogen- iron-nitrite-oxidizing bacteria; Nitrate and sulfate reduction; Methanogenesis and acetogenesis.

Prokaryotic cells: structure-function - Cells walls of eubacteria (peptidoglycan) and related molecules; Outer-membrane of gram-negative bacteria; Cell wall and cell membrane synthesis; Flagella and motility; Cell inclusions like endospores, gas vesicles.

Microbial diseases and host parasite relationships - Normal microflora of skin; Oral cavity; Gastrointestinal tract; Entry of pathogens into the host; Infectious disease transmission; Respiratory infections caused by bacteria and viruses; Tuberculosis; Sexually transmitted diseases including AIDS; Diseases transmitted by animals (Rabies, plague), insects and ticks (rikettsias, Lyme disease, malaria); Food and water borne diseases; Public health and water quality; Pahtogenic fungi; Emerging and resurgent infectious diseases.

Chemotherapy/Antibiotics - Antimicrobial agents; Sulfa drugs; Antibiotics; Pencillins and cephalosporins; Broad-spectrum antibiotics; Antibiotics from prokaryotes; Antifungal antibiotics; Mode of action; Resistance to antibiotics.

Microbial genetics - Genes, mutation and mutagenesis - UV and chemical mutagnes; Types of mutations; Ames test for mutagenesis; Methods of genetic analysis. Bacterial genetic system - Transformation; Conjugation; Transduction; Recombination; Plasmids and Transposons; Bacterial genetic map with reference to E. coli. Viruses and their genetic system - Phage ? and its life cycle; RNA phages; RNA viruses; Retroviruses; Genetic systems of yeast and Neurospora; Extrachromosomal inheritance and mitochondrial genetics; Basic concept of genomics.

SECTION M. ZOOLOGY

Animal world: Animal diversity, distribution, systematic and classification of animals, the phylogenetic relationship.

Evolution: Origin of life, history of life on earth, evolutionary theories, natural selection, adaptation, speciation.

Genetics: Principles of inheritance, molecular basis of heredity, the genetic material, transmission of genetic material, mutations, cytoplasmic inheritance.

Biochemistry and Molecular Biology: Nucleic acids, proteins and other biological macromolecules. Replication, transcription and translation, regulation of gene expression, organization of genome, Kreb's cycle, glycolysis, enzyme catalysis, hormones and their action.

Cell Biology: Structure of cell, cellular organelles and their structure and function, cell cycle, cell division, cellular differentiation, chromosome and chromatin structure. Eukaryotic gene organisation and expression.

Animal Anatomy and Physiology: Comparative physiology, the respiratory system, circulatory system, digestive system, the nervous system, the excretory system, the endocrine system, the reproductive system, the skeletal system, osmoregulation.

Parasitology and Immunology: Nature of parasite, host-parasite relation, protozoan and helminthic parasites, the immune response, cellular and humoral immune response, evolution of the immune system.

Development Biology: Embryonic development, cellular differentiation, organogenesis, metamorphosis, genetic basis of development.

Ecology: The ecosystem, habitats the food chain, population dynamics, species diversity, zoogeography, biogeochemical cycles, conservation biology.

Animal Behaviour: Types of behaviours, courtship, mating and territoriality, instinct, learning and memory, social behaviour across the animal taxa, communication, pheromones, evolution of animal behaviour.

IT - INFORMATION TECHNOLOGY

ENGINEERING MATHEMATICS

Mathematical Logic: Propositional Logic; First Order Logic.

Probability: Conditional Probability; Mean, Median, Mode and Standard Deviation; Random Variables; Distributions; uniform, normal, exponential, Poisson, Binomial.

Set Theory & Algebra: Sets; Relations; Functions; Groups; Partial Orders; Lattice; Boolean Algebra.

Combinatorics: Permutations; Combinations; Counting; Summation; generating functions; recurrence relations; asymptotics.

Graph Theory: Connectivity; spanning trees; Cut vertices & edges; covering; matching; independent sets; Colouring; Planarity; Isomorphism.

Linear Algebra: Algebra of matrices, determinants, systems of linear equations, Eigen values and Eigen vectors.

Numerical Methods: LU decomposition for systems of linear equations; numerical solutions of non linear algebraic equations by Secant, Bisection and Newton-Raphson Methods; Numerical integration by trapezoidal and Simpson's rules.

Calculus: Limit, Continuity & differentiability, Mean value Theorems, Theorems of integral calculus, evaluation of definite & improper integrals, Partial derivatives, Total derivatives, maxima & minima.

FORMAL LANGUAGES AND AUTOMATA

Regular Languages: finite automata, regular expressions, regular grammar.

Context free languages: push down automata, context free grammars

COMPUTER HARDWARE

Digital Logic: Logic functions, minimization, design and synthesis of combinatorial and sequential circuits, number representation and computer arithmetic (fixed and floating point)

Computer organization: Machine instructions and addressing modes, ALU and data path, hardwired and microprogrammed control, memory interface, I/O interface (interrupt and DMA mode), serial communication interface, instruction pipelining, cache, main and secondary storage

SOFTWARE SYSTEMS

Data structures and Algorithms: the notion of abstract data types, stack, queue, list, set, string, tree, binary search tree, heap, graph, tree and graph traversals, connected components, spanning trees, shortest paths, hashing, sorting, searching, design techniques (greedy, dynamic, divide and conquer), asymptotic analysis (best, worst, average cases) of time and space, upper and lower bounds, intractability

Programming Methodology: C programming, program control (iteration, recursion, functions), scope, binding, parameter passing, elementary concepts of object oriented programming

Operating Systems (in the context of Unix): classical concepts (concurrency, synchronization, deadlock), processes, threads and interprocess communication, CPU scheduling, memory management, file systems, I/O systems, protection and security

Information Systems and Software Engineering: information gathering, requirement and feasibility analysis, data flow diagrams, process specifications, input/output design, process life cycle, planning and managing the project, design, coding, testing, implementation, maintenance.

Databases: relational model, database design, integrity constraints, normal forms, query languages (SQL), file structures (sequential, indexed), b-trees, transaction and concurrency control

Data Communication: data encoding and transmission, data link control, multiplexing, packet switching, LAN architecture, LAN systems (Ethernet, token ring), Network devices: switches, gateways, routers

Networks: ISO/OSI stack, sliding window protocols, routing protocols, TCP/UDP, application layer protocols & systems (http, smtp, dns, ftp), network security

Web technologies: three tier web based architecture; JSP, ASP, J2EE, .NET systems; html, XML

AG - AGRICULTURAL ENGINEERING

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

FARM MACHINERY AND POWER:

Sources of power on the farm-human, animal, mechanical, electrical, wind, solar and biomass; design and selection of machine elements - gears, pulleys, chains and sprockets and belts; overload safety devices used in farm machinery; measurement of force, torque, speed, displacement and acceleration on machine elements.

Soil tillage; forces acting on a tillage tool; hitch systems and hitching of tillage implements; functional requirements, principles of working, construction and operation of manual, animal and power operated equipment for tillage. sowing, planting, fertilizer application, inter-cultivation, spraying, mowing, chaff cutting, harvesting, threshing and transport; testing of agricultural machinery and equipment; calculation of performance parameters -field capacity, efficiency, application rate and losses; cost analysis of implements and tractors.

Thermodynamic principles of I.C. engines; I.C. engine cycles; engine components; fuels and combustion; lubricants and their properties; I.C. engine systems - fuel, cooling, lubrication, ignition, electrical, intake and exhaust; selection, operation, maintenance and repair of I.C. engines; power efficiencies and measurement; calculation of power, torque, fuel consumption, heat load and power losses.

Tractors and power tillers - type, selection, maintenance and repair; tractor clutches and brakes; power transmission systems - gear trains, differential, final drives and power take-off; mechanics of tractor chassis; traction theory; three point hitches- free link and restrained link operations; mechanical steering and hydraulic control systems used in tractors; human engineering and safety in tractor design; tractor tests and performance.

SOIL AND WATER CONSERVATION ENGINEERING:

Ideal and real fluids, properties of fluids; hydrostatic pressure and its measurement; hydrostatic forces on plane and curved surface; continuity equation; Bernoulli's theorem; laminar and turbulent flow in pipes, Darcy-Weisbach and Hazen-Williams equations, Moody's diagram; flow through orifices and notches; flow in open channels.

Engineering properties of soils, fundamental definitions and relationships; index properties of soils; permeability and seepage analysis; shear strength, Mohr's circle of stresses; active and passive earth pressures; stability of slopes.

Hydrological cycle; precipitation measurement, analysis of precipitation data; abstraction from precipitation; runoff; hydrograph analysis, unit hydrograph theory and application; stream flow measurement; flood routing, hydrological reservoir and channel routing.

Mechanics of soil erosion, factors affecting erosion; soil loss estimation; biological and engineering measures to control erosion, terraces and bunds; vegetative waterways; gully control structures, drop, drop inlet and chute spillways; farm ponds; earthen dams; principles of watershed management.

Water requirement of crops; consumptive use and evapo-transpiration; irrigation scheduling; irrigation efficiencies; design of prismatic and silt loaded channels; methods of irrigation water application; design and evaluation of irrigation methods; drainage coefficient; surface and subsurface drainage systems; leaching requirement and salinity control; irrigation and drainage water quality; classification of pumps; pump characteristics; pump selection; types of aquifer; evaluation of aquifer properties; well hydraulics; ground water recharge.

AGRICULTURAL PROCESSING AND FOOD ENGINEERING:

Steady state heat transfer in conduction, convection and radiation; transient heat transfer in simple geometry; condensation and boiling heat transfer; working principles of heat exchangers; diffusive and convective mass transfer; simultaneous heat and mass transfer in agricultural processing operations.

Material and energy balances in food processing systems; water activity, sorption and desorption isotherms; centrifugal separation of solids, liquids and gases; kinetics of microbial death - pasteurisation and sterilization of liquid foods; preservation of food by cooling and freezing; psychrometry - properties of air-vapour mixture; concentration and dehydration of liquid foods - evaporators, tray, drum and spray dryers.

Mechanics and energy requirement in size reduction of granular solids; particle size analysis for comminuted solids; size separation by screening; fluidisation of granular solids; cleaning and grading efficiency and effectiveness of grain cleaners; conditioning and hydrothermal treatments for grains; dehydration of food grains; processes and machines for processing of cereals, pulses and oilseeds; design considerations for grain silos.

AR - ARCHITECTURE AND PLANNING

City planning: Historical development of cities; principles of city planning; new towns; survey methods, site planning, planning regulations and building bye-laws.

Housing: Concept of shelter; housing policies and design; community planning; role of government agencies; finance and management.

Landscape Design: Principles of landscape design and site planning; history and landscape styles; landscape elements and materials; planting design.

Computer Aided Design: Application of computers in architecture and planning; understanding elements of hardware and software; computer graphics; programming languages - C and Visual Basic and usage of packages such as AutoCAD.

Environmental and Building Science: Elements of environmental science; ecological principles concerning environment; role of micro-climate in design; climatic control through design elements; thermal comfort; elements of solar architecture; principles of lighting and illumination; basic principles of architectural acoustics; air pollution, noise pollution and their control.

Visual and Urban Design: Principles of visual composition; proportion, scale, rhythm, symmetry, harmony, balance, form and colour; sense of place and space, division of space; focal point, vista, imageability, visual survey.

History of Architecture: Indian - Indus valley, Vedic, Buddhist, Indo-Aryan, Dravidian and Mughal periods; European - Egyptian, Greek, Roman, medieval and renaissance periods.

Development of Contemporary Architecture: Architectural developments and impacts on society since industrial revolution; influence of modern art on architecture; works of national and international architects; post modernism in architecture.

Building Services: Water supply, Sewerage and Drainage systems; Sanitary fittings and fixtures; principles of electrification of buildings; elevators, their standards and uses; air-conditioning systems; fire fighting systems.

Building Construction and Management: Building construction techniques, methods and details; building systems and prefabrication of building elements; principles of modular coordination; estimation, specification, valuation, professional practice; project management, PERT, CPM.

Materials and Structural Systems: Behavioural characteristics of all types of building materials e.g. mud, timber, bamboo, brick, concrete, steel, glass, FRP; principles of strength of materials; design of structural elements in wood, steel and RCC; elastic and limit state design; complex structural systems; principles of pre-stressing.

Planning Theory: Planning process; multilevel planning; comprehensive planning; central place theory; settlement pattern; land use and land utilization.

Techniques of Planning: Planning surveys; Preparation of urban and regional structure plans, development plans, action plans; site planning principles and design; statistical methods; application of remote sensing techniques in urban and regional planning.

Traffic and Transportation Planning: Principles of traffic engineering and transportation planning; methods of conducting surveys; design of roads, intersections and parking areas; hierarchy of roads and levels of services; traffic and transport management in urban areas; traffic safety and traffic laws; public transportation planning; modes of transportation.

Services and Amenities: Principles and design of water supply systems, sewerage systems, solid waste disposal systems, power supply and communication systems; Health, education, recreation and demography related standards at various levels of the settlements.

Development Administration and Management: Planning laws; development control and zoning regulations; laws relating to land acquisition; development enforcements, land ceiling; regional and urban plan preparations; planning and municipal administration; taxation, revenue resources and fiscal management; public participation and role of NGO.

CE - CIVIL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

STRUCTURAL ENGINEERING

Mechanics: Bending moments and shear forces in statically determinate beams; simple stress and strain: relationship; stress and strain in two dimensions, principal stresses, stress transformation, Mohr's circle; simple bending theory; flexural shear stress; thin-walled pressure vessels; uniform torsion.

Structural Analysis: Analysis of statically determinate trusses, arches and frames; displacements in statically determinate structures and analysis of statically indeterminate structures by force/energy methods; analysis by displacement methods (slope-deflection and moment-distribution methods); influence lines for determinate and indeterminate structures; basic concepts of matrix methods of structural analysis.

Concrete Structures: Basic working stress and limit states design concepts; analysis of ultimate load capacity and design of members subject to flexure, shear, compression and torsion (beams, columns and isolated footings); basic elements of prestressed concrete: analysis of beam sections at transfer and service loads.

Steel Structures: Analysis and design of tension and compression members, beams and beam-columns, column bases; connections - simple and eccentric, beam-column connections, plate girders and trusses; plastic analysis of beams and frames.

GEOTECHNICAL ENGINEERING

Soil Mechanics: Origin of soils; soil classification; three-phase system, fundamental definitions, relationship and inter-relationships; permeability and seepage; effective stress principle: consolidation, compaction; shear strength.

Foundation Engineering: Sub-surface investigation - scope, drilling bore holes, sampling, penetrometer tests, plate load test; earth pressure theories, effect of water table, layered soils; stability of slopes - infinite slopes, finite slopes; foundation types - foundation design requirements; shallow foundations; bearing capacity, effect of shape, water table and other factors, stress distribution, settlement analysis in sands and clays; deep foundations - pile types, dynamic and static formulae, load capacity of piles in sands and clays.

WATER RESOURCES ENGINEERING

Fluid Mechanics and Hydraulics: Hydrostatics, applications of Bernoulli equation, laminar and

turbulent flow in pipes, pipe networks; concept of boundary layer and its growth; uniform flow, critical flow and gradually varied flow in channels, specific energy concept, hydraulic jump; forces on immersed bodies; flow measurement in channels; tanks and pipes; dimensional analysis and hydraulic modeling. Applications of momentum equation, potential flow, kinematics of flow; velocity triangles and specific speed of pumps and turbines.

Hydrology: Hydrologic cycle; rainfall; evaporation infiltration, unit hydrographs, flood estimation, reservoir design, reservoir and channel routing, well hydraulics.

Irrigation: Duty, delta, estimation of evapo-transpiration; crop water requirements; design of lined and unlined canals; waterways; head works, gravity dams and Ogee spillways. Designs of weirs on permeable foundation, irrigation methods.

ENVIRONMENTAL ENGINEERING

Water requirements; quality and standards, basic unit processes and operations for water treatment, distribution of water. Sewage and sewerage treatment: quantity and characteristic of waste water sewerage; primary and secondary treatment of waste water; sludge disposal; effluent discharge standards.

TRANSPORTATION ENGINEERING

Highway planning; geometric design of highways; testing and specifications of paving materials; design of flexible and rigid pavements.

CH - CHEMICAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

CHEMICAL ENGINEERING

Process Calculations and Thermodynamics: Laws of conservation of mass and energy; use of tie components; recycle, bypass and purge calculations; degree of freedom analysis.

First and Second laws of thermodynamics and their applications; equations of state and thermodynamic properties of real systems; phase equilibria; fugacity, excess properties and

correlations of activity coefficients; chemical reaction equilibria.

Fluid Mechanics and Mechanical Operations: Fluid statics, Newtonian and non-Newtonian fluids, Bernoulli equation, Macroscopic friction factors, energy balance, dimensional analysis, shell balances, flow through pipeline systems, flow meters, pumps and compressors, packed and fluidized beds, elementary boundary layer theory, size reduction and size separation; free and hindered settling; centrifuge and cyclones; thickening and classification, filtration, mixing and agitation; conveying of solids.

Heat Transfer: Conduction, convection and radiation, heat transfer coefficients, steady and unsteady heat conduction, boiling, condensation and evaporation; types of heat exchangers and evaporators and their design.

Mass Transfer: Fick's law, molecular diffusion in fluids, mass transfer coefficients, film, penetration and surface renewal theories; momentum, heat and mass transfer analogies; stagewise and continuous contacting and stage efficiencies; HTU & NTU concepts design and operation of equipment for distillation, absorption, leaching, liquid-liquid extraction, crystallization, drying, humidification, dehumidification and adsorption.

Chemical Reaction Engineering: Theories of reaction rates; kinetics of homogeneous reactions, interpretation of kinetic data, single and multiple reactions in ideal reactors, non-ideal reactors; residence time; non-isothermal reactors; kinetics of heterogeneous catalytic reactions; diffusion effects in catalysis.

Instrumentation and Process Control: Measurement of process variables; sensors, transducers and their dynamics, dynamics of simple systems, dynamics such as CSTRs, transfer functions and responses of simple systems, process reaction curve, controller modes (P, PI, and PID); control valves; analysis of closed loop systems including stability, frequency response (including Bode plots) and controller tuning, cascade, feed forward control.

Plant Design and Economics: Design and sizing of chemical engineering equipment such as compressors, heat exchangers, multistage contactors; principles of process economics and cost estimation including total annualized cost, cost indexes, rate of return, payback period, discounted cash flow, optimization in Design.

Chemical Technology: Inorganic chemical industries; sulfuric acid, NaOH, fertilizers (Ammonia, Urea, SSP and TSP); natural products industries (Pulp and Paper, Sugar, Oil, and Fats); petroleum refining and petrochemicals; polymerization industries; polyethylene, polypropylene, PVC and polyester synthetic fibers.

CS - COMPUTER SCIENCE AND ENGINEERING

ENGINEERING MATHEMATICS

Mathematical Logic: Propositional Logic; First Order Logic.

Probability: Conditional Probability; Mean, Median, Mode and Standard Deviation; Random Variables; Distributions; uniform, normal, exponential, Poisson, Binomial.

Set Theory & Algebra: Sets; Relations; Functions; Groups; Partial Orders; Lattice; Boolean Algebra.

Combinatorics: Permutations; Combinations; Counting; Summation; generating functions; recurrence relations; asymptotics.

Graph Theory: Connectivity; spanning trees; Cut vertices & edges; covering; matching; independent sets; Colouring; Planarity; Isomorphism.

Linear Algebra: Algebra of matrices, determinants, systems of linear equations, Eigen values

and Eigen vectors.

Numerical Methods: LU decomposition for systems of linear equations; numerical solutions of non linear algebraic equations by Secant, Bisection and Newton-Raphson Methods; Numerical integration by trapezoidal and Simpson's rules.

Calculus: Limit, Continuity & differentiability, Mean value Theorems, Theorems of integral calculus, evaluation of definite & improper integrals, Partial derivatives, Total derivatives, maxima & minima.

THEORY OF COMPUTATION

Formal Languages and Automata Theory: Regular languages and finite automata, Context free languages and Push-down automata, Recursively enumerable sets and Turing machines, Un-decidability;

Analysis of Algorithms and Computational Complexity: Asymptotic analysis (best, worst, average case) of time and space, Upper and lower bounds on the complexity of specific problems, NP-completeness.

COMPUTER HARDWARE

Digital Logic: Logic functions, Minimization, Design and synthesis of Combinational and Sequential circuits; Number representation and Computer Arithmetic (fixed and floating point);

Computer Organization: Machine instructions and addressing modes, ALU and Data-path, hardwired and micro-programmed control, Memory interface, I/O interface (Interrupt and DMA mode), Serial communication interface, Instruction pipelining, Cache, main and secondary storage.

SOFTWARE SYSTEMS

Data structures: Notion of abstract data types, Stack, Queue, List, Set, String, Tree, Binary search tree, Heap, Graph;

Programming Methodology: C programming, Program control (iteration, recursion, Functions), Scope, Binding, Parameter passing, Elementary concepts of Object oriented, Functional and Logic Programming;

Algorithms for problem solving: Tree and graph traversals, Connected components, Spanning trees, Shortest paths; Hashing, Sorting, Searching; Design techniques (Greedy, Dynamic Programming, Divide-and-conquer);

Compiler Design: Lexical analysis, Parsing, Syntax directed translation, Runtime environment, Code generation, Linking (static and dynamic); Operating Systems: Classical concepts (concurrency, synchronization, deadlock), Processes, threads and Inter-process communication, CPU scheduling, Memory management, File systems, I/O systems, Protection and security.

Databases: Relational model (ER-model, relational algebra, tuple calculus), Database design (integrity constraints, normal forms), Query languages (SQL), File structures (sequential files, indexing, B+ trees), Transactions and concurrency control;

Computer Networks: ISO/OSI stack, sliding window protocol, LAN Technologies (Ethernet, Token ring), TCP/UDP, IP, Basic concepts of switches, gateways, and routers.

CH - CHEMISTRY

PHYSICAL CHEMISTRY

Structure: Quantum theory - principles and techniques; applications to particle in a box, harmonic oscillator, rigid rotor and hydrogen atom; valence bond and molecular orbital theories and Huckel approximation, approximate techniques: variation and perturbation; symmetry, point groups; rotational, vibrational, electronic, NMR and ESR spectroscopy.

Equilibrium: First law of thermodynamics, heat, energy and work; second law of thermodynamics and entropy; third law and absolute entropy; free energy; partial molar quantities; ideal and non-ideal solutions; phase transformation: phase rule and phase diagrams- one, two, and three component systems; activity, activity coefficient, fugacity and fugacity coefficient ; chemical equilibrium, response of chemical equilibrium to temperature and pressure; colligative properties; kinetic theory of gases; thermodynamics of electrochemical cells; standard electrode potentials: applications - corrosion and energy conversion; molecular partition function (translational, rotational, vibrational and electronic).

Kinetics: Rates of chemical reactions, theories of reaction rates, collision and transition state theory; temperature dependence of chemical reactions; elementary reactions, consecutive elementary reactions; steady state approximation, kinetics of photochemical reactions and free radical polymerization, homogenous and heterogeneous catalysis.

INORGANIC CHEMISTRY

Non-Transition Elements: General characteristics, structure and reactions of simple and industrially important compounds, boranes, carboranes, silicates, silicones, diamond and graphite; hydrides, oxides and oxoacids of N, P, S and halogens; boron nitride, borazines and phosphazenes; xenon compounds. Shapes of molecules, hard-soft acid base concept.

Transition Elements: General characteristics of d and f block elements; coordination chemistry: structure and isomerism, stability, theories of metal-ligand bonding (CFT and LFT), electronic spectra and magnetic properties of transition metal complexes and lanthanides; metal carbonyls, metal-metal bonds and metal atom clusters, metallocenes; transition metal complexes with bonds to hydrogen, alkyls, alkenes, and arenes; metal carbenes; use of organometallic compounds as catalysts in organic synthesis; mechanisms of substitution and electron transfer reactions of coordination complexes. Role of metals with special reference to Na, K, Mg, Ca, Fe, Co, Zn, and Mo in biological systems.

Solids: Crystal systems and lattices, Miller planes, crystal packing, crystal defects; Bragg's Law; ionic crystals, band theory, metals and semiconductors. Spinels.

Instrumental methods of analysis: atomic absorption, UV-visible spectrometry, chromatographic and electro-analytical methods.

ORGANIC CHEMISTRY

Synthesis, reactions and mechanisms involving the following: Alkenes, alkynes, arenes, alcohols, phenols, aldehydes, ketones, carboxylic acids and their derivatives; halides, nitro compounds and amines; stereochemical and conformational effects on reactivity and specificity; reactions with diborane and peracids. Michael reaction, Robinson annulation, reactivity umpolung, acyl anion equivalents; molecular rearrangements involving electron deficient atoms.

Photochemistry: Basic principles, photochemistry of olefins, carbonyl compounds, arenes, photo oxidation and reduction.

Pericyclic reactions: Cycloadditions, electrocyclic reactions, sigmatropic reactions; Woodward-Hoffmann rules.

Heterocycles: Structural properties and reactions of furan, pyrrole, thiophene, pyridine, indole.

Biomolecules: Structure, properties and reactions of mono- and di-saccharides, physico-chemical properties of amino acids, structural features of proteins and nucleic acids.

Spectroscopy: Principles and applications of IR, UV-visible, NMR and mass spectrometry in the determination of structures of organic compounds.

EC - ELECTRONICS AND COMMUNICATION ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix Algebra, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Mean value theorems, Theorems of integral calculus, Evaluation of definite and improper integrals, Partial Derivatives, Maxima and minima, Multiple integrals, Fourier series. Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equation (linear and nonlinear), Higher order linear differential equations with constant coefficients, Method of variation of parameters, Cauchy's and Euler's equations, Initial and boundary value problems, Partial Differential Equations and variable separable method.

Complex variables: Analytic functions, Cauchy's integral theorem and integral formula, Taylor's and Laurent' series, Residue theorem, solution integrals.

Probability and Statistics: Sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Discrete and continuous distributions, Poisson, Normal and Binomial distribution, Correlation and regression analysis.

Numerical Methods: Solutions of non-linear algebraic equations, single and multi-step methods for differential equations.

Transform Theory: Fourier transform, Laplace transform, Z-transform.

ELECTRONICS & COMMUNICATION ENGINEERING

Networks: Network graphs: matrices associated with graphs; incidence, fundamental cut set and fundamental circuit matrices. Solution methods: nodal and mesh analysis. Network theorems: superposition, Thevenin and Norton's maximum power transfer, Wye-Delta transformation. Steady state sinusoidal analysis using phasors. Linear constant coefficient differential equations; time domain analysis of simple RLC circuits, Solution of network equations using Laplace transform: frequency domain analysis of RLC circuits. 2-port network parameters: driving point and transfer functions. State equations for networks.

Electronic Devices: Energy bands in silicon, intrinsic and extrinsic silicon. Carrier transport in silicon: diffusion current, drift current, mobility, resistivity. Generation and recombination of carriers. p-n junction diode, Zener diode, tunnel diode, BJT, JFET, MOS capacitor, MOSFET, LED, p-I-n and avalanche photo diode, LASERs. Device technology: integrated circuits fabrication process, oxidation, diffusion, ion implantation, photolithography, n-tub, p-tub and twin-tub CMOS process.

Analog Circuits: Equivalent circuits (large and small-signal) of diodes, BJTs, JFETs, and MOSFETs. Simple diode circuits, clipping, clamping, rectifier. Biasing and bias stability of transistor and FET amplifiers. Amplifiers: single-and multi-stage, differential, operational, feedback and power. Analysis of amplifiers; frequency response of amplifiers. Simple op-amp circuits. Filters. Sinusoidal oscillators; criterion for oscillation; single-transistor and op-amp configurations. Function generators and wave-shaping circuits. Power supplies.

Digital circuits: Boolean algebra, minimization of Boolean functions; logic gates digital IC families (DTL, TTL, ECL, MOS, CMOS). Combinational circuits: arithmetic circuits, code converters, multiplexers and decoders. Sequential circuits: latches and flip-flops, counters and shift-registers. Sample and hold circuits, ADCs, DACs. Semiconductor memories. Microprocessor(8085): architecture, programming, memory and I/O interfacing.

Signals and Systems: Definitions and properties of Laplace transform, continuous-time and discrete-time Fourier series, continuous-time and discrete-time Fourier Transform, z-transform. Sampling theorems. Linear Time-Invariant (LTI) Systems: definitions and properties; casuality, stability, impulse response, convolution, poles and zeros frequency response, group delay, phase delay. Signal transmission through LTI systems. Random signals and noise: probability, random variables, probability density function, autocorrelation, power spectral density.

Controls Systems: Basic control system components; block diagrammatic description, reduction of block diagrams. Open loop and closed loop (feedback) systems and stability analysis of these systems. Signal flow graphs and their use in determining transfer functions of systems; transient and steady state analysis of LTI control systems and frequency response. Tools and techniques for LTI control system analysis: root loci, Routh-Hurwitz criterion, Bode and Nyquist plots. Control system compensators: elements of lead and lag compensation, elements of Proportional-Integral-Derivative(PID) control. State variable representation and solution of state equation of LTI control systems.

Communications: Analog communication systems: amplitude and angle modulation and demodulation systems, spectral analysis of these operations, superheterodyne receivers; elements of hardware, realizations of analog communication systems; signal-to-noise ratio (SNR) calculations for amplitude modulation (AM) and frequency modulation (FM) for low noise conditions. Digital communication systems: pulse code modulation (PCM), differential pulse code modulation (DPCM), delta modulation (DM); digital modulation schemes-amplitude, phase and frequency shift keying schemes (ASK, PSK, FSK), matched filter receivers, bandwith consideration and probability of error calculations for these schemes.

Electromagnetics: Elements of vector calculus: divergence and curl; Gauss' and Stokes' theorems, Maxwell's equations: differential and integral forms. Wave equation, Poynting vector. Plane waves: propagation through various media; reflection and refraction; phase and group velocity; skin depth. Transmission lines: characteristic impedance; impedance transformation; Smith chart; impedance matching; pulse excitation. Waveguides: modes in rectangular waveguides; boundary conditions; cut-off frequencies; dispersion relations. Antennas: Dipole antennas; antenna arrays; radiation pattern; reciprocity theorem, antenna gain.

EE - ELECTRICAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix Algebra, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Mean value theorems, Theorems of integral calculus, Evaluation of definite and improper integrals, Partial Derivatives, Maxima and minima, Multiple integrals, Fourier series. Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equation (linear and nonlinear), Higher order linear differential equations with constant coefficients, Method of variation of parameters, Cauchy's and Euler's equations, Initial and boundary value problems, Partial Differential Equations and variable separable method.

Complex variables: Analytic functions, Cauchy's integral theorem and integral formula, Taylor's and Laurent' series, Residue theorem, solution integrals.

Probability and Statistics: Sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Discrete and continuous distributions, Poisson, Normal and Binomial distribution, Correlation and regression analysis.

Numerical Methods: Solutions of non-linear algebraic equations, single and multi-step methods for differential equations.

Transform Theory: Fourier transform, Laplace transform, Z-transform.

ELECTRICAL ENGINEERING

Electrical Circuits and Fields: Network graph, KCL, KVL, node/ cut set, mesh/ tie set analysis, transient response of d.c. and a.c. networks; sinusoidal steady-state analysis; resonance in electrical circuits; concepts of ideal voltage and current sources, network theorems, driving point, immittance and transfer functions of two port networks, elementary concepts of filters; three phase circuits; Fourier series and its application; Gauss theorem, electric field intensity and potential due to point, line, plane and spherical charge distribution, dielectrics, capacitance calculations for simple configurations; Ampere's and Biot-Savart's law, inductance calculations for simple configurations.

Electrical Machines: Single phase transformer - equivalent circuit, phasor diagram, tests, regulation and efficiency; three phase transformers - connections, parallel operation; auto transformer and three-winding transformer; principles of energy conversion, windings of rotating machines: D. C. generators and motors - characteristics, starting and speed control, armature reaction and commutation; three phase induction motors-performance characteristics, starting and speed control; single-phase induction motors; synchronous generators-performance, regulation, parallel operation; synchronous motors - starting, characteristics, applications, synchronous condensers; fractional horse power motors; permanent magnet and stepper motors.

Power Systems: Electric power generation - thermal, hydro, nuclear; transmission line parameters; steady-state performance of overhead transmission lines and cables and surge propagation; distribution systems, insulators, bundle conductors, corona and radio interference effects; per-unit quantities; bus admittance and impedance matrices; load flow; voltage control and power factor correction; economic operation; symmetrical components, analysis of symmetrical and unsymmetrical faults; principles of over current, differential and distance protections; concept of solid state relays and digital protection; circuit breakers; concept of system stability-swing curves and equal area criterion; basic concepts of HVDC transmission.

Control Systems: Principles of feedback; transfer function; block diagrams: steady-state errors; stability-Routh and Nyquist criteria; Bode plots; compensation; root loci; elementary state variable formulation; state transition matrix and response for Linear Time Invariant systems.

Electrical and Electronic Measurements: Bridges and potentiometers, PMMC, moving iron, dynamometer and induction type instruments; measurement of voltage, current, power, energy and power factor; instrument transformers; digital voltmeters and multimeters; phase, time and frequency measurement; Q-meter, oscilloscopes, potentiometric recorders, error analysis.

Analog and Digital Electronics: Characteristics of diodes, BJT, FET, SCR; amplifiers-biasing, equivalent circuit and frequency response; oscillators and feedback amplifiers, operational amplifiers- characteristics and applications; simple active filters; VCOs and timers; combinational and sequential logic circuits, multiplexer, Schmitt trigger, multivibrators, sample and hold circuits, A/D and D/A converters; microprocessors and their applications.

Power Electronics and Electric Drives: Semiconductor power devices-diodes, transistors,

thyristors, triacs, GTOs, MOSFETs and IGBTs - static characteristics and principles of operation; triggering circuits; phase control rectifiers; bridge converters-fully controlled and half controlled; principles of choppers and inverters, basic concepts of adjustable speed dc and ac drives.

GG - GEOLOGY AND GEOPHYSICS

PART - I

Earth and planetary system; size, shape, internal structure and composition of the earth; atmosphere and greenhouse effect; isostasy; elements of seismology; continents and continental processes; physical oceanography; palaeomagnetism, continental drift plate tectonics, geothermal energy.

Weathering; soil formation; action of river, wind and glacier; oceans and oceanic features; earthquakes, volcanoes, orogeny and mountain building; elements of structural geology; crystallography; classification, composition and properties of minerals and rocks; engineering properties of rocks and soils, role of geology in the construction of engineering structures.

Processes of ore formation, occurrence and distribution of ores on land and on ocean floor; coal and petroleum resources in India; ground water geology including well hydraulics, geological time scale and geochronology; stratigraphic principles and stratigraphy of India; basics concepts of gravity, magnetic and electrical prospecting for ores and ground water.

PART - IIA: GEOLOGY

Crystal symmetry, forms, twinning; crystal chemistry; optical mineralogy, classification of minerals, diagnostic properties of rock minerals.

Mineralogy, structure, texture and classification of igneous, sedimentary and metamorphic rock, their origin and evolution; application of thermodynamics; structure and petrology of sedimentary rocks; sedimentary processes and environments, sedimentary facies, basin studies; basement cover relationship;

Primary and secondary structures; geometry and genesis of folds, faults, joints, unconformities, cleavage, schistosity and lineation; methods of projection. Tectonites and their significance; shear zone; superposed folding.

Morphology, classification and geological significance of important invertebrates, vertebrates, microfossils and palaeoflora; stratigraphic principles and Indian stratigraphy; geomorphic processes and agents; development and evolution of landforms; slope and drainage; processes on deep oceanic and near-shore regions; quantitative and applied geomorphology; air photo interpretation and remote sensing; chemical and optical properties of ore minerals; formation and localization of ore deposits; prospecting and exploration of economic minerals; coal and petroleum geology; origin and distribution of mineral and fuel deposits in India; ore dressing and mineral economics.

Cosmic abundance; meteorites; geochemical evolution of the earth; geochemical cycles; distribution of major, minor and trace elements; isotope geochemistry; geochemistry of waters including solution equilibria and water rock interaction.

Engineering properties of rocks and soils; rocks as construction material; geology of dams, tunnels and excavation sites; natural hazards; the fly ash problem; ground water geology and exploration; water quality; impact of human activity; Remote sensing techniques for the interpretation of landforms and resource management.

PART - II B: GEOPHYSICS

The earth as a planet; different motions of the earth; gravity filed of the earth and its shape;

geochronology; isostasy, seismology and interior of the earth; variation of density, velocity, pressure, temperature, electrical and magnetic properties inside the earth; earthquakes-causes and measurements; zonation and seismic hazards; geomagnetic field, palaeomagnetism; oceanic and continental lithosphere; plate tectonics; heat flow; upper and lower atmospheric phenomena.

Theories of scalar and vector potential fields; Laplace, Maxwell and Helmholtz equations for solution of different types of boundary value problems for Cartesian, cylindrical and spherical polar coordinates; Green's theorem; Image theory; integral equations and conformal transformations in potential theory; Eikonal equation and ray theory.

'G' and 'g' units of measurement, density of rocks, gravimeters, preparation, analysis and interpretation of gravity maps; derivative maps, analytical continuation; gravity anomaly type curves; calculation of mass.

Earth's magnetic field, units of measurement, magnetic susceptibility of rocks, magnetometers, corrections, preparation of magnetic maps, magnetic anomaly type curve, analytical continuation, interpretation and application; magnetic well logging.

Conduction of electricity through rocks, electrical conductivities of metals, metallic, non-metallic and rock forming minerals, D.C. resistivity units and methods of measurement, electrode configuration for sounding and profiling, application of filter theory, interpretation of resistivity field data, application; self potential origin, classification, field measurement, interpretation of induced polarization time frequency, phase domain; IP units and methods of measurement, interpretation and application; ground-water exploration.

Origin of electromagnetic field elliptic polarization, methods of measurement for different source-receiver configuration components in EM measurements, interpretation and applications; earth's natural electromagnetic field, tellurics, magneto-tellurics; geomagnetic depth sounding principles, methods of measurement, processing of data and interpretation.

Seismic methods of prospecting: Reflection, refraction and CDP surveys; land and marine seismic sources, generation and propagation of elastic waves, velocity increasing with depth, geophones, hydrophones, recording instruments (DFS), digital formats, field layouts, seismic noises and noise profile analysis, optimum geophone grouping, noise cancellation by shot and geophone arrays, 2D and 3D seismic data acquisition and processing, CDP stacking charts, binning, filtering, dip-moveout, static and dynamic corrections, deconvolution, migration, signal processing, Fourier and Hilbert transforms, attribute analysis, bright and dim spots, seismic stratigraphy, high resolution seismics, VSP.

Principles and techniques of geophysical well-logging, SP, resistivity, induction, micro gamma ray, neutron, density, sonic, temperature, dip meter, caliper, nuclear magnetic, cement bond logging. Quantitative evaluation of formations from well logs; well hydraulics and application of geophysical methods for groundwater study; application of bore hole geophysics in ground water, mineral and oil exploration. Remote sensing techniques and application of remote sensing methods in geophysics.

IN - INSTRUMENTATION ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix Algebra, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Mean value theorems, Theorems of integral calculus, Evaluation of definite and improper integrals, Partial Derivatives, Maxima and minima, Multiple integrals, Fourier series. Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equation (linear and nonlinear), Higher order linear

differential equations with constant coefficients, Method of variation of parameters, Cauchy's and Euler's equations, Initial and boundary value problems, Partial Differential Equations and variable separable method.

Complex variables: Analytic functions, Cauchy's integral theorem and integral formula, Taylor's and Laurent' series, Residue theorem, solution integrals.

Probability and Statistics: Sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Discrete and continuous distributions, Poisson, Normal and Binomial distribution, Correlation and regression analysis.

Numerical Methods: Solutions of non-linear algebraic equations, single and multi-step methods for differential equations.

Transform Theory: Fourier transform, Laplace transform, Z-transform.

INSTRUMENTATION ENGINEERING

Measurement Basics and Metrology: Static and dynamic characteristics of measurement systems. Standards and calibration. Error and uncertainty analysis, statistical analysis of data, and curve fitting. Linear and angular measurements; Measurement of straightness, flatness, roundness and roughness.

Transducers, Mechanical Measurements and Industrial Instrumentation: Transducers - elastic, resistive, inductive, capacitive, thermo-electric, piezoelectric, photoelectric, electro-mechanical, electro-chemical, and ultrasonic. Measurement of displacement, velocity (linear and rotational), acceleration, shock, vibration, force, torque, power, strain, stress, pressure, flow, temperature, humidity, viscosity, and density. energy storing elements, suspension systems and dampers.

Analog Electronics: Characteristics of diodes, BJTs, JFETs and MOSFETs; Diode circuits; Amplifiers: single and multi-stage, feedback; Frequency response; Operational amplifiers - design, characteristic, linear and non-linear applications: difference amplifiers; instrumentation amplifiers; precision rectifiers, I-to-V converters, active filters, oscillators, comparators, signal generators, wave shaping circuits.

Digital Electronics: Combinational logic circuits, minimization of Boolean functions; IC families (TTL, MOS, CMOS), arithmetic circuits, multiplexer and decoders. Sequential circuits: flip-flops, counters, shift registers. Schmitt trigger, timers, and multivibrators. Analog switches, multiplexers, S/H circuits. Analog-to-digital and digital-to-analog converters. Basics of computer organization and architecture. 8-bit microprocessor (8085), applications, memory, I/O interfacing, and microcontrollers.

Signals and Systems: Vectors and matrices; Fourier series; Fourier transforms; Ordinary differential equations. Impulse and frequency responses of first and second order systems. Laplace transform and transfer function, convolution and correlation. Amplitude and frequency modulations and demodulations. Discrete time systems, difference equations, impulse and frequency responses; Z-transforms and transfer functions; IIR and FIR filters.

Electrical and Electronic Measurements: Measurement of R, L and C; bridges and potentiometers. Measurement of voltage, current, power, power factor, and energy; Instrument transformers; Q meter, waveform analyzers. Digital volt-meters and multi-meters. Time, phase and frequency measurements; Oscilloscope. Noise and interference in instrumentation.

Control Systems & Process Control: Principles of feedback; transfer function, signal flow graphs. Stability criteria, Bode plots, root-loci, Routh and Nyquist criteria. Compensation techniques; State space analysis. System components: mechanical, hydraulic, pneumatic, electrical and electronic; Servos and synchros; Stepper motors. On-off, cascade, P, PI, PID

and feed-forward controls. Controller tuning and general frequency response.

Analytical, Optical and Biomedical Instrumentation: Principles of spectrometry, UV, visible, IR mass spectrometry, X-ray methods; nuclear radiation measurements, gas, solid and semi conductor lasers and their characteristics, interferometers, basics of fibre optics, transducers in biomedical applications, cardiovascular system measurements, instrumentation for clinical laboratory.

MA - MATHEMATICS

Linear Algebra: Finite dimensional vector spaces. Linear transformations and their matrix representations, rank; systems of linear equations, eigenvalues and eigenvectors, minimal polynomial, Cayley-Hamilton theorem, diagonalisation, Hermitian, Skew-Hermitian and unitary matrices. Finite dimensional inner product spaces, self-adjoint and Normal linear operators, spectral theorem, Quadratic forms.

Complex Analysis: Analytic functions, conformal mappings, bilinear transformations, complex integration: Cauchy's integral theorem and formula, Liouville's theorem, maximum modulus principle, Taylor and Laurent's series, residue theorem and applications for evaluating real integrals.

Real Analysis: Sequences and series of functions, uniform convergence, power series, Fourier series, functions of several variables, maxima, minima, multiple integrals, line, surface and volume integrals, theorems of Green, Stokes and Gauss; metric spaces, completeness, Weierstrass approximation theorem, compactness. Lebesgue measure, measurable functions; Lebesgue integral, Fatou's lemma, dominated convergence theorem.

Ordinary Differential Equations: First order ordinary differential equations, existence and uniqueness theorems, systems of linear first order ordinary differential equations, linear ordinary differential equations of higher order with constant coefficients; linear second order ordinary differential equations with variable coefficients, method of Laplace transforms for solving ordinary differential equations, series solutions; Legendre and Bessel functions and their orthogonality, Sturm Liouville system, Greeen's functions.

Algebra: Normal subgroups and homomorphisms theorems, automorphisms. Group actions, sylow's theorems and their applications groups of order less than or equal to 20, Finite p-groups. Euclidean domains, Principal ideal domains and unique factorizations domains. Prime ideals and maximal ideals in commutative rings.

Functional Analysis: Banach spaces, Hahn-Banach theorems, open mapping and closed graph theorems, principle of uniform boundedness; Hilbert spaces, orthonormal sets, Riesz representation theorem, self-adjoint, unitary and normal linear operators on Hilbert Spaces.

Numerical Analysis: Numerical solution of algebraic and transcendental equations; bisection, secant method, Newton-Raphson method, fixed point iteration, interpolation: existence and error of polynomial interpolation, Lagrange, Newton, Hermite(osculatory)interpolations; numerical differentiation and integration, Trapezoidal and Simpson rules; Gaussian quadrature; (Gauss-Legendre and Gauss-Chebyshev), method of undetermined parameters, least square and orthonormal polynomial approximation; numerical solution of systems of linear equations: direct and iterative methods, (Jacobi Gauss-Seidel and SOR) with convergence; matrix eigenvalue problems: Jacobi and Given's methods, numerical solution of ordinary differential equations: initial value problems, Taylor series method, Runge-Kutta methods, predictor-corrector methods; convergence and stability.

Partial Differential Equations: Linear and quasilinear first order partial differential equations, method of characteristics; second order linear equations in two variables and their classification; Cauchy, Dirichlet and Neumann problems, Green's functions; solutions of Laplace, wave and diffusion equations in two variables Fourier series and transform methods of solutions of the above equations and applications to physical problems.

Mechanics: Forces in three dimensions, Poinsot central axis, virtual work, Lagrange's equations for holonomic systems, theory of small oscillations, Hamiltonian equations;

Topology: Basic concepts of topology, product topology, connectedness, compactness, countability and separation axioms, Urysohn's Lemma, Tietze extension theorem, metrization theorems, Tychonoff theorem on compactness of product spaces.

Probability and Statistics: Probability space, conditional probability, Bayes' theorem, independence, Random variables, joint and conditional distributions, standard probability distributions and their properties, expectation, conditional expectation, moments. Weak and strong law of large numbers, central limit theorem. Sampling distributions, UMVU estimators, sufficiency and consistency, maximum likelihood estimators. Testing of hypotheses, Neyman-Pearson tests, monotone likelihood ratio, likelihood ratio tests, standard parametric tests based on normal, X2 ,t, F-distributions. Linear regression and test for linearity of regression. Interval estimation.

Linear Programming: Linear programming problem and its formulation, convex sets their properties, graphical method, basic feasible solution, simplex method, big-M and two phase methods, infeasible and unbounded LPP's, alternate optima. Dual problem and duality theorems, dual simplex method and its application in post optimality analysis, interpretation of dual variables. Balanced and unbalanced transportation problems, unimodular property and u-v method for solving transportation problems. Hungarian method for solving assignment problems.

Calculus of Variations and Integral Equations: Variational problems with fixed boundaries; sufficient conditions for extremum, Linear integral equations of Fredholm and Volterra type, their iterative solutions. Fredholm alternative.

ME - MECHANICAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

APPLIED MECHANICS AND DESIGN

Engineering Mechanics: Equivalent force systems, free-body concepts, equations of

equilibrium, trusses and frames, virtual work and minimum potential energy. Kinematics and dynamics of particles and rigid bodies, impulse and momentum (linear and angular), energy methods, central force motion.

Strength of Materials: Stress and strain, stress-strain relationship and elastic constants, Mohr's circle for plane stress and plane strain, shear force and bending moment diagrams, bending and shear stresses, deflection of beams, torsion of circular shafts, thin and thick cylinders, Euler's theory of columns, strain energy methods, thermal stresses.

Theory of Machines: Displacement, velocity and acceleration, analysis of plane mechanisms, dynamic analysis of slider-crank mechanism, planar cams and followers, gear tooth profiles, kinematics of gears, governors and flywheels, balancing of reciprocating and rotating masses.

Vibrations: Free and forced vibration of single degree freedom systems, effect of damping, vibration isolation, resonance, critical speed of rotors.

Design of Machine Elements: Design for static and dynamic loading, failure theories, fatigue strength; design of bolted, riveted and welded joints; design of shafts and keys; design of spur gears, rolling and sliding contact bearings; brakes and clutches; belt, rope and chain drives.

FLUID MECHANICS AND THERMAL SCIENCES

Fluid Mechanics: Fluid properties, fluid statics, manometry, buoyancy; control-volume analysis of mass, momentum and energy; fluid acceleration; differential equations of continuity and momentum; Bernoulli's equation; viscous flow of incompressible fluids; boundary layer; elementary turbulent flow; flow through pipes, head losses in pipes, bends etc.

Heat-Transfer: Modes of heat transfer; one dimensional heat conduction, resistance concept, electrical analogy, unsteady heat conduction, fins; dimensionless parameters in free and forced convective heat transfer, various correlations for heat transfer in flow over flat plates and through pipes; thermal boundary layer; effect of turbulence; radiative heat transfer, black and grey surfaces, shape factors, network analysis; heat exchanger performance, LMTD and NTU methods.

Thermodynamics: Zeroth, First and Second laws of thermodynamics; thermodynamic system and processes; irreversibility and availability; behaviour of ideal and real gases, properties of pure substances, calculation of work and heat in ideal processes; analysis of thermodynamic cycles related to energy conversion; Carnot, Rankine, Otto, Diesel, Brayton and vapour compression cycles.

Power Plant Engineering: Steam generators; steam power cycles; steam turbines; impulse and reaction principles, velocity diagrams, pressure and velocity compounding; reheating and reheat factor; condensers and feed heaters.

I.C. Engines: Requirements and suitability of fuels in IC engines, fuel ratings, fuel-air mixture requirements; normal combustion in SI and CI engines; engine performance calculations.

Refrigeration and air-conditioning: Refrigerant compressors, expansion devices, condensers and evaporators; properties of moist air, psychrometric chart, basic psychometric processes.

Turbomachinery: Components of gas turbines; compression processes, centrifugal and axial flow compressors; axial flow turbines, elementary theory; hydraulic turbines; Euler-turbine equation; specific speed, Pelton-wheel, Francis and Kaplan turbines; centrifugal pumps.

MANUFACTURING AND INDUSTRIAL ENGINEERING

Engineering Materials: Structure and properties of engineering materials and their applications, heat treatment.

Metal Casting: Casting processes (expendable and non-expendable) -pattern, moulds and cores, heating and pouring, solidification and cooling, gating design, design considerations, defects.

Forming Processes: Stress-strain diagrams for ductile and brittle material, Plastic deformation and yield criteria, fundamentals of hot and cold working processes, Bulk metal forming processes (forging, rolling, extrusion, drawing), sheet metal working processes (punching, blanking, bending, deep drawing, coining, spinning, load estimation using homogeneous deformation methods, defects). processing of powder metals- atomization, compaction, sintering, secondary and finishing operations. forming and shaping of plastics- extrusion, injection moulding.

Joining Processes: Physics of welding, fusion and non-fusion welding processes, brazing and soldering, adhesive bonding, design considerations in welding, weld quality defects.

Machining and Machine Tool Operations: Mechanics of machining, single and multi-point cutting tools, tool geometry and materials, tool life and wear, cutting fluids, machinability, economics of machining, non-traditional machining processes.

Metrology and Inspection: Limits, fits and tolerances, linear and angular measurements, comparators, gauge design, interferometry, form and finish measurement, measurement of screw threads, alignment and testing methods.

Tool Engineering: Principles of work holding, design of jigs and fixtures.

Computer Integrated Manufacturing: Basic concepts of CAD, CAM and their integration tools.

Manufacturing Analysis: Part-print analysis, tolerance analysis in manufacturing and assembly, time and cost analysis.

Work-Study: Method study, work measurement, time study, work sampling, job evaluation, merit rating.

Production Planning and Control: Forecasting models, aggregate production planning, master scheduling, materials requirements planning.

Inventory Control: Deterministic and probabilistic models, safety stock inventory control systems.

Operations Research: Linear programming, simplex and duplex method, transportation, assignment, network flow models, simple queuing models, PERT and CPM

MN - MINING ENGINEERING

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace,

heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

MINING ENGINEERING

Mechanics: Equivalent force systems, equations of equilibrium, two dimensional frames and trusses, free body diagrams, friction forces, particle kinematics and dynamics.

Mine Development, Geomechanics and Strata Control: Drivages for underground mine development, drilling methods and machines, explosives, blasting devices and practices, shaft sinking. Physico-mechanical properties of rocks, rock mass classification, ground control instrumentation and stress measurement techniques, theories of rock failure, ground vibrations, stress distribution around mine openings, subsidence, design of supports in roadways and workings, stability of open pits, slopes.

Mining Methods and Machinery: Surface mining - layout, development, loading, transportation and mechanization, continuous surface mining systems. Underground coal mining - bord and pillar system, longwall mining, thick seam mining methods. Underground metal mining: different stoping methods, stope mechanization, ore handling systems, mine filling. Generation and transmission of mechanical, hydraulic, and pneumatic power. Materials handling - haulages, conveyors, ropeways, face and development machinery, hoisting systems, and pumps.

Ventilation, Underground Hazards and Surface Environment: Underground atmosphere, heat load sources and thermal environment, air cooling, mechanics of air flow distribution, natural and mechanical ventilation, mine fans and their usage, auxiliary ventilation. Subsurface hazards from fires, explosions, gases, dust, and inundation, rescue apparatus and practices, safety in mines, accident analysis, noise, mine lighting. Air and water pollution: causes, dispersion, quality standards, and control.

Surveying, Mine Planning and Systems Engineering: Fundamentals of engineering surveying, Levels and levelling, Theodolite, tacheometry, triangulation, contouring, errors and adjustments, correlation, underground surveying, curves, photogrammetry, field astronomy, GPS fundamentals. Principles of planning - Sampling methods and practices, reserve estimation techniques, basics of geostatistics, optimization of facility location, cash flow concepts and mine valuation, open pit design. Work study, concepts of reliability, reliability of series and parallel systems. Linear programming, transportation and assignment problems, queueing, network analysis, inventory control.

MT - METALLURGICAL ENGINEERING

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace,

heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

METALLURGICAL ENGINEERING

Thermodynamics and Rate Processes: Laws of thermodynamics, activity, equilibrium constant, applications to metallurgical systems, solutions, phase equilibria, basic kinetic laws, order of reactions, rate constants and rate limiting steps principles of electro chemistry, aqueous, corrosion and protection of metals, oxidation and high temperature corrosion - characterization and control; momentum transfer - concepts of viscosity, shell balances, Bernoulli's equation; heat transfer - conduction, convection and heat transfer coefficient relations, radiation, mass transfer - diffusion and Fick's laws.

Extractive Metallurgy: Flotation, gravity and other methods of mineral processing; agglomeration, pyro-hydro-and electro-metallurgical processes; material and energy balances; principles and processes for the extraction of non-ferrous metals - aluminium, copper, zinc, lead, magnesium, nickel, titanium and other rare metals; iron and steel making - principles, blast furnace, direct reduction processes, primary and secondary steel making, deoxidation and inclusion in steel; ingot and continuous casting; stainless steel making, design of furnaces; fuels and refractories.

Physical Metallurgy: Crystal structure and bonding characteristics of metals, alloys, ceramics and polymers; solid solutions; solidification; phase transformation and binary phase diagrams; principles of heat treatment of steels, aluminum alloys and cast irons; recovery, recrystallization and grain growth; industrially important ferrous and non-ferrous alloys; elements of X-ray and electron diffraction; principles of scanning and transmission electron microscopy; elements of ceramics, composites and electronic materials; electronic basis of thermal, optical, electrical and magnetic properties of materials.

Mechanical Metallurgy: Elements of elasticity and plasticity; defects in crystals; elements of dislocation theory - types of dislocations, slip and twinning, stress fields of dislocations, dislocation interactions and reactions, methods of seeing dislocations; strengthening mechanisms; tensile, fatigue and creep behaviour; superplasticity; fracture - Griffith theory, ductile to brittle transition, fracture toughness; failure analysis; mechanical testing - tension, compression, torsion, hardness, impact, creep, fatigue, fracture toughness and formability tests.

Manufacturing Processes: Metal casting - patterns, moulds, melting, gating, feeding and casting processes, defects and castings, hot and cold working of metals; Metal forming - fundamentals of metal forming, rolling wire drawing, extrusion, forming, sheet metal forming processes, defects in forming; Metal joining - soldering, brazing and welding, common welding processes, welding metallurgy, problems associated with welding of steels and aluminium alloys, defects in welding, powder metallurgy; NDT methods - ultrasonic, radiography, eddy current, acoustic emission and magnetic.

PH - PHYSICS

Mathematical Physics: Linear vector space, matrices; vector calculus; linear differential equations; elements of complex analysis; Laplace transforms, Fourier analysis, elementary ideas about tensors.

Classical Mechanics: Conservation laws; central forces; collisions and scattering in laboratory and centre of mass reference frames; mechanics of system of particles; rigid body dynamics; moment of inertia tensor; noninertial frames and pseudo forces; variational principle;

Lagrange's and Hamilton's formalisms; equation of motion, cyclic coordinates, Poisson bracket; periodic motion, small oscillations, normal modes; wave equation and wave propagation; special theory of relativity - Lorentz transformations, relativistic kinematics, mass-energy equivalence.

Electromagnetic Theory: Laplace and Poisson equations; conductors and dielectrics; boundary value problems; Ampere's and Biot-Savart's laws; Faraday's law; Maxwell's equations; scalar and vector potentials; Coulomb and Lorentz gauges; boundary conditions at interfaces; electromagnetic waves; interference, diffraction and polarization; radiation from moving charges.

Quantum Mechanics: Physical basis of quantum mechanics; uncertainty principle; Schrodinger equation; one and three dimensional potential problems; Particle in a box, harmonic oscillator, hydrogen atom; linear vectors and operators in Hilbert space; angular momentum and spin; addition of angular momentum; time independent perturbation theory; elementary scattering theory.

Atomic and Molecular Physics: Spectra of one-and many-electron atoms; LS and jj coupling; hyperfine structure; Zeeman and Stark effects; electric dipole transitions and selection rules; X-ray spectra; rotational and vibrational spectra of diatomic molecules; electronic transition in diatomic molecules, Franck-Condon principle; Raman effect; NMR and ESR; lasers.

Thermodynamics and Statistical Physics: Laws of thermodynamics; macrostates, phase space; probability ensembles; partition function, free energy, calculation of thermodynamic quantities; classical and quantum statistics; degenerate Fermi gas; black body radiation and Planck's distribution law; Bose-Einstein condensation; first and second order phase transitions, critical point.

Solid State Physics: Elements of crystallography; diffraction methods for structure determination; bonding in solids; elastic properties of solids; defects in crystals; lattice vibrations and thermal properties of solids; free electron theory; band theory of solids; metals, semiconductors and insulators; transport properties; optical, dielectric and magnetic properties of solids; elements of superconductivity.

Nuclear and Particle Physics: Rutheford scattering; basic properties of nuclei; radioactive decay; nuclear forces; two nucleon problem; nuclear reactions; conservation laws; fission and fusion; nuclear models; particle accelerators, detectors; elementary particles; photons, baryons, mesons and leptons; Quark model.

Electronics: Network analysis; semiconductor devices; bipolar transistors; FETs; power supplies, amplifier, oscillators; operational amplifiers; elements of digital electronics; logic circuits.

PI - PRODUCTION AND INDUSTRIAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

GENERAL ENGINEERING:

Engineering Materials: Structure and properties of engineering materials and their applications; effect of strain, strain rate and temperature on mechanical properties of metals and alloys; heat treatment of metals and alloys.

Applied Mechanics: Engineering mechanics - equivalent force systems, free body concepts, equations of equilibrium, virtual work and minimum potential energy; strength of materials-stress, strain and their relationship, Mohr's circle, deflection of beams, bending and shear stress, Euler's theory of columns.

Theory of Machines and Design: Analysis of planar mechanisms, plane cams and followers; governers and fly wheels; design of elements-failure theories; design of bolted, riveted and welded joints; design of shafts, keys, belt drives, brakes and clutches.

Thermal Engineering: Fluid machines - fluid statics, Bernoulli's equation, flow through pipes, equations of continuity and momentum; Thermodynamics - zeroth, First and Second laws of thermodynamics, thermodynamic system and processes, calculation of work and heat for systems and control volumes; Heat transfer - fundamentals of conduction, convection and radiation.

PRODUCTION ENGINEERING

Metal Casting: Casting processes; patterns-materials; allowances; moulds and cores - materials, making and testing; melting and founding of cast iron, steels and nonferrous metals and alloys; solidification; design of casting, gating and risering; casting defects and inspection.

Metal working: Stress-strain in elastic and plastic deformation; deformation mechanisms; hot and cold working-forging, rolling, extrusion, wire and tube drawing; sheet metal working; analysis of rolling, forging, extrusion and wire /rod drawing; metal working defects, high energy rate forming processes-explosive, magnetic, electro and electrohydraulic.

Metal Joining Processes: Welding processes - gas shielded metal arc, TIG, MIG, submerged arc, electroslag, thermit, resistance, pressure and forge welding; thermal cutting; other joining processes - soldering, brazing, braze welding; welding codes, welding symbols, design of welded joints, defects and inspection; introduction to modern welding processes - friction, ultrasonic, explosive, electron beam, laser and plasma.

Machining and Machine Tool Operations: Machining processes-turning, drilling, boring, milling, shaping, planing, sawing, gear cutting, thread production, broaching, grinding, lapping, honing super finishing; mechanics of cutting- Merchant's analysis, geometry of cutting tools, cutting forces, power requirements; selection of process parameters; tool materials, tool wear and tool life, cutting fluids, machinability; nontraditional machining processes and hybrid processes- EDM, CHM, ECM, USM, LBM, EBM, AJM, PAM AND WJM; economics of machining.

Metrology and Inspection: Limits and fits, linear and angular measurements by mechanical and optical methods, comparators; design of limit gauges; interferometry; measurement of straightness, flatness, roundness, squareness and symmetry; surface finish measurement; inspection of screw threads and gears; alignment testing.

Powder Metallurgy and Processing of Plastics: Production of powders, compaction, sintering; Polymers and composites; injection, compression and blow molding, extrusion, calendaring and thermoforming; molding of composites.

Tool Engineering: Work-holding-location and clamping; principles and methods; design of jigs and fixtures; design of press working tools, forging dies.

Manufacturing Analysis: Sources of errors in manufacturing; process capability; part-print analysis; tolerance analysis in manufacturing and assembly; process planning; parameter selection and comparison of production alternatives; time and cost analysis; Issues in choosing manufacturing technologies and strategies.

Computer Integrated Manufacturing: Basic concepts of CAD, CAM, CAPP, group technology, NC, CNC, DNC, FMS, Robotics and CIM.

INDUSTRIAL ENGINEERING

Product Design and Development: Principles of good product design, component and tolerance design; efficiency, quality and cost considerations; product life cycle; standardization, simplification, diversification, value analysis, concurrent engineering.

Engineering Economy and Costing: Financial statements; elementary cost accounting, methods of depreciation; break-even analysis, techniques for evaluation of capital investments.

Work System Design: Taylor's scientific management, Gilbreths's contributions; productivity concepts and measurements; method study, micro-motion study, principles of motion economy; human factors engineering, ergonomics; work measurement - time study, PMTS, work sampling; job evaluation, merit rating, wage administration, incentive systems; business process reengineering.

Logistics and Facility Design: Facility location factors, evaluation of alternatives, types of plant layout, evaluation; computer aided layout; assembly line balancing; material handling systems; supply chain management.

Production Planning and Inventory Control: Inventory Function costs, classifications - deterministic and probabilistic models; quantity discount; safety stock; inventory control system; Forecasting techniques - causal and time series models, moving average, exponential smoothing; trend and seasonality; aggregate production planning; master scheduling; bill of materials and material requirement planning; order control and flow control, routing, scheduling and priority dispatching; JIT; Kanban PULL systems; bottleneck scheduling and theory of constraints.

Operation Research: Linear programming - problem formulation, simplex method, duality and sensitivity analysis; transportation; assignment; network flow models, constrained optimization and Lagrange multipliers; simple queuing models; dynamic programming; simulation; PERT and CPM, time-cost trade-off, resource leveling.

Quality Control: Taguchi method; design of experiments; quality costs, statistical quality assurance, process control charts, acceptance sampling, zero defects; quality circles, total quality management.

Reliability and Maintenance: Reliability, availability and maintainability; probabilistic failure and repair times; system reliability; preventive maintenance and replacement, TPM.

Management Information System: Value of information; information storage and retrieval system - database and data structures; interactive systems; knowledge based systems.

Intellectual Property System: Definition of intellectual property, importance of IPR; TRIPS, and its implications, WIPO and Global IP structure, and IPS in India; patent, copyright, industrial design and trademark; meanings, rules and procedures, terms, infringements and remedies.

PY - PHARMACEUTICAL SCIENCES

Natural Products: Pharmacognosy & Phytochemistry - Chemistry, tests, isolation, characterization and estimation of phytopharmaceuticals belonging to the group of Alkaloids, Glycosides, Terpenoids, Steroids, Bioflavanoids, Purines, Guggul lipids. Pharmacognosy of crude drugs which contain the above constituents. Standardisation of raw materials and herbal products. WHO guide lines. Quantitative microscopy including modern techniques used for evaluation. Biotechnological principles and techniques for plant development Tissue culture.

Pharmacology: General pharmacological principles including Toxicology. Drug interaction. Pharmacology of drugs acting on Central nervous system, Cardiovascular system, Autonomic nervous system, Gastro intestinal system and Respiratory system. Pharmacology of Autocoids, Hormones, Chemotherapeutic agents including anticancer drugs. Bioassays. Immuno Pharmacology.

Medicinal Chemistry: Structure, nomenclature, classification, synthesis, SAR and metabolism of the following category of drugs which are official in Indian Pharmacopoeia and British Pharmacopoeia Hypnotics and Sedatives, Analgesics, NSAIDS, Neuroleptics, Antidepressants, Anxiolytics, Anticonvulsants, Antihistaminics, Local anaesthetics, Cardio Vascular drugs - Antianginal agents Vasodilators, Adrenergic & cholinergic drugs, Cardiotonic agents, Diuretics, Antihypertensive drugs, Hypoglycemic agents, Antilipedmic agents, Coagulants, Anticoagulants, Antiplatelet agents. Chemotherapeutic agents - Antibiotics, Antibacterials, Sulphadrugs. Antiproliozoal drugs, Antiviral, Antitubercular, Antimalarial, Anticancer, Antiamoebic drugs. Diagnostic agents. Preparation and storage and uses of official Radiopharmaceuticals. Vitamins and Hormones.

Pharmaceutics: Development, manufacturing standards, labeling, packing as per the pharmacopoeal requirements, Storage of different dosage forms and new drug delivery systems. Biopharmaceutics and Pharmacokinetics and their importance in formulation. Formulation and preparation of cosmetics - lipstick, shampoo, creams, nail preparations and dentifrices. Pharmaceutical calculations.

Pharmaceutical Jurisprudence: Legal aspects of manufacture, storage, sale of drugs. D and C act and rules. Pharmacy act.

Pharmaceutical Analysis: Principles, instrumentation and applications of the following. Absorption spectroscopy (UV, visible & IR), Fluorimetry, Flame photometry, Potentiometry, Conductometry and Plarography. Pharmacopoeial assays. Principles of NMR, ESR, Mass spectroscopy, X-ray diffraction analysis and different chromatographic methods.

Biochemistry and Clinical Pharmacy: Biochemical role of hormones, Vitamins, Enzymes, Nucleic acids. Bioenergetics. General principles of immunology. Immunological techniques. Adverse drug interaction.

Microbiology: Principles and methods of microbiological assays of the Pharmacopoeia. Methods of preparation of official sera and vaccines. Serological and diagnostic tests. Applications of microorganisms in Bio Conversions and in Pharmaceutical industry.

TF - TEXTILE ENGINEERING AND FIBRE SCIENCE

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

TEXTILE ENGINEERING & FIBRE SCIENCE

Textile Fibres: Classification of textile fibres according to their nature and origin; general characteristics of textile fibres-their chemical and physical structures and their properties; essential characteristics of fibre forming polymers; uses of natural and man-made fibres; physical and chemical methods of fibre and blend identification and blend analysis.

Melt Spinning processes with special reference to polyamide and polyester fibres; wet and dry spinning of viscose and acrylic fibres; post spinning operations-drawing, heat setting, texturing- false twist and air-jet, tow-to-top conversion. Methods of investigating fibre structure e.g. X-ray diffraction, birefringence, optical and electron microscopy, I.R. absorption, thermal methods; structure and morphology and principal natural and man-made fibres, mechanical properties of fibres, moisture sorption in fibres; fibre structure and property correlation.

Textile Testing: Sampling techniques, sample size and sampling errors; measurement of fibre length, fineness, crimp, strength and reflectance; measurement of cotton fibre maturity ad trash content; HVI and AFIS for fibre testing. Measurement of yarn count, twist and hairiness; tensile testing of fibres, yarn and fabrics; evenness testing of slivers, rovings and yarns; testing equipment for measurement test methods of fabric properties like thickness, compressibility, air permeability, drape, crease recovery, tear strength bursting strength and abrasion resistance. Correlation analysis, significance tests and analysis of variance; frequency distributions and control charts.

Yarn Manufacture and Yarn Structure: Modern methods of opening, cleaning and blending of fibrous materials; the technology of carding with particular reference to modern developments; causes of irregularity introduced by drafting, the development of modern drafting systems; principles and techniques of preparing material for combing; recent development in combers; functions and synchronization of various mechanisms concerned with roving production; forces acting on yarn and traveller, ring and traveller designs; causes of end breakages; properties of doubles yarns; new methods of yarn production such as rotor spinning, air jet spinning and friction spinning.

Yarn diameter; specific volume, packing coefficient; twist-strength relationship; fibre orientation in yarn; fibre migration.

Fabric Manufacture and Fabric Structure: Principles of cheese and cone winding processes and machines; random and precision winding; package faults and their remedies; yarn clearers and tensioners; different systems of yarn splicing; features of modern cone winding machines; different types of warping creels; features of modern beam and sectional warping machines; different sizing systems, sizing of spun and filament yarns, modern sizing machines; principles of pirn winding processes and machines; primary and secondary motions of loom, effect of their settings and timings on fabric formation, fabric appearance and weaving performance;

dobby and jacquard shedding; mechanics of weft insertion with shuttle; warp and weft stop motions, warp protection, weft replenishment; functional principles of weft insertion systems of shuttleless weaving machines, principles of multiphase and circular looms. Principles of weft and warp knitting; basic weft and warp knitted structures; classification, production and areas of application of nonwoven fabrics.

Basic woven fabric constructions and their derivatives; crepe, cord, terry, gauze, lino and double cloth constructions.

Peirce's equations for fabric geometry; thickness, cover and maximum sett of woven fabrics

Textile Chemical Processing: Preparatory processes for natural-and and their blends; mercerization of cotton; machines for yarn and fabric mercerization.

Dyeing and printing of natural- and synthetic- fibre fabrics and their blends with different dye classes; dyeing and printing machines; styles of printing; fastness properties of dyed and printed textile materials.

Finishing of textile materials, wash and wear, durable press, soil release, water repellent, flame retardant and antistatic finishes; shrink-resistance finish for wool; heat setting of synthetic-fibre fabrics, finishing machines; energy efficient processes; pollution control.

XE - ENGINERING SCIENCES

The syllabi of the sections of this paper are as follows:

SECTION A. ENGINEERING MATHEMATICS (Compulsory)

Linear Algebra : Determinates, algebra of matrices, rank, inverse, system of linear equations, symmetric, skew-symmetric and orthogonal matrices. Hermitian, skew-hermitian and unitary matrices. eigenvalues and eigenvectors, diagonalisation of matrices, Cayley-Hamiltonian, quadratic forms.

Calculus : Functions of single variables, limit, continuity and differentiability, Mean value theorems, Intermediate forms and L'Hospital rule, Maxima and minima, Taylor's series, Fundamental and mean value-theorems of integral calculus. Evaluation of definite and improper integrals, Beta and Gamma functions, Functions of two variables, limit, continuity, partial derivatives, Euler's theorem for homogeneous functions, total derivatives, maxima and minima, Lagrange method of multipliers, double and triple integrals and their applications, sequence and series, tests for convergence, power series, Fourier Series, Fourier integrals.

Complex variable: Analytic functions, Cauchy's integral theorem and integral formula without proof. Taylor's and Laurent' series, Residue theorem (without proof) with application to the evaluation of real integarls.

Vector Calculus: Gradient, divergence and curl, vector identities, directional derivatives, line, surface and volume integrals, Stokes, Gauss and Green's theorems (without proofs) with applications.

Ordinary Differential Equations: First order equation (linear and nonlinear), higher order linear differential equations with constant coefficients, method of variation of paramaters, Cauchy's and Euler's equations, initial and boundary value problems, power series solutions, Legendre polynomials and Bessel's functions of the first kind.

Partial Differential Equations: Variables separable method, solutions of one dimensional heat, wave and Laplace equations.

Probability and Statistics: Definitions of probability and simple theorems, conditional probability, mean, mode and standard deviation, random variables, discrete and continuous

distributions, Poisson, normal and Binomial distribution, correlation and regression

Numerical Methods: L-U decomposition for systems of linear equations,Newton-Raphson method, numerical integration(trapezoidal and Simpson's rule), numerical methods for first order differential equation (Euler method)

SECTION B. COMPUTATIONAL SCIENCE

Numerical Methods: Truncation errors, round off errors and their propagation; Interpolation; Lagrange, Newton's forward, backward and divided difference formulas, least square curve fitting, solution of non-linear equations of one variables using bisection, false position, secant and Newton Raphson methods; Rate of convergence of these methods, general iterative methods. Simple and multiple roots of polynomials. Solutions of system of linear algebraic equations using Gauss elimination methods, Jacobi and Gauss-Seidel iterative methods and their rate of convergence; ill conditioned and well conditioned system. eigen values and eigen vectors using power methods. Numerical integration using trapezoidal, Simpson's rule and other quadrature formulas. Numerical Differentiation. Solution of boundary value problems. Solution of initial value problems of ordinary differential equations using Euler's method, predictor corrector and Runge Kutta method.

Programming : Elementary concepts and terminology of a computer system and system software, Fortran77 and C programming.

Fortran : Program organization, arithmetic statements, transfer of control, Do loops, subscripted variables, functions and subroutines.

C language : Basic data types and declarations, flow of control- iterative statement, conditional statement, unconditional branching, arrays, functions and procedures.

SECTION C. ELECTRICAL SCIENCES

Electric Circuits: Ideal voltage and current sources; RLC circuits, steady state and transient analysis of DC circuits, network theorems; alternating currents and voltages, single-phase AC circuits, resonance; three-phase circuits.

Magnetic circuits: Mmf and flux, and their relationship with voltage and current; transformer, equivalent circuit of a practical transformer, three-phase transformer connections.

Electrical machines: Principle of operation, characteristics, efficiency and regulation of DC and synchronous machines; equivalent circuit and performance of three-phase and single-phase induction motors.

Electronic Circuits: Characteristics of p-n junction diodes, zener diodes, bipolar junction transistors (BJT) and junction field effect transistors (JFET); MOSFET's structure, characteristics, and operations; rectifiers, filters, and regulated power supplies; biasing circuits, different configurations of transistor amplifiers, class A, B and C of power amplifiers; linear applications of operational amplifiers; oscillators; tuned and phase shift types.

Digital circuits: Number systems, Boolean algebra; logic gates, combinational circuits, flip-flops (RS, JK, D and T) counters.

Measuring instruments: Moving coil, moving iron, and dynamometer type instruments; shunts, instrument transformers, cathode ray oscilloscopes; D/A and A/D converters.

SECTION D. FLUID MECHANICS

Fluid Properties: Relation between stress and strain rate for Newtonian fluids

Hydrostatics, buoyancy, manometry

Concept of local and convective accelerations; control volume analysis for mass, momentum and energy conservation.

Differential equations of continuity and momentum (Euler's equation of motion); concept of fluid rotation, stream function, potential function; Bernoulli's equation and its applications.

Qualitative ideas of boundary layers and its separation; streamlined and bluff bodies; drag and lift forces.

Fully-developed pipe flow; laminar and turbulent flows; friction factor; Darcy Weisbach relation; Moody's friction chart; losses in pipe fittings; flow measurements using venturimeter and orifice plates.

Dimensional analysis; similitude and concept of dynamic similarity; importance of dimensionless numbers in model studies.

SECTION E. MATERIALS SCIENCE

Atomic structure and bonding in materials: metals, ceramics and polymers.

Structure of materials: Crystal systems, unit cells and space lattice; determination of structures of simple crystals by X-ray diffraction; Miller indices for planes and directions. Packing geometry in metallic, ionic and covalent solids.

Concept of amorphous, single and polycrystalline structures and their effects on properties of materials.

Imperfections in crystalline solids and their role in influencing various properties.

Fick´s laws of diffusion and applications of diffusion in sintering, doping of semiconductors and surface hardening of metals.

Alloys: solid solution and solubility limit. Binary phase diagram, intermediate phases and intermetallic compounds; iron-iron carbide phase diagram. Phase transformation in steels. Cold and hot working of metals, recovery, recrystallization and grain growth.

Properties and applications of ferrous and nonferrous alloys.

Structure, properties, processing and applications of traditional and advanced ceramics.

Polymers: classification, polymerization, structure and properties, additives for polymer products, processing and application.

Composites: properties and application of various composites.

Corrosion and environmental degradation of materials (metals, ceramics and polymers).

Mechanical properties of materials: Stress-strain diagrams of metallic, ceramic and polymeric materials, modulus of elasticity, yield strength, plastic deformation and toughness, tensile strength and elongation at break; viscoelasticity, hardness, impact strength. ductile and brittle fracture. creep and fatigue properties of materials.

Heat capacity, thermal conductivity, thermal expansion of materials.

Concept of energy band diagram for materials; conductors, semiconductors and insulators in terms of energy bands. Electrical conductivity, effect of temperature on conductivity in materials, intrinsic and extrinsic semiconductors, dielectric properties of materials.

Refraction, reflection, absorption and transmission of electromagnetic radiation in solids.

Origin of magnetism in metallic and ceramic materials, paramagnetism, diamagnetism, antiferromagnetism, ferromagnetism, ferrimagnetism in materials and magnetic hysteresis.

Advanced materials: Smart materials exhibiting ferroelectric, piezoelectric, optoelectronic, semiconducting behaviour; lasers and optical fibers; photoconductivity and superconductivity in materials.

SECTION F. SOLID MECHANICS

Equivalent force systems; free-body diagrams; equilibrium equations; analysis of determinate and indeterminate trusses and frames; friction.

Simple relative motion of particles; force as function of position, time and speed; force acting on a body in motion; laws of motion; law of conservation of energy; law of conservation of momentum

Stresses and strains; principal stresses and strains; Mohr's circle; generalized Hooke's Law; equilibrium equations; compatibility conditions; yield criteria.

Axial, shear and bending moment diagrams; axial, shear and bending stresses; deflection (for symmetric bending); torsion in circular shafts; thin cylinders; energy methods (Castigliano's Theorems); Euler buckling.

SECTION G. THERMODYNAMICS

Basic Concepts: Continuum, macroscopic approach, thermodynamic system (closed and open or control volume); thermodynamic properties and equilibrium; state of a system, state diagram, path and process; different modes of work; Zeroth law of thermodynamics; concept of temperature; heat.

First Law of Thermodynamics: Energy, enthalpy, specific heats, first law applied to systems and control volumes, steady and unsteady flow analysis.

Second Law of Thermodynamics: Kelvin-Planck and Clausius statements, reversible and irreversible processes, Carnot theorems, thermodynamic temperature scale, Clausius inequality and concept of entropy, principle of increase of entropy; availability and irreversibility.

Properties of Pure Substances: Thermodynamic properties of pure substances in solid, liquid and vapour phases, P-V-T behaviour of simple compressible substances, phase rule, thermodynamic property tables and charts, ideal and real gases, equations of state, compressibility chart.

Thermodynamic Relations: T-ds relations, Maxwell equations, Joule-Thomson coefficient, coefficient of volume expansion, adiabatic and isothermal compressibilities, Clapeyron equation.

Ideal Gas Mixtures: Dalton's and Amagat's laws, calculations of properties, air-water vapour mixtures.

XL - LIFE SCIENCES

The syllabi of the Sections of this paper are as follows:

SECTION H. CHEMISTRY (Compulsory)

Atomic structure and periodicity: Quantum chemistry; Planck's quantum theory, wave particle

duality, uncertainty principle, quantum mechanical model of hydrogen atom; electronic configuration of atoms; periodic table and periodic properties; ionization energy, election affinity, electronegativity, atomic size.

Structure and bonding: Ionic and covalent bonding M.O. and V.B. approaches for diatomic molecules, VSEPR theory and shape of molecules, hybridisation, resonance, dipole moment, structure parameters such as bond length, bond angle and bond energy, hydrogen bonding, van der Waals interactions. Ionic solids; ionic radii, lattice energy (Born-Haber Cycle).

s.p. and d Block Elements: Oxides, halides and hydrides of alkali and alkaline earth metals, B, Al, S, N, P and S, silicones, general characteristics of 3d elements, coordination complexes: valence bond and crystal field theory, color, geometry and magnetic properties.

Chemical Equilibria: Colligative properties of solutions, ionic equilibria in solution, solubility product, common ion effect, hydrolysis of salts, pH, buffer and their applications in chemical analysis.

Electrochemistry: Conductance, Kohlrausch law, Half Cell potentials, emf, Nernst equation, galvanic cells, thermodynamic aspects and their applications.

Reaction Kinetics: Rate constant, order of reaction, molecularity, activation energy, zero, first and second order kinetics, equilibrium constants (Kc, Kp and Kx) for homogeneous reactions, catalysis and elementary enzyme reactions.

Thermodynamics: First law, reversible and irreversible processes, internal energy, enthalpy, Kirchoff's equation, heat of reaction, Hess law, heat of formation, Second law, entropy, free energy, and work function. Gibbs-Helmholtz equation, Clausius-Clapeyron equation, free energy change and equilibrium constant, Troutons rule, Third law of thermodynamics.

Mechanistic Basis of Organic Reactions: Elementary treatment of SN1, SN2, E1 and E2 reactions, Hoffmann and Saytzeff rules, Addition reactions, Markonikoff rule and Kharash effect, Diels-Alder reaction, aromatic electrophilic substitution, orientation effect as exemplified by various functional groups.

Structure-Reactivity Correlations: Acids and bases, electronic and steric effects, optical and geometrical isomerism, tautomerism, concept of aromaticity

SECTION I. BIOCHEMISTRY

Organization of life. Importance of water. Cell structure and organelles. Structure and function of biomolecules: Carbohydrates, Lipids, Proteins and Nucleic acids. Biochemical separation techniques. Spectroscopic methods; UV-visible and fluorescence. Protein structure, folding and function: Myoglobin, Hemoglobin, Lysozyme, ribonuclease A, Carboxypeptidase and Chymotrypsin. Enzyme kinetics and regulation, Coenzymes.

Metabolism and bioenergitics. Generation and utilization of ATP. Photosynthesis. Major metabolic pathways and their regulation. Biological membranes. Transport across membranes. Signal transduction; hormones and neurotransmitters.

DNA replication, transcription and translation. Biochemical regulation of gene expression. Recombinant DNA technology and applications. Genomics and Proteomics.

The immune system. Active and passive immunity. Complement system. Antobody structure, function and diversity. Cells of the immune system: T, B and macrophages. T and B cell activation. Major histocompatibilty complex. T cell receptor. Immunological techniques: Immunodiffusion, immunoelectrophoresis, RIA and ELISA.

SECTION J. BIOTECHNOLOGY

Recombinant DNA technology for the production of therapeutic proteins. Micro array technology. Heterologous protein expression systems in bacteria, yeast etc.

Architecture of plant genome; plant tissue culture techniques; methods of gene transfer into plant cells; manipulation of phenotypic traits in plants; plant cell fermentations and production of secondary metabolites using suspension/ immobilized cell culture; methods for plant micro propagation; crop improvement and development of transgenic plants. Expression of animal proteins in plants.

Animal cell metabolism and regulation; cell cycle; primary cell culture; nutritional requirements for animal cell culture; techniques for the mass culture of animal cell lines; production of vaccines; growth hormones and interferons using animal cell culture; cytokines-production and therapeutic uses; hybridoma technology; vectors for gene transfer and expression in animal cells. Transgenic animals and molecular pharming.

Microbial production of industrial enzymes; methods for immobilization of enzymes; kinetics of soluble and immobilized enzymes; application of soluble and immobilized enzymes; enzyme-based sensors.

Microbial growth kinetics; batch, fed batch and continuous culture of microbial cells; media for industrial fermentations; sterilization of air and media; design features and operation of stirred tank, air-lift and fluidized bed reactors; aeration and agitation in aerobic fermentations; recovery and purification of fermentation products- filtration, centrifugation, cell disintegration, solvent extraction and chromatographic separations; industrial fermentations for the production of ethanol, citric acid, lysine, penicillin and other biomolecules; simple calculations based on material and energy balance of fermentation processes; application of microbes in the management of domestic and industrial wastes.

SECTION K. BOTANY

Anatomy: Roots, stem and leaves of land plants, meristems, vascular system, their ontogeny, structure and functions. Plant cell structure, organisation, organelles, cytoskeleton, cell wall and membranes.

Development: Cell cycle, cell division, senescence, hormonal regulation of growth; life cycle of an angiosperm, pollination, fertilization, embryogenesis, seed formation, seed storage proteins, seed dormancy and germination. Concept of cellular totipotency, organogenesis and somatic embryogenesis, somaclonal variation, embryo culture, in vitro fertilization.

Physiology and Biochemistry: Plant water relations, transport of minerals and solutes, N2 metabolism, proteins and nucleic acid, respiration, photophysiology, photosynthesis, photorespiration; biosynthesis, mechanism of action and physiological effects of plant growth regulators.

Genetics: Principles of Mendelian inheritance, linkage, recombination and genetic mapping; extrachromosomal inheritance; eukaryotic genome organization (chromatin structure) and regulation of gene expression, gene mutation, chromosome aberrations (numerical and structural), transposons.

Plant Breeding: Principles, methods - selection, hybridization, heterosis; male sterility, self and inter-specific incompatibility; haploidy; somatic cell hybridization; molecular marker-assisted selection; gene transfer methods viz. direct and vector-mediated, transgenic plants and their applications in agriculture.

Economic Botany: Economically important plants - cereals, pulses, plants yielding fiber, timber, sugar, beverages, oils, rubber, dyes, gums, drugs and narcotics - a general account.

Systematics: Systems of classification (non-phylogenetic vs. phylogenetic - outline), plant groups, molecular systematics.

Plant Pathology: Nature and classification of plant diseases, diseases of important crops caused by fungi, bacteria and viruses, and their control measures, mechanism(s) of pathogenesis and resistance, molecular detection of pathogens; plant-microbe beneficial interactions.

Ecology and Plant Geography: Ecosystems - types, dynamics, degradation, ecological succession; food chains; vegetation types of the world; pollution and global warming; speciation and extinction, conservation strategies, cryopreservation.

SECTION L. MICROBIOLOGY

Historical perspective - Discovery of the microbial world; Controversy over spontaneous generation; Role of microorganisms in transformation of organic matter and in the causation of diseases.

Methods in microbiology - Pure culture techniques; Theory and practice of sterilization; Principles of microbial nutrition; Construction of culture media; Enrichment culture techniques for isolation of chemoautotrophs, chemoheterotrophs and photosynthetic microorganisms.

Microbial evolution, systematics and taxonomy - Evolution of earth and earliest life forms; Primitive organisms and their metabolic strategies; New approaches to bacterial taxonomic classification including ribotyping; Nomenclature.

Microbial diversity - Bacteria, archea and their broad classification; Eukaryotic microbes, yeast, fungi, slime mold and protozoa; Viruses and their classification.

Microbial growth -The definition of growth, mathematical expression of growth, growth curve, measurement of growth and growth yields; Synchronous growth; Continuous culture.

Nutrition and metabolism - Overview of metabolism; Microbial nutrition; Energy classes of microorganisms; Culture media; Energetics, modes of ATP generation; ATP generation by heterotrophs; Fermentation; Glycolysis; Respiration; The citric acid cycle; Electron transport systems; Alternate modes of energy generation; Pathways (anabolism) in the biosynthesis of amino acids, purines, pyrimidines and fatty acids.

Metabolic diversity among microorganisms - Photosynthesis in microorganisms; Role of chlorophylls, carotenoids and phycobilins; Calvin cycle; Chemolithotrophy; Hydrogen- iron-nitrite-oxidizing bacteria; Nitrate and sulfate reduction; Methanogenesis and acetogenesis.

Prokaryotic cells: structure-function - Cells walls of eubacteria (peptidoglycan) and related molecules; Outer-membrane of gram-negative bacteria; Cell wall and cell membrane synthesis; Flagella and motility; Cell inclusions like endospores, gas vesicles.

Microbial diseases and host parasite relationships - Normal microflora of skin; Oral cavity; Gastrointestinal tract; Entry of pathogens into the host; Infectious disease transmission; Respiratory infections caused by bacteria and viruses; Tuberculosis; Sexually transmitted diseases including AIDS; Diseases transmitted by animals (Rabies, plague), insects and ticks (rikettsias, Lyme disease, malaria); Food and water borne diseases; Public health and water quality; Pahtogenic fungi; Emerging and resurgent infectious diseases.

Chemotherapy/Antibiotics - Antimicrobial agents; Sulfa drugs; Antibiotics; Pencillins and cephalosporins; Broad-spectrum antibiotics; Antibiotics from prokaryotes; Antifungal antibiotics; Mode of action; Resistance to antibiotics.

Microbial genetics - Genes, mutation and mutagenesis - UV and chemical mutagnes; Types of mutations; Ames test for mutagenesis; Methods of genetic analysis. Bacterial genetic system - Transformation; Conjugation; Transduction; Recombination; Plasmids and Transposons; Bacterial genetic map with reference to E. coli. Viruses and their genetic system - Phage ? and

its life cycle; RNA phages; RNA viruses; Retroviruses; Genetic systems of yeast and Neurospora; Extrachromosomal inheritance and mitochondrial genetics; Basic concept of genomics.

SECTION M. ZOOLOGY

Animal world: Animal diversity, distribution, systematic and classification of animals, the phylogenetic relationship.

Evolution: Origin of life, history of life on earth, evolutionary theories, natural selection, adaptation, speciation.

Genetics: Principles of inheritance, molecular basis of heredity, the genetic material, transmission of genetic material, mutations, cytoplasmic inheritance.

Biochemistry and Molecular Biology: Nucleic acids, proteins and other biological macromolecules. Replication, transcription and translation, regulation of gene expression, organization of genome, Kreb's cycle, glycolysis, enzyme catalysis, hormones and their action.

Cell Biology: Structure of cell, cellular organelles and their structure and function, cell cycle, cell division, cellular differentiation, chromosome and chromatin structure. Eukaryotic gene organisation and expression.

Animal Anatomy and Physiology: Comparative physiology, the respiratory system, circulatory system, digestive system, the nervous system, the excretory system, the endocrine system, the reproductive system, the skeletal system, osmoregulation.

Parasitology and Immunology: Nature of parasite, host-parasite relation, protozoan and helminthic parasites, the immune response, cellular and humoral immune response, evolution of the immune system.

Development Biology: Embryonic development, cellular differentiation, organogenesis, metamorphosis, genetic basis of development.

Ecology: The ecosystem, habitats the food chain, population dynamics, species diversity, zoogeography, biogeochemical cycles, conservation biology.

Animal Behaviour: Types of behaviours, courtship, mating and territoriality, instinct, learning and memory, social behaviour across the animal taxa, communication, pheromones, evolution of animal behaviour.

IT - INFORMATION TECHNOLOGY

ENGINEERING MATHEMATICS

Mathematical Logic: Propositional Logic; First Order Logic.

Probability: Conditional Probability; Mean, Median, Mode and Standard Deviation; Random Variables; Distributions; uniform, normal, exponential, Poisson, Binomial.

Set Theory & Algebra: Sets; Relations; Functions; Groups; Partial Orders; Lattice; Boolean Algebra.

Combinatorics: Permutations; Combinations; Counting; Summation; generating functions; recurrence relations; asymptotics.

Graph Theory: Connectivity; spanning trees; Cut vertices & edges; covering; matching; independent sets; Colouring; Planarity; Isomorphism.

Linear Algebra: Algebra of matrices, determinants, systems of linear equations, Eigen values and Eigen vectors.

Numerical Methods: LU decomposition for systems of linear equations; numerical solutions of non linear algebraic equations by Secant, Bisection and Newton-Raphson Methods; Numerical integration by trapezoidal and Simpson's rules.

Calculus: Limit, Continuity & differentiability, Mean value Theorems, Theorems of integral calculus, evaluation of definite & improper integrals, Partial derivatives, Total derivatives, maxima & minima.

FORMAL LANGUAGES AND AUTOMATA

Regular Languages: finite automata, regular expressions, regular grammar.

Context free languages: push down automata, context free grammars

COMPUTER HARDWARE

Digital Logic: Logic functions, minimization, design and synthesis of combinatorial and sequential circuits, number representation and computer arithmetic (fixed and floating point)

Computer organization: Machine instructions and addressing modes, ALU and data path, hardwired and microprogrammed control, memory interface, I/O interface (interrupt and DMA mode), serial communication interface, instruction pipelining, cache, main and secondary storage

SOFTWARE SYSTEMS

Data structures and Algorithms: the notion of abstract data types, stack, queue, list, set, string, tree, binary search tree, heap, graph, tree and graph traversals, connected components, spanning trees, shortest paths, hashing, sorting, searching, design techniques (greedy, dynamic, divide and conquer), asymptotic analysis (best, worst, average cases) of time and space, upper and lower bounds, intractability

Programming Methodology: C programming, program control (iteration, recursion, functions), scope, binding, parameter passing, elementary concepts of object oriented programming

Operating Systems (in the context of Unix): classical concepts (concurrency, synchronization, deadlock), processes, threads and interprocess communication, CPU scheduling, memory management, file systems, I/O systems, protection and security

Information Systems and Software Engineering: information gathering, requirement and feasibility analysis, data flow diagrams, process specifications, input/output design, process life cycle, planning and managing the project, design, coding, testing, implementation, maintenance.

Databases: relational model, database design, integrity constraints, normal forms, query languages (SQL), file structures (sequential, indexed), b-trees, transaction and concurrency control

Data Communication: data encoding and transmission, data link control, multiplexing, packet switching, LAN architecture, LAN systems (Ethernet, token ring), Network devices: switches, gateways, routers

Networks: ISO/OSI stack, sliding window protocols, routing protocols, TCP/UDP, application layer protocols & systems (http, smtp, dns, ftp), network security

Web technologies: three tier web based architecture; JSP, ASP, J2EE, .NET systems; html, XML

AG - AGRICULTURAL ENGINEERING

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

FARM MACHINERY AND POWER:

Sources of power on the farm-human, animal, mechanical, electrical, wind, solar and biomass; design and selection of machine elements - gears, pulleys, chains and sprockets and belts; overload safety devices used in farm machinery; measurement of force, torque, speed, displacement and acceleration on machine elements.

Soil tillage; forces acting on a tillage tool; hitch systems and hitching of tillage implements; functional requirements, principles of working, construction and operation of manual, animal and power operated equipment for tillage. sowing, planting, fertilizer application, inter-cultivation, spraying, mowing, chaff cutting, harvesting, threshing and transport; testing of agricultural machinery and equipment; calculation of performance parameters -field capacity, efficiency, application rate and losses; cost analysis of implements and tractors.

Thermodynamic principles of I.C. engines; I.C. engine cycles; engine components; fuels and combustion; lubricants and their properties; I.C. engine systems - fuel, cooling, lubrication, ignition, electrical, intake and exhaust; selection, operation, maintenance and repair of I.C. engines; power efficiencies and measurement; calculation of power, torque, fuel consumption, heat load and power losses.

Tractors and power tillers - type, selection, maintenance and repair; tractor clutches and brakes; power transmission systems - gear trains, differential, final drives and power take-off; mechanics of tractor chassis; traction theory; three point hitches- free link and restrained link operations; mechanical steering and hydraulic control systems used in tractors; human engineering and safety in tractor design; tractor tests and performance.

SOIL AND WATER CONSERVATION ENGINEERING:

Ideal and real fluids, properties of fluids; hydrostatic pressure and its measurement; hydrostatic forces on plane and curved surface; continuity equation; Bernoulli's theorem; laminar and turbulent flow in pipes, Darcy-Weisbach and Hazen-Williams equations, Moody's diagram; flow through orifices and notches; flow in open channels.

Engineering properties of soils, fundamental definitions and relationships; index properties of soils; permeability and seepage analysis; shear strength, Mohr's circle of stresses; active and passive earth pressures; stability of slopes.

Hydrological cycle; precipitation measurement, analysis of precipitation data; abstraction from precipitation; runoff; hydrograph analysis, unit hydrograph theory and application; stream flow measurement; flood routing, hydrological reservoir and channel routing.

Mechanics of soil erosion, factors affecting erosion; soil loss estimation; biological and engineering measures to control erosion, terraces and bunds; vegetative waterways; gully control structures, drop, drop inlet and chute spillways; farm ponds; earthen dams; principles of watershed management.

Water requirement of crops; consumptive use and evapo-transpiration; irrigation scheduling; irrigation efficiencies; design of prismatic and silt loaded channels; methods of irrigation water application; design and evaluation of irrigation methods; drainage coefficient; surface and subsurface drainage systems; leaching requirement and salinity control; irrigation and drainage water quality; classification of pumps; pump characteristics; pump selection; types of aquifer; evaluation of aquifer properties; well hydraulics; ground water recharge.

AGRICULTURAL PROCESSING AND FOOD ENGINEERING:

Steady state heat transfer in conduction, convection and radiation; transient heat transfer in simple geometry; condensation and boiling heat transfer; working principles of heat exchangers; diffusive and convective mass transfer; simultaneous heat and mass transfer in agricultural processing operations.

Material and energy balances in food processing systems; water activity, sorption and desorption isotherms; centrifugal separation of solids, liquids and gases; kinetics of microbial death - pasteurisation and sterilization of liquid foods; preservation of food by cooling and freezing; psychrometry - properties of air-vapour mixture; concentration and dehydration of liquid foods - evaporators, tray, drum and spray dryers.

Mechanics and energy requirement in size reduction of granular solids; particle size analysis for comminuted solids; size separation by screening; fluidisation of granular solids; cleaning and grading efficiency and effectiveness of grain cleaners; conditioning and hydrothermal treatments for grains; dehydration of food grains; processes and machines for processing of cereals, pulses and oilseeds; design considerations for grain silos.

AR - ARCHITECTURE AND PLANNING

City planning: Historical development of cities; principles of city planning; new towns; survey methods, site planning, planning regulations and building bye-laws.

Housing: Concept of shelter; housing policies and design; community planning; role of government agencies; finance and management.

Landscape Design: Principles of landscape design and site planning; history and landscape styles; landscape elements and materials; planting design.

Computer Aided Design: Application of computers in architecture and planning; understanding elements of hardware and software; computer graphics; programming languages - C and Visual Basic and usage of packages such as AutoCAD.

Environmental and Building Science: Elements of environmental science; ecological principles concerning environment; role of micro-climate in design; climatic control through design elements; thermal comfort; elements of solar architecture; principles of lighting and illumination; basic principles of architectural acoustics; air pollution, noise pollution and their control.

Visual and Urban Design: Principles of visual composition; proportion, scale, rhythm, symmetry, harmony, balance, form and colour; sense of place and space, division of space; focal point, vista, imageability, visual survey.

History of Architecture: Indian - Indus valley, Vedic, Buddhist, Indo-Aryan, Dravidian and Mughal periods; European - Egyptian, Greek, Roman, medieval and renaissance periods.

Development of Contemporary Architecture: Architectural developments and impacts on society since industrial revolution; influence of modern art on architecture; works of national and international architects; post modernism in architecture.

Building Services: Water supply, Sewerage and Drainage systems; Sanitary fittings and fixtures; principles of electrification of buildings; elevators, their standards and uses; air-conditioning systems; fire fighting systems.

Building Construction and Management: Building construction techniques, methods and details; building systems and prefabrication of building elements; principles of modular coordination; estimation, specification, valuation, professional practice; project management, PERT, CPM.

Materials and Structural Systems: Behavioural characteristics of all types of building materials e.g. mud, timber, bamboo, brick, concrete, steel, glass, FRP; principles of strength of materials; design of structural elements in wood, steel and RCC; elastic and limit state design; complex structural systems; principles of pre-stressing.

Planning Theory: Planning process; multilevel planning; comprehensive planning; central place theory; settlement pattern; land use and land utilization.

Techniques of Planning: Planning surveys; Preparation of urban and regional structure plans, development plans, action plans; site planning principles and design; statistical methods; application of remote sensing techniques in urban and regional planning.

Traffic and Transportation Planning: Principles of traffic engineering and transportation planning; methods of conducting surveys; design of roads, intersections and parking areas; hierarchy of roads and levels of services; traffic and transport management in urban areas; traffic safety and traffic laws; public transportation planning; modes of transportation.

Services and Amenities: Principles and design of water supply systems, sewerage systems, solid waste disposal systems, power supply and communication systems; Health, education, recreation and demography related standards at various levels of the settlements.

Development Administration and Management: Planning laws; development control and zoning regulations; laws relating to land acquisition; development enforcements, land ceiling; regional and urban plan preparations; planning and municipal administration; taxation, revenue resources and fiscal management; public participation and role of NGO.

CE - CIVIL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

STRUCTURAL ENGINEERING

Mechanics: Bending moments and shear forces in statically determinate beams; simple stress and strain: relationship; stress and strain in two dimensions, principal stresses, stress transformation, Mohr's circle; simple bending theory; flexural shear stress; thin-walled pressure vessels; uniform torsion.

Structural Analysis: Analysis of statically determinate trusses, arches and frames; displacements in statically determinate structures and analysis of statically indeterminate structures by force/energy methods; analysis by displacement methods (slope-deflection and moment-distribution methods); influence lines for determinate and indeterminate structures; basic concepts of matrix methods of structural analysis.

Concrete Structures: Basic working stress and limit states design concepts; analysis of ultimate load capacity and design of members subject to flexure, shear, compression and torsion (beams, columns and isolated footings); basic elements of prestressed concrete: analysis of beam sections at transfer and service loads.

Steel Structures: Analysis and design of tension and compression members, beams and beam-columns, column bases; connections - simple and eccentric, beam-column connections, plate girders and trusses; plastic analysis of beams and frames.

GEOTECHNICAL ENGINEERING

Soil Mechanics: Origin of soils; soil classification; three-phase system, fundamental definitions, relationship and inter-relationships; permeability and seepage; effective stress principle: consolidation, compaction; shear strength.

Foundation Engineering: Sub-surface investigation - scope, drilling bore holes, sampling, penetrometer tests, plate load test; earth pressure theories, effect of water table, layered soils; stability of slopes - infinite slopes, finite slopes; foundation types - foundation design requirements; shallow foundations; bearing capacity, effect of shape, water table and other factors, stress distribution, settlement analysis in sands and clays; deep foundations - pile types, dynamic and static formulae, load capacity of piles in sands and clays.

WATER RESOURCES ENGINEERING

Fluid Mechanics and Hydraulics: Hydrostatics, applications of Bernoulli equation, laminar and turbulent flow in pipes, pipe networks; concept of boundary layer and its growth; uniform flow, critical flow and gradually varied flow in channels, specific energy concept, hydraulic jump; forces on immersed bodies; flow measurement in channels; tanks and pipes; dimensional analysis and hydraulic modeling. Applications of momentum equation, potential flow, kinematics of flow; velocity triangles and specific speed of pumps and turbines.

Hydrology: Hydrologic cycle; rainfall; evaporation infiltration, unit hydrographs, flood estimation, reservoir design, reservoir and channel routing, well hydraulics.

Irrigation: Duty, delta, estimation of evapo-transpiration; crop water requirements; design of lined and unlined canals; waterways; head works, gravity dams and Ogee spillways. Designs of weirs on permeable foundation, irrigation methods.

ENVIRONMENTAL ENGINEERING

Water requirements; quality and standards, basic unit processes and operations for water treatment, distribution of water. Sewage and sewerage treatment: quantity and characteristic of waste water sewerage; primary and secondary treatment of waste water; sludge disposal; effluent discharge standards.

TRANSPORTATION ENGINEERING

Highway planning; geometric design of highways; testing and specifications of paving materials; design of flexible and rigid pavements.

CH - CHEMICAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

CHEMICAL ENGINEERING

Process Calculations and Thermodynamics: Laws of conservation of mass and energy; use of tie components; recycle, bypass and purge calculations; degree of freedom analysis.

First and Second laws of thermodynamics and their applications; equations of state and thermodynamic properties of real systems; phase equilibria; fugacity, excess properties and correlations of activity coefficients; chemical reaction equilibria.

Fluid Mechanics and Mechanical Operations: Fluid statics, Newtonian and non-Newtonian fluids, Bernoulli equation, Macroscopic friction factors, energy balance, dimensional analysis, shell balances, flow through pipeline systems, flow meters, pumps and compressors, packed and fluidized beds, elementary boundary layer theory, size reduction and size separation; free and hindered settling; centrifuge and cyclones; thickening and classification, filtration, mixing and agitation; conveying of solids.

Heat Transfer: Conduction, convection and radiation, heat transfer coefficients, steady and unsteady heat conduction, boiling, condensation and evaporation; types of heat exchangers and evaporators and their design.

Mass Transfer: Fick's law, molecular diffusion in fluids, mass transfer coefficients, film, penetration and surface renewal theories; momentum, heat and mass transfer analogies; stagewise and continuous contacting and stage efficiencies; HTU & NTU concepts design and operation of equipment for distillation, absorption, leaching, liquid-liquid extraction, crystallization, drying, humidification, dehumidification and adsorption.

Chemical Reaction Engineering: Theories of reaction rates; kinetics of homogeneous reactions, interpretation of kinetic data, single and multiple reactions in ideal reactors, non-ideal reactors; residence time; non-isothermal reactors; kinetics of heterogeneous catalytic reactions; diffusion effects in catalysis.

Instrumentation and Process Control: Measurement of process variables; sensors, transducers and their dynamics, dynamics of simple systems, dynamics such as CSTRs, transfer functions and responses of simple systems, process reaction curve, controller modes (P, PI, and PID); control valves; analysis of closed loop systems including stability, frequency response (including Bode plots) and controller tuning, cascade, feed forward control.

Plant Design and Economics: Design and sizing of chemical engineering equipment such as compressors, heat exchangers, multistage contactors; principles of process economics and cost estimation including total annualized cost, cost indexes, rate of return, payback period, discounted cash flow, optimization in Design.

Chemical Technology: Inorganic chemical industries; sulfuric acid, NaOH, fertilizers (Ammonia, Urea, SSP and TSP); natural products industries (Pulp and Paper, Sugar, Oil, and Fats); petroleum refining and petrochemicals; polymerization industries; polyethylene, polypropylene, PVC and polyester synthetic fibers.

CS - COMPUTER SCIENCE AND ENGINEERING

ENGINEERING MATHEMATICS

Mathematical Logic: Propositional Logic; First Order Logic.

Probability: Conditional Probability; Mean, Median, Mode and Standard Deviation; Random Variables; Distributions; uniform, normal, exponential, Poisson, Binomial.

Set Theory & Algebra: Sets; Relations; Functions; Groups; Partial Orders; Lattice; Boolean Algebra.

Combinatorics: Permutations; Combinations; Counting; Summation; generating functions; recurrence relations; asymptotics.

Graph Theory: Connectivity; spanning trees; Cut vertices & edges; covering; matching; independent sets; Colouring; Planarity; Isomorphism.

Linear Algebra: Algebra of matrices, determinants, systems of linear equations, Eigen values and Eigen vectors.

Numerical Methods: LU decomposition for systems of linear equations; numerical solutions of non linear algebraic equations by Secant, Bisection and Newton-Raphson Methods; Numerical integration by trapezoidal and Simpson's rules.

Calculus: Limit, Continuity & differentiability, Mean value Theorems, Theorems of integral calculus, evaluation of definite & improper integrals, Partial derivatives, Total derivatives, maxima & minima.

THEORY OF COMPUTATION

Formal Languages and Automata Theory: Regular languages and finite automata, Context free languages and Push-down automata, Recursively enumerable sets and Turing machines, Un-decidability;

Analysis of Algorithms and Computational Complexity: Asymptotic analysis (best, worst, average case) of time and space, Upper and lower bounds on the complexity of specific problems, NP-completeness.

COMPUTER HARDWARE

Digital Logic: Logic functions, Minimization, Design and synthesis of Combinational and Sequential circuits; Number representation and Computer Arithmetic (fixed and floating point);

Computer Organization: Machine instructions and addressing modes, ALU and Data-path, hardwired and micro-programmed control, Memory interface, I/O interface (Interrupt and DMA mode), Serial communication interface, Instruction pipelining, Cache, main and secondary storage.

SOFTWARE SYSTEMS

Data structures: Notion of abstract data types, Stack, Queue, List, Set, String, Tree, Binary search tree, Heap, Graph;

Programming Methodology: C programming, Program control (iteration, recursion, Functions), Scope, Binding, Parameter passing, Elementary concepts of Object oriented, Functional and Logic Programming;

Algorithms for problem solving: Tree and graph traversals, Connected components, Spanning trees, Shortest paths; Hashing, Sorting, Searching; Design techniques (Greedy, Dynamic Programming, Divide-and-conquer);

Compiler Design: Lexical analysis, Parsing, Syntax directed translation, Runtime environment, Code generation, Linking (static and dynamic); Operating Systems: Classical concepts (concurrency, synchronization, deadlock), Processes, threads and Inter-process communication, CPU scheduling, Memory management, File systems, I/O systems, Protection and security.

Databases: Relational model (ER-model, relational algebra, tuple calculus), Database design (integrity constraints, normal forms), Query languages (SQL), File structures (sequential files, indexing, B+ trees), Transactions and concurrency control;

Computer Networks: ISO/OSI stack, sliding window protocol, LAN Technologies (Ethernet, Token ring), TCP/UDP, IP, Basic concepts of switches, gateways, and routers.

CH - CHEMISTRY

PHYSICAL CHEMISTRY

Structure: Quantum theory - principles and techniques; applications to particle in a box, harmonic oscillator, rigid rotor and hydrogen atom; valence bond and molecular orbital theories and Huckel approximation, approximate techniques: variation and perturbation; symmetry, point groups; rotational, vibrational, electronic, NMR and ESR spectroscopy.

Equilibrium: First law of thermodynamics, heat, energy and work; second law of thermodynamics and entropy; third law and absolute entropy; free energy; partial molar quantities; ideal and non-ideal solutions; phase transformation: phase rule and phase diagrams- one, two, and three component systems; activity, activity coefficient, fugacity and fugacity coefficient ; chemical equilibrium, response of chemical equilibrium to temperature and pressure; colligative properties; kinetic theory of gases; thermodynamics of electrochemical cells; standard electrode potentials: applications - corrosion and energy conversion; molecular partition function (translational, rotational, vibrational and electronic).

Kinetics: Rates of chemical reactions, theories of reaction rates, collision and transition state theory; temperature dependence of chemical reactions; elementary reactions, consecutive elementary reactions; steady state approximation, kinetics of photochemical reactions and free radical polymerization, homogenous and heterogeneous catalysis.

INORGANIC CHEMISTRY

Non-Transition Elements: General characteristics, structure and reactions of simple and industrially important compounds, boranes, carboranes, silicates, silicones, diamond and graphite; hydrides, oxides and oxoacids of N, P, S and halogens; boron nitride, borazines and phosphazenes; xenon compounds. Shapes of molecules, hard-soft acid base concept.

Transition Elements: General characteristics of d and f block elements; coordination chemistry: structure and isomerism, stability, theories of metal-ligand bonding (CFT and LFT), electronic spectra and magnetic properties of transition metal complexes and lanthanides; metal carbonyls, metal-metal bonds and metal atom clusters, metallocenes; transition metal complexes with bonds to hydrogen, alkyls, alkenes, and arenes; metal carbenes; use of organometallic compounds as catalysts in organic synthesis; mechanisms of substitution and electron transfer reactions of coordination complexes. Role of metals with special reference to Na, K, Mg, Ca, Fe, Co, Zn, and Mo in biological systems.

Solids: Crystal systems and lattices, Miller planes, crystal packing, crystal defects; Bragg's Law; ionic crystals, band theory, metals and semiconductors. Spinels.

Instrumental methods of analysis: atomic absorption, UV-visible spectrometry, chromatographic and electro-analytical methods.

ORGANIC CHEMISTRY

Synthesis, reactions and mechanisms involving the following: Alkenes, alkynes, arenes, alcohols, phenols, aldehydes, ketones, carboxylic acids and their derivatives; halides, nitro compounds and amines; stereochemical and conformational effects on reactivity and specificity; reactions with diborane and peracids. Michael reaction, Robinson annulation, reactivity umpolung, acyl anion equivalents; molecular rearrangements involving electron deficient atoms.

Photochemistry: Basic principles, photochemistry of olefins, carbonyl compounds, arenes, photo oxidation and reduction.

Pericyclic reactions: Cycloadditions, electrocyclic reactions, sigmatropic reactions; Woodward-Hoffmann rules.

Heterocycles: Structural properties and reactions of furan, pyrrole, thiophene, pyridine, indole.

Biomolecules: Structure, properties and reactions of mono- and di-saccharides, physico-chemical properties of amino acids, structural features of proteins and nucleic acids.

Spectroscopy: Principles and applications of IR, UV-visible, NMR and mass spectrometry in the determination of structures of organic compounds.

EC - ELECTRONICS AND COMMUNICATION ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix Algebra, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Mean value theorems, Theorems of integral calculus, Evaluation of definite and improper integrals, Partial Derivatives, Maxima and minima, Multiple integrals, Fourier series. Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equation (linear and nonlinear), Higher order linear differential equations with constant coefficients, Method of variation of parameters, Cauchy's and Euler's equations, Initial and boundary value problems, Partial Differential Equations and variable separable method.

Complex variables: Analytic functions, Cauchy's integral theorem and integral formula, Taylor's and Laurent' series, Residue theorem, solution integrals.

Probability and Statistics: Sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Discrete and continuous distributions, Poisson, Normal and Binomial distribution, Correlation and regression analysis.

Numerical Methods: Solutions of non-linear algebraic equations, single and multi-step methods for differential equations.

Transform Theory: Fourier transform, Laplace transform, Z-transform.

ELECTRONICS & COMMUNICATION ENGINEERING

Networks: Network graphs: matrices associated with graphs; incidence, fundamental cut set and fundamental circuit matrices. Solution methods: nodal and mesh analysis. Network theorems: superposition, Thevenin and Norton's maximum power transfer, Wye-Delta transformation. Steady state sinusoidal analysis using phasors. Linear constant coefficient differential equations; time domain analysis of simple RLC circuits, Solution of network equations using Laplace transform: frequency domain analysis of RLC circuits. 2-port network parameters: driving point and transfer functions. State equations for networks.

Electronic Devices: Energy bands in silicon, intrinsic and extrinsic silicon. Carrier transport in silicon: diffusion current, drift current, mobility, resistivity. Generation and recombination of carriers. p-n junction diode, Zener diode, tunnel diode, BJT, JFET, MOS capacitor, MOSFET, LED, p-I-n and avalanche photo diode, LASERs. Device technology: integrated circuits fabrication process, oxidation, diffusion, ion implantation, photolithography, n-tub, p-tub and twin-tub CMOS process.

Analog Circuits: Equivalent circuits (large and small-signal) of diodes, BJTs, JFETs, and MOSFETs. Simple diode circuits, clipping, clamping, rectifier. Biasing and bias stability of transistor and FET amplifiers. Amplifiers: single-and multi-stage, differential, operational, feedback and power. Analysis of amplifiers; frequency response of amplifiers. Simple op-amp circuits. Filters. Sinusoidal oscillators; criterion for oscillation; single-transistor and op-amp configurations. Function generators and wave-shaping circuits. Power supplies.

Digital circuits: Boolean algebra, minimization of Boolean functions; logic gates digital IC families (DTL, TTL, ECL, MOS, CMOS). Combinational circuits: arithmetic circuits, code converters, multiplexers and decoders. Sequential circuits: latches and flip-flops, counters and shift-registers. Sample and hold circuits, ADCs, DACs. Semiconductor memories. Microprocessor(8085): architecture, programming, memory and I/O interfacing.

Signals and Systems: Definitions and properties of Laplace transform, continuous-time and discrete-time Fourier series, continuous-time and discrete-time Fourier Transform, z-transform. Sampling theorems. Linear Time-Invariant (LTI) Systems: definitions and properties; casuality, stability, impulse response, convolution, poles and zeros frequency response, group delay, phase delay. Signal transmission through LTI systems. Random signals and noise: probability, random variables, probability density function, autocorrelation, power spectral density.

Controls Systems: Basic control system components; block diagrammatic description, reduction of block diagrams. Open loop and closed loop (feedback) systems and stability analysis of these systems. Signal flow graphs and their use in determining transfer functions of systems; transient and steady state analysis of LTI control systems and frequency response. Tools and techniques for LTI control system analysis: root loci, Routh-Hurwitz criterion, Bode and Nyquist plots. Control system compensators: elements of lead and lag compensation, elements of Proportional-Integral-Derivative(PID) control. State variable representation and solution of state equation of LTI control systems.

Communications: Analog communication systems: amplitude and angle modulation and demodulation systems, spectral analysis of these operations, superheterodyne receivers; elements of hardware, realizations of analog communication systems; signal-to-noise ratio (SNR) calculations for amplitude modulation (AM) and frequency modulation (FM) for low noise conditions. Digital communication systems: pulse code modulation (PCM), differential pulse code modulation (DPCM), delta modulation (DM); digital modulation schemes-amplitude, phase and frequency shift keying schemes (ASK, PSK, FSK), matched filter receivers, bandwith consideration and probability of error calculations for these schemes.

Electromagnetics: Elements of vector calculus: divergence and curl; Gauss' and Stokes' theorems, Maxwell's equations: differential and integral forms. Wave equation, Poynting vector. Plane waves: propagation through various media; reflection and refraction; phase and group velocity; skin depth. Transmission lines: characteristic impedance; impedance transformation; Smith chart; impedance matching; pulse excitation. Waveguides: modes in rectangular waveguides; boundary conditions; cut-off frequencies; dispersion relations. Antennas: Dipole antennas; antenna arrays; radiation pattern; reciprocity theorem, antenna gain.

EE - ELECTRICAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix Algebra, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Mean value theorems, Theorems of integral calculus, Evaluation of definite and improper integrals, Partial Derivatives, Maxima and minima, Multiple integrals, Fourier series. Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equation (linear and nonlinear), Higher order linear differential equations with constant coefficients, Method of variation of parameters, Cauchy's and Euler's equations, Initial and boundary value problems, Partial Differential Equations and variable separable method.

Complex variables: Analytic functions, Cauchy's integral theorem and integral formula, Taylor's and Laurent' series, Residue theorem, solution integrals.

Probability and Statistics: Sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Discrete and continuous distributions, Poisson, Normal and Binomial distribution, Correlation and regression analysis.

Numerical Methods: Solutions of non-linear algebraic equations, single and multi-step

methods for differential equations.

Transform Theory: Fourier transform, Laplace transform, Z-transform.

ELECTRICAL ENGINEERING

Electrical Circuits and Fields: Network graph, KCL, KVL, node/ cut set, mesh/ tie set analysis, transient response of d.c. and a.c. networks; sinusoidal steady-state analysis; resonance in electrical circuits; concepts of ideal voltage and current sources, network theorems, driving point, immittance and transfer functions of two port networks, elementary concepts of filters; three phase circuits; Fourier series and its application; Gauss theorem, electric field intensity and potential due to point, line, plane and spherical charge distribution, dielectrics, capacitance calculations for simple configurations; Ampere's and Biot-Savart's law, inductance calculations for simple configurations.

Electrical Machines: Single phase transformer - equivalent circuit, phasor diagram, tests, regulation and efficiency; three phase transformers - connections, parallel operation; auto transformer and three-winding transformer; principles of energy conversion, windings of rotating machines: D. C. generators and motors - characteristics, starting and speed control, armature reaction and commutation; three phase induction motors-performance characteristics, starting and speed control; single-phase induction motors; synchronous generators-performance, regulation, parallel operation; synchronous motors - starting, characteristics, applications, synchronous condensers; fractional horse power motors; permanent magnet and stepper motors.

Power Systems: Electric power generation - thermal, hydro, nuclear; transmission line parameters; steady-state performance of overhead transmission lines and cables and surge propagation; distribution systems, insulators, bundle conductors, corona and radio interference effects; per-unit quantities; bus admittance and impedance matrices; load flow; voltage control and power factor correction; economic operation; symmetrical components, analysis of symmetrical and unsymmetrical faults; principles of over current, differential and distance protections; concept of solid state relays and digital protection; circuit breakers; concept of system stability-swing curves and equal area criterion; basic concepts of HVDC transmission.

Control Systems: Principles of feedback; transfer function; block diagrams: steady-state errors; stability-Routh and Nyquist criteria; Bode plots; compensation; root loci; elementary state variable formulation; state transition matrix and response for Linear Time Invariant systems.

Electrical and Electronic Measurements: Bridges and potentiometers, PMMC, moving iron, dynamometer and induction type instruments; measurement of voltage, current, power, energy and power factor; instrument transformers; digital voltmeters and multimeters; phase, time and frequency measurement; Q-meter, oscilloscopes, potentiometric recorders, error analysis.

Analog and Digital Electronics: Characteristics of diodes, BJT, FET, SCR; amplifiers-biasing, equivalent circuit and frequency response; oscillators and feedback amplifiers, operational amplifiers- characteristics and applications; simple active filters; VCOs and timers; combinational and sequential logic circuits, multiplexer, Schmitt trigger, multivibrators, sample and hold circuits, A/D and D/A converters; microprocessors and their applications.

Power Electronics and Electric Drives: Semiconductor power devices-diodes, transistors, thyristors, triacs, GTOs, MOSFETs and IGBTs - static characteristics and principles of operation; triggering circuits; phase control rectifiers; bridge converters-fully controlled and half controlled; principles of choppers and inverters, basic concepts of adjustable speed dc and ac drives.

GG - GEOLOGY AND GEOPHYSICS

PART - I

Earth and planetary system; size, shape, internal structure and composition of the earth; atmosphere and greenhouse effect; isostasy; elements of seismology; continents and continental processes; physical oceanography; palaeomagnetism, continental drift plate tectonics, geothermal energy.

Weathering; soil formation; action of river, wind and glacier; oceans and oceanic features; earthquakes, volcanoes, orogeny and mountain building; elements of structural geology; crystallography; classification, composition and properties of minerals and rocks; engineering properties of rocks and soils, role of geology in the construction of engineering structures.

Processes of ore formation, occurrence and distribution of ores on land and on ocean floor; coal and petroleum resources in India; ground water geology including well hydraulics, geological time scale and geochronology; stratigraphic principles and stratigraphy of India; basics concepts of gravity, magnetic and electrical prospecting for ores and ground water.

PART - IIA: GEOLOGY

Crystal symmetry, forms, twinning; crystal chemistry; optical mineralogy, classification of minerals, diagnostic properties of rock minerals.

Mineralogy, structure, texture and classification of igneous, sedimentary and metamorphic rock, their origin and evolution; application of thermodynamics; structure and petrology of sedimentary rocks; sedimentary processes and environments, sedimentary facies, basin studies; basement cover relationship;

Primary and secondary structures; geometry and genesis of folds, faults, joints, unconformities, cleavage, schistosity and lineation; methods of projection. Tectonites and their significance; shear zone; superposed folding.

Morphology, classification and geological significance of important invertebrates, vertebrates, microfossils and palaeoflora; stratigraphic principles and Indian stratigraphy; geomorphic processes and agents; development and evolution of landforms; slope and drainage; processes on deep oceanic and near-shore regions; quantitative and applied geomorphology; air photo interpretation and remote sensing; chemical and optical properties of ore minerals; formation and localization of ore deposits; prospecting and exploration of economic minerals; coal and petroleum geology; origin and distribution of mineral and fuel deposits in India; ore dressing and mineral economics.

Cosmic abundance; meteorites; geochemical evolution of the earth; geochemical cycles; distribution of major, minor and trace elements; isotope geochemistry; geochemistry of waters including solution equilibria and water rock interaction.

Engineering properties of rocks and soils; rocks as construction material; geology of dams, tunnels and excavation sites; natural hazards; the fly ash problem; ground water geology and exploration; water quality; impact of human activity; Remote sensing techniques for the interpretation of landforms and resource management.

PART - II B: GEOPHYSICS

The earth as a planet; different motions of the earth; gravity filed of the earth and its shape; geochronology; isostasy, seismology and interior of the earth; variation of density, velocity, pressure, temperature, electrical and magnetic properties inside the earth; earthquakes-causes and measurements; zonation and seismic hazards; geomagnetic field, palaeomagnetism; oceanic and continental lithosphere; plate tectonics; heat flow; upper and lower atmospheric phenomena.

Theories of scalar and vector potential fields; Laplace, Maxwell and Helmholtz equations for solution of different types of boundary value problems for Cartesian, cylindrical and spherical polar coordinates; Green's theorem; Image theory; integral equations and conformal transformations in potential theory; Eikonal equation and ray theory.

'G' and 'g' units of measurement, density of rocks, gravimeters, preparation, analysis and interpretation of gravity maps; derivative maps, analytical continuation; gravity anomaly type curves; calculation of mass.

Earth's magnetic field, units of measurement, magnetic susceptibility of rocks, magnetometers, corrections, preparation of magnetic maps, magnetic anomaly type curve, analytical continuation, interpretation and application; magnetic well logging.

Conduction of electricity through rocks, electrical conductivities of metals, metallic, non-metallic and rock forming minerals, D.C. resistivity units and methods of measurement, electrode configuration for sounding and profiling, application of filter theory, interpretation of resistivity field data, application; self potential origin, classification, field measurement, interpretation of induced polarization time frequency, phase domain; IP units and methods of measurement, interpretation and application; ground-water exploration.

Origin of electromagnetic field elliptic polarization, methods of measurement for different source-receiver configuration components in EM measurements, interpretation and applications; earth's natural electromagnetic field, tellurics, magneto-tellurics; geomagnetic depth sounding principles, methods of measurement, processing of data and interpretation.

Seismic methods of prospecting: Reflection, refraction and CDP surveys; land and marine seismic sources, generation and propagation of elastic waves, velocity increasing with depth, geophones, hydrophones, recording instruments (DFS), digital formats, field layouts, seismic noises and noise profile analysis, optimum geophone grouping, noise cancellation by shot and geophone arrays, 2D and 3D seismic data acquisition and processing, CDP stacking charts, binning, filtering, dip-moveout, static and dynamic corrections, deconvolution, migration, signal processing, Fourier and Hilbert transforms, attribute analysis, bright and dim spots, seismic stratigraphy, high resolution seismics, VSP.

Principles and techniques of geophysical well-logging, SP, resistivity, induction, micro gamma ray, neutron, density, sonic, temperature, dip meter, caliper, nuclear magnetic, cement bond logging. Quantitative evaluation of formations from well logs; well hydraulics and application of geophysical methods for groundwater study; application of bore hole geophysics in ground water, mineral and oil exploration. Remote sensing techniques and application of remote sensing methods in geophysics.

IN - INSTRUMENTATION ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix Algebra, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Mean value theorems, Theorems of integral calculus, Evaluation of definite and improper integrals, Partial Derivatives, Maxima and minima, Multiple integrals, Fourier series. Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equation (linear and nonlinear), Higher order linear differential equations with constant coefficients, Method of variation of parameters, Cauchy's and Euler's equations, Initial and boundary value problems, Partial Differential Equations and variable separable method.

Complex variables: Analytic functions, Cauchy's integral theorem and integral formula, Taylor's and Laurent' series, Residue theorem, solution integrals.

Probability and Statistics: Sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Discrete and continuous distributions, Poisson, Normal and Binomial distribution, Correlation and regression analysis.

Numerical Methods: Solutions of non-linear algebraic equations, single and multi-step methods for differential equations.

Transform Theory: Fourier transform, Laplace transform, Z-transform.

INSTRUMENTATION ENGINEERING

Measurement Basics and Metrology: Static and dynamic characteristics of measurement systems. Standards and calibration. Error and uncertainty analysis, statistical analysis of data, and curve fitting. Linear and angular measurements; Measurement of straightness, flatness, roundness and roughness.

Transducers, Mechanical Measurements and Industrial Instrumentation: Transducers - elastic, resistive, inductive, capacitive, thermo-electric, piezoelectric, photoelectric, electro-mechanical, electro-chemical, and ultrasonic. Measurement of displacement, velocity (linear and rotational), acceleration, shock, vibration, force, torque, power, strain, stress, pressure, flow, temperature, humidity, viscosity, and density. energy storing elements, suspension systems and dampers.

Analog Electronics: Characteristics of diodes, BJTs, JFETs and MOSFETs; Diode circuits; Amplifiers: single and multi-stage, feedback; Frequency response; Operational amplifiers - design, characteristic, linear and non-linear applications: difference amplifiers; instrumentation amplifiers; precision rectifiers, I-to-V converters, active filters, oscillators, comparators, signal generators, wave shaping circuits.

Digital Electronics: Combinational logic circuits, minimization of Boolean functions; IC families (TTL, MOS, CMOS), arithmetic circuits, multiplexer and decoders. Sequential circuits: flip-flops, counters, shift registers. Schmitt trigger, timers, and multivibrators. Analog switches, multiplexers, S/H circuits. Analog-to-digital and digital-to-analog converters. Basics of computer organization and architecture. 8-bit microprocessor (8085), applications, memory, I/O interfacing, and microcontrollers.

Signals and Systems: Vectors and matrices; Fourier series; Fourier transforms; Ordinary differential equations. Impulse and frequency responses of first and second order systems. Laplace transform and transfer function, convolution and correlation. Amplitude and frequency modulations and demodulations. Discrete time systems, difference equations, impulse and frequency responses; Z-transforms and transfer functions; IIR and FIR filters.

Electrical and Electronic Measurements: Measurement of R, L and C; bridges and potentiometers. Measurement of voltage, current, power, power factor, and energy; Instrument transformers; Q meter, waveform analyzers. Digital volt-meters and multi-meters. Time, phase and frequency measurements; Oscilloscope. Noise and interference in instrumentation.

Control Systems & Process Control: Principles of feedback; transfer function, signal flow graphs. Stability criteria, Bode plots, root-loci, Routh and Nyquist criteria. Compensation techniques; State space analysis. System components: mechanical, hydraulic, pneumatic, electrical and electronic; Servos and synchros; Stepper motors. On-off, cascade, P, PI, PID and feed-forward controls. Controller tuning and general frequency response.

Analytical, Optical and Biomedical Instrumentation: Principles of spectrometry, UV, visible, IR mass spectrometry, X-ray methods; nuclear radiation measurements, gas, solid and semi conductor lasers and their characteristics, interferometers, basics of fibre optics, transducers in biomedical applications, cardiovascular system measurements, instrumentation for clinical laboratory.

MA - MATHEMATICS

Linear Algebra: Finite dimensional vector spaces. Linear transformations and their matrix representations, rank; systems of linear equations, eigenvalues and eigenvectors, minimal polynomial, Cayley-Hamilton theorem, diagonalisation, Hermitian, Skew-Hermitian and unitary matrices. Finite dimensional inner product spaces, self-adjoint and Normal linear operators, spectral theorem, Quadratic forms.

Complex Analysis: Analytic functions, conformal mappings, bilinear transformations, complex integration: Cauchy's integral theorem and formula, Liouville's theorem, maximum modulus principle, Taylor and Laurent's series, residue theorem and applications for evaluating real integrals.

Real Analysis: Sequences and series of functions, uniform convergence, power series, Fourier series, functions of several variables, maxima, minima, multiple integrals, line, surface and volume integrals, theorems of Green, Stokes and Gauss; metric spaces, completeness, Weierstrass approximation theorem, compactness. Lebesgue measure, measurable functions; Lebesgue integral, Fatou's lemma, dominated convergence theorem.

Ordinary Differential Equations: First order ordinary differential equations, existence and uniqueness theorems, systems of linear first order ordinary differential equations, linear ordinary differential equations of higher order with constant coefficients; linear second order ordinary differential equations with variable coefficients, method of Laplace transforms for solving ordinary differential equations, series solutions; Legendre and Bessel functions and their orthogonality, Sturm Liouville system, Greeen's functions.

Algebra: Normal subgroups and homomorphisms theorems, automorphisms. Group actions, sylow's theorems and their applications groups of order less than or equal to 20, Finite p-groups. Euclidean domains, Principal ideal domains and unique factorizations domains. Prime ideals and maximal ideals in commutative rings.

Functional Analysis: Banach spaces, Hahn-Banach theorems, open mapping and closed graph theorems, principle of uniform boundedness; Hilbert spaces, orthonormal sets, Riesz representation theorem, self-adjoint, unitary and normal linear operators on Hilbert Spaces.

Numerical Analysis: Numerical solution of algebraic and transcendental equations; bisection, secant method, Newton-Raphson method, fixed point iteration, interpolation: existence and error of polynomial interpolation, Lagrange, Newton, Hermite(osculatory)interpolations; numerical differentiation and integration, Trapezoidal and Simpson rules; Gaussian quadrature; (Gauss-Legendre and Gauss-Chebyshev), method of undetermined parameters, least square and orthonormal polynomial approximation; numerical solution of systems of linear equations: direct and iterative methods, (Jacobi Gauss-Seidel and SOR) with convergence; matrix eigenvalue problems: Jacobi and Given's methods, numerical solution of ordinary differential equations: initial value problems, Taylor series method, Runge-Kutta methods, predictor-corrector methods; convergence and stability.

Partial Differential Equations: Linear and quasilinear first order partial differential equations, method of characteristics; second order linear equations in two variables and their classification; Cauchy, Dirichlet and Neumann problems, Green's functions; solutions of Laplace, wave and diffusion equations in two variables Fourier series and transform methods of solutions of the above equations and applications to physical problems.

Mechanics: Forces in three dimensions, Poinsot central axis, virtual work, Lagrange's equations for holonomic systems, theory of small oscillations, Hamiltonian equations;

Topology: Basic concepts of topology, product topology, connectedness, compactness, countability and separation axioms, Urysohn's Lemma, Tietze extension theorem, metrization theorems, Tychonoff theorem on compactness of product spaces.

Probability and Statistics: Probability space, conditional probability, Bayes' theorem, independence, Random variables, joint and conditional distributions, standard probability distributions and their properties, expectation, conditional expectation, moments. Weak and strong law of large numbers, central limit theorem. Sampling distributions, UMVU estimators, sufficiency and consistency, maximum likelihood estimators. Testing of hypotheses, Neyman-Pearson tests, monotone likelihood ratio, likelihood ratio tests, standard parametric tests based on normal, X2 ,t, F-distributions. Linear regression and test for linearity of regression. Interval estimation.

Linear Programming: Linear programming problem and its formulation, convex sets their properties, graphical method, basic feasible solution, simplex method, big-M and two phase methods, infeasible and unbounded LPP's, alternate optima. Dual problem and duality theorems, dual simplex method and its application in post optimality analysis, interpretation of dual variables. Balanced and unbalanced transportation problems, unimodular property and u-v method for solving transportation problems. Hungarian method for solving assignment problems.

Calculus of Variations and Integral Equations: Variational problems with fixed boundaries; sufficient conditions for extremum, Linear integral equations of Fredholm and Volterra type, their iterative solutions. Fredholm alternative.

ME - MECHANICAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

APPLIED MECHANICS AND DESIGN

Engineering Mechanics: Equivalent force systems, free-body concepts, equations of equilibrium, trusses and frames, virtual work and minimum potential energy. Kinematics and dynamics of particles and rigid bodies, impulse and momentum (linear and angular), energy methods, central force motion.

Strength of Materials: Stress and strain, stress-strain relationship and elastic constants, Mohr's circle for plane stress and plane strain, shear force and bending moment diagrams, bending and shear stresses, deflection of beams, torsion of circular shafts, thin and thick cylinders, Euler's theory of columns, strain energy methods, thermal stresses.

Theory of Machines: Displacement, velocity and acceleration, analysis of plane mechanisms, dynamic analysis of slider-crank mechanism, planar cams and followers, gear tooth profiles, kinematics of gears, governors and flywheels, balancing of reciprocating and rotating masses.

Vibrations: Free and forced vibration of single degree freedom systems, effect of damping, vibration isolation, resonance, critical speed of rotors.

Design of Machine Elements: Design for static and dynamic loading, failure theories, fatigue strength; design of bolted, riveted and welded joints; design of shafts and keys; design of spur gears, rolling and sliding contact bearings; brakes and clutches; belt, rope and chain drives.

FLUID MECHANICS AND THERMAL SCIENCES

Fluid Mechanics: Fluid properties, fluid statics, manometry, buoyancy; control-volume analysis of mass, momentum and energy; fluid acceleration; differential equations of continuity and momentum; Bernoulli's equation; viscous flow of incompressible fluids; boundary layer; elementary turbulent flow; flow through pipes, head losses in pipes, bends etc.

Heat-Transfer: Modes of heat transfer; one dimensional heat conduction, resistance concept, electrical analogy, unsteady heat conduction, fins; dimensionless parameters in free and forced convective heat transfer, various correlations for heat transfer in flow over flat plates and through pipes; thermal boundary layer; effect of turbulence; radiative heat transfer, black and grey surfaces, shape factors, network analysis; heat exchanger performance, LMTD and NTU methods.

Thermodynamics: Zeroth, First and Second laws of thermodynamics; thermodynamic system and processes; irreversibility and availability; behaviour of ideal and real gases, properties of pure substances, calculation of work and heat in ideal processes; analysis of thermodynamic cycles related to energy conversion; Carnot, Rankine, Otto, Diesel, Brayton and vapour compression cycles.

Power Plant Engineering: Steam generators; steam power cycles; steam turbines; impulse and reaction principles, velocity diagrams, pressure and velocity compounding; reheating and reheat factor; condensers and feed heaters.

I.C. Engines: Requirements and suitability of fuels in IC engines, fuel ratings, fuel-air mixture requirements; normal combustion in SI and CI engines; engine performance calculations.

Refrigeration and air-conditioning: Refrigerant compressors, expansion devices, condensers and evaporators; properties of moist air, psychrometric chart, basic psychometric processes.

Turbomachinery: Components of gas turbines; compression processes, centrifugal and axial flow compressors; axial flow turbines, elementary theory; hydraulic turbines; Euler-turbine equation; specific speed, Pelton-wheel, Francis and Kaplan turbines; centrifugal pumps.

MANUFACTURING AND INDUSTRIAL ENGINEERING

Engineering Materials: Structure and properties of engineering materials and their applications, heat treatment.

Metal Casting: Casting processes (expendable and non-expendable) -pattern, moulds and cores, heating and pouring, solidification and cooling, gating design, design considerations, defects.

Forming Processes: Stress-strain diagrams for ductile and brittle material, Plastic deformation and yield criteria, fundamentals of hot and cold working processes, Bulk metal forming processes (forging, rolling, extrusion, drawing), sheet metal working processes (punching, blanking, bending, deep drawing, coining, spinning, load estimation using homogeneous deformation methods, defects). processing of powder metals- atomization, compaction, sintering, secondary and finishing operations. forming and shaping of plastics- extrusion, injection moulding.

Joining Processes: Physics of welding, fusion and non-fusion welding processes, brazing and soldering, adhesive bonding, design considerations in welding, weld quality defects.

Machining and Machine Tool Operations: Mechanics of machining, single and multi-point cutting tools, tool geometry and materials, tool life and wear, cutting fluids, machinability, economics of machining, non-traditional machining processes.

Metrology and Inspection: Limits, fits and tolerances, linear and angular measurements, comparators, gauge design, interferometry, form and finish measurement, measurement of screw threads, alignment and testing methods.

Tool Engineering: Principles of work holding, design of jigs and fixtures.

Computer Integrated Manufacturing: Basic concepts of CAD, CAM and their integration tools.

Manufacturing Analysis: Part-print analysis, tolerance analysis in manufacturing and assembly, time and cost analysis.

Work-Study: Method study, work measurement, time study, work sampling, job evaluation, merit rating.

Production Planning and Control: Forecasting models, aggregate production planning, master scheduling, materials requirements planning.

Inventory Control: Deterministic and probabilistic models, safety stock inventory control systems.

Operations Research: Linear programming, simplex and duplex method, transportation, assignment, network flow models, simple queuing models, PERT and CPM

MN - MINING ENGINEERING

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of

trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

MINING ENGINEERING

Mechanics: Equivalent force systems, equations of equilibrium, two dimensional frames and trusses, free body diagrams, friction forces, particle kinematics and dynamics.

Mine Development, Geomechanics and Strata Control: Drivages for underground mine development, drilling methods and machines, explosives, blasting devices and practices, shaft sinking. Physico-mechanical properties of rocks, rock mass classification, ground control instrumentation and stress measurement techniques, theories of rock failure, ground vibrations, stress distribution around mine openings, subsidence, design of supports in roadways and workings, stability of open pits, slopes.

Mining Methods and Machinery: Surface mining - layout, development, loading, transportation and mechanization, continuous surface mining systems. Underground coal mining - bord and pillar system, longwall mining, thick seam mining methods. Underground metal mining: different stoping methods, stope mechanization, ore handling systems, mine filling. Generation and transmission of mechanical, hydraulic, and pneumatic power. Materials handling - haulages, conveyors, ropeways, face and development machinery, hoisting systems, and pumps.

Ventilation, Underground Hazards and Surface Environment: Underground atmosphere, heat load sources and thermal environment, air cooling, mechanics of air flow distribution, natural and mechanical ventilation, mine fans and their usage, auxiliary ventilation. Subsurface hazards from fires, explosions, gases, dust, and inundation, rescue apparatus and practices, safety in mines, accident analysis, noise, mine lighting. Air and water pollution: causes, dispersion, quality standards, and control.

Surveying, Mine Planning and Systems Engineering: Fundamentals of engineering surveying, Levels and levelling, Theodolite, tacheometry, triangulation, contouring, errors and adjustments, correlation, underground surveying, curves, photogrammetry, field astronomy, GPS fundamentals. Principles of planning - Sampling methods and practices, reserve estimation techniques, basics of geostatistics, optimization of facility location, cash flow concepts and mine valuation, open pit design. Work study, concepts of reliability, reliability of series and parallel systems. Linear programming, transportation and assignment problems, queueing, network analysis, inventory control.

MT - METALLURGICAL ENGINEERING

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of

trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

METALLURGICAL ENGINEERING

Thermodynamics and Rate Processes: Laws of thermodynamics, activity, equilibrium constant, applications to metallurgical systems, solutions, phase equilibria, basic kinetic laws, order of reactions, rate constants and rate limiting steps principles of electro chemistry, aqueous, corrosion and protection of metals, oxidation and high temperature corrosion - characterization and control; momentum transfer - concepts of viscosity, shell balances, Bernoulli's equation; heat transfer - conduction, convection and heat transfer coefficient relations, radiation, mass transfer - diffusion and Fick's laws.

Extractive Metallurgy: Flotation, gravity and other methods of mineral processing; agglomeration, pyro-hydro-and electro-metallurgical processes; material and energy balances; principles and processes for the extraction of non-ferrous metals - aluminium, copper, zinc, lead, magnesium, nickel, titanium and other rare metals; iron and steel making - principles, blast furnace, direct reduction processes, primary and secondary steel making, deoxidation and inclusion in steel; ingot and continuous casting; stainless steel making, design of furnaces; fuels and refractories.

Physical Metallurgy: Crystal structure and bonding characteristics of metals, alloys, ceramics and polymers; solid solutions; solidification; phase transformation and binary phase diagrams; principles of heat treatment of steels, aluminum alloys and cast irons; recovery, recrystallization and grain growth; industrially important ferrous and non-ferrous alloys; elements of X-ray and electron diffraction; principles of scanning and transmission electron microscopy; elements of ceramics, composites and electronic materials; electronic basis of thermal, optical, electrical and magnetic properties of materials.

Mechanical Metallurgy: Elements of elasticity and plasticity; defects in crystals; elements of dislocation theory - types of dislocations, slip and twinning, stress fields of dislocations, dislocation interactions and reactions, methods of seeing dislocations; strengthening mechanisms; tensile, fatigue and creep behaviour; superplasticity; fracture - Griffith theory, ductile to brittle transition, fracture toughness; failure analysis; mechanical testing - tension, compression, torsion, hardness, impact, creep, fatigue, fracture toughness and formability tests.

Manufacturing Processes: Metal casting - patterns, moulds, melting, gating, feeding and casting processes, defects and castings, hot and cold working of metals; Metal forming - fundamentals of metal forming, rolling wire drawing, extrusion, forming, sheet metal forming processes, defects in forming; Metal joining - soldering, brazing and welding, common welding processes, welding metallurgy, problems associated with welding of steels and aluminium alloys, defects in welding, powder metallurgy; NDT methods - ultrasonic, radiography, eddy current, acoustic emission and magnetic.

PH - PHYSICS

Mathematical Physics: Linear vector space, matrices; vector calculus; linear differential equations; elements of complex analysis; Laplace transforms, Fourier analysis, elementary ideas about tensors.

Classical Mechanics: Conservation laws; central forces; collisions and scattering in laboratory and centre of mass reference frames; mechanics of system of particles; rigid body dynamics; moment of inertia tensor; noninertial frames and pseudo forces; variational principle; Lagrange's and Hamilton's formalisms; equation of motion, cyclic coordinates, Poisson bracket; periodic motion, small oscillations, normal modes; wave equation and wave propagation; special theory of relativity - Lorentz transformations, relativistic kinematics, mass-energy equivalence.

Electromagnetic Theory: Laplace and Poisson equations; conductors and dielectrics; boundary value problems; Ampere's and Biot-Savart's laws; Faraday's law; Maxwell's equations; scalar and vector potentials; Coulomb and Lorentz gauges; boundary conditions at interfaces; electromagnetic waves; interference, diffraction and polarization; radiation from moving charges.

Quantum Mechanics: Physical basis of quantum mechanics; uncertainty principle; Schrodinger equation; one and three dimensional potential problems; Particle in a box, harmonic oscillator, hydrogen atom; linear vectors and operators in Hilbert space; angular momentum and spin; addition of angular momentum; time independent perturbation theory; elementary scattering theory.

Atomic and Molecular Physics: Spectra of one-and many-electron atoms; LS and jj coupling; hyperfine structure; Zeeman and Stark effects; electric dipole transitions and selection rules; X-ray spectra; rotational and vibrational spectra of diatomic molecules; electronic transition in diatomic molecules, Franck-Condon principle; Raman effect; NMR and ESR; lasers.

Thermodynamics and Statistical Physics: Laws of thermodynamics; macrostates, phase space; probability ensembles; partition function, free energy, calculation of thermodynamic quantities; classical and quantum statistics; degenerate Fermi gas; black body radiation and Planck's distribution law; Bose-Einstein condensation; first and second order phase transitions, critical point.

Solid State Physics: Elements of crystallography; diffraction methods for structure determination; bonding in solids; elastic properties of solids; defects in crystals; lattice vibrations and thermal properties of solids; free electron theory; band theory of solids; metals, semiconductors and insulators; transport properties; optical, dielectric and magnetic properties of solids; elements of superconductivity.

Nuclear and Particle Physics: Rutheford scattering; basic properties of nuclei; radioactive decay; nuclear forces; two nucleon problem; nuclear reactions; conservation laws; fission and fusion; nuclear models; particle accelerators, detectors; elementary particles; photons, baryons, mesons and leptons; Quark model.

Electronics: Network analysis; semiconductor devices; bipolar transistors; FETs; power supplies, amplifier, oscillators; operational amplifiers; elements of digital electronics; logic circuits.

PI - PRODUCTION AND INDUSTRIAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

GENERAL ENGINEERING:

Engineering Materials: Structure and properties of engineering materials and their applications; effect of strain, strain rate and temperature on mechanical properties of metals and alloys; heat treatment of metals and alloys.

Applied Mechanics: Engineering mechanics - equivalent force systems, free body concepts, equations of equilibrium, virtual work and minimum potential energy; strength of materials-stress, strain and their relationship, Mohr's circle, deflection of beams, bending and shear stress, Euler's theory of columns.

Theory of Machines and Design: Analysis of planar mechanisms, plane cams and followers; governers and fly wheels; design of elements-failure theories; design of bolted, riveted and welded joints; design of shafts, keys, belt drives, brakes and clutches.

Thermal Engineering: Fluid machines - fluid statics, Bernoulli's equation, flow through pipes, equations of continuity and momentum; Thermodynamics - zeroth, First and Second laws of thermodynamics, thermodynamic system and processes, calculation of work and heat for systems and control volumes; Heat transfer - fundamentals of conduction, convection and radiation.

PRODUCTION ENGINEERING

Metal Casting: Casting processes; patterns-materials; allowances; moulds and cores - materials, making and testing; melting and founding of cast iron, steels and nonferrous metals and alloys; solidification; design of casting, gating and risering; casting defects and inspection.

Metal working: Stress-strain in elastic and plastic deformation; deformation mechanisms; hot and cold working-forging, rolling, extrusion, wire and tube drawing; sheet metal working; analysis of rolling, forging, extrusion and wire /rod drawing; metal working defects, high energy rate forming processes-explosive, magnetic, electro and electrohydraulic.

Metal Joining Processes: Welding processes - gas shielded metal arc, TIG, MIG, submerged arc, electroslag, thermit, resistance, pressure and forge welding; thermal cutting; other joining processes - soldering, brazing, braze welding; welding codes, welding symbols, design of welded joints, defects and inspection; introduction to modern welding processes - friction, ultrasonic, explosive, electron beam, laser and plasma.

Machining and Machine Tool Operations: Machining processes-turning, drilling, boring, milling, shaping, planing, sawing, gear cutting, thread production, broaching, grinding, lapping, honing super finishing; mechanics of cutting- Merchant's analysis, geometry of cutting tools, cutting forces, power requirements; selection of process parameters; tool materials, tool wear and tool life, cutting fluids, machinability; nontraditional machining processes and hybrid processes- EDM, CHM, ECM, USM, LBM, EBM, AJM, PAM AND WJM; economics of machining.

Metrology and Inspection: Limits and fits, linear and angular measurements by mechanical and optical methods, comparators; design of limit gauges; interferometry; measurement of straightness, flatness, roundness, squareness and symmetry; surface finish measurement; inspection of screw threads and gears; alignment testing.

Powder Metallurgy and Processing of Plastics: Production of powders, compaction, sintering; Polymers and composites; injection, compression and blow molding, extrusion, calendaring and thermoforming; molding of composites.

Tool Engineering: Work-holding-location and clamping; principles and methods; design of jigs and fixtures; design of press working tools, forging dies.

Manufacturing Analysis: Sources of errors in manufacturing; process capability; part-print analysis; tolerance analysis in manufacturing and assembly; process planning; parameter selection and comparison of production alternatives; time and cost analysis; Issues in choosing manufacturing technologies and strategies.

Computer Integrated Manufacturing: Basic concepts of CAD, CAM, CAPP, group technology, NC, CNC, DNC, FMS, Robotics and CIM.

INDUSTRIAL ENGINEERING

Product Design and Development: Principles of good product design, component and tolerance design; efficiency, quality and cost considerations; product life cycle; standardization, simplification, diversification, value analysis, concurrent engineering.

Engineering Economy and Costing: Financial statements; elementary cost accounting, methods of depreciation; break-even analysis, techniques for evaluation of capital investments.

Work System Design: Taylor's scientific management, Gilbreths's contributions; productivity concepts and measurements; method study, micro-motion study, principles of motion economy; human factors engineering, ergonomics; work measurement - time study, PMTS, work sampling; job evaluation, merit rating, wage administration, incentive systems; business process reengineering.

Logistics and Facility Design: Facility location factors, evaluation of alternatives, types of plant layout, evaluation; computer aided layout; assembly line balancing; material handling systems; supply chain management.

Production Planning and Inventory Control: Inventory Function costs, classifications - deterministic and probabilistic models; quantity discount; safety stock; inventory control system; Forecasting techniques - causal and time series models, moving average, exponential smoothing; trend and seasonality; aggregate production planning; master scheduling; bill of materials and material requirement planning; order control and flow control, routing, scheduling and priority dispatching; JIT; Kanban PULL systems; bottleneck scheduling and theory of constraints.

Operation Research: Linear programming - problem formulation, simplex method, duality and sensitivity analysis; transportation; assignment; network flow models, constrained optimization and Lagrange multipliers; simple queuing models; dynamic programming; simulation; PERT and CPM, time-cost trade-off, resource leveling.

Quality Control: Taguchi method; design of experiments; quality costs, statistical quality assurance, process control charts, acceptance sampling, zero defects; quality circles, total quality management.

Reliability and Maintenance: Reliability, availability and maintainability; probabilistic failure and repair times; system reliability; preventive maintenance and replacement, TPM.

Management Information System: Value of information; information storage and retrieval system - database and data structures; interactive systems; knowledge based systems.

Intellectual Property System: Definition of intellectual property, importance of IPR; TRIPS, and its implications, WIPO and Global IP structure, and IPS in India; patent, copyright, industrial design and trademark; meanings, rules and procedures, terms, infringements and remedies.

PY - PHARMACEUTICAL SCIENCES

Natural Products: Pharmacognosy & Phytochemistry - Chemistry, tests, isolation, characterization and estimation of phytopharmaceuticals belonging to the group of Alkaloids, Glycosides, Terpenoids, Steroids, Bioflavanoids, Purines, Guggul lipids. Pharmacognosy of crude drugs which contain the above constituents. Standardisation of raw materials and herbal products. WHO guide lines. Quantitative microscopy including modern techniques used for evaluation. Biotechnological principles and techniques for plant development Tissue culture.

Pharmacology: General pharmacological principles including Toxicology. Drug interaction. Pharmacology of drugs acting on Central nervous system, Cardiovascular system, Autonomic nervous system, Gastro intestinal system and Respiratory system. Pharmacology of Autocoids, Hormones, Chemotherapeutic agents including anticancer drugs. Bioassays. Immuno Pharmacology.

Medicinal Chemistry: Structure, nomenclature, classification, synthesis, SAR and metabolism of the following category of drugs which are official in Indian Pharmacopoeia and British Pharmacopoeia Hypnotics and Sedatives, Analgesics, NSAIDS, Neuroleptics, Antidepressants, Anxiolytics, Anticonvulsants, Antihistaminics, Local anaesthetics, Cardio Vascular drugs - Antianginal agents Vasodilators, Adrenergic & cholinergic drugs, Cardiotonic agents, Diuretics, Antihypertensive drugs, Hypoglycemic agents, Antilipedmic agents, Coagulants, Anticoagulants, Antiplatelet agents. Chemotherapeutic agents - Antibiotics, Antibacterials, Sulphadrugs. Antiproliozoal drugs, Antiviral, Antitubercular, Antimalarial, Anticancer, Antiamoebic drugs. Diagnostic agents. Preparation and storage and uses of official Radiopharmaceuticals. Vitamins and Hormones.

Pharmaceutics: Development, manufacturing standards, labeling, packing as per the pharmacopoeal requirements, Storage of different dosage forms and new drug delivery systems. Biopharmaceutics and Pharmacokinetics and their importance in formulation. Formulation and preparation of cosmetics - lipstick, shampoo, creams, nail preparations and dentifrices. Pharmaceutical calculations.

Pharmaceutical Jurisprudence: Legal aspects of manufacture, storage, sale of drugs. D and C act and rules. Pharmacy act.

Pharmaceutical Analysis: Principles, instrumentation and applications of the following. Absorption spectroscopy (UV, visible & IR), Fluorimetry, Flame photometry, Potentiometry, Conductometry and Plarography. Pharmacopoeial assays. Principles of NMR, ESR, Mass spectroscopy, X-ray diffraction analysis and different chromatographic methods.

Biochemistry and Clinical Pharmacy: Biochemical role of hormones, Vitamins, Enzymes, Nucleic acids. Bioenergetics. General principles of immunology. Immunological techniques. Adverse drug interaction.

Microbiology: Principles and methods of microbiological assays of the Pharmacopoeia. Methods of preparation of official sera and vaccines. Serological and diagnostic tests. Applications of microorganisms in Bio Conversions and in Pharmaceutical industry.

TF - TEXTILE ENGINEERING AND FIBRE SCIENCE

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

TEXTILE ENGINEERING & FIBRE SCIENCE

Textile Fibres: Classification of textile fibres according to their nature and origin; general characteristics of textile fibres-their chemical and physical structures and their properties; essential characteristics of fibre forming polymers; uses of natural and man-made fibres; physical and chemical methods of fibre and blend identification and blend analysis.

Melt Spinning processes with special reference to polyamide and polyester fibres; wet and dry spinning of viscose and acrylic fibres; post spinning operations-drawing, heat setting, texturing- false twist and air-jet, tow-to-top conversion. Methods of investigating fibre structure e.g. X-ray diffraction, birefringence, optical and electron microscopy, I.R. absorption, thermal methods; structure and morphology and principal natural and man-made fibres, mechanical properties of fibres, moisture sorption in fibres; fibre structure and property correlation.

Textile Testing: Sampling techniques, sample size and sampling errors; measurement of fibre length, fineness, crimp, strength and reflectance; measurement of cotton fibre maturity ad trash content; HVI and AFIS for fibre testing. Measurement of yarn count, twist and hairiness; tensile testing of fibres, yarn and fabrics; evenness testing of slivers, rovings and yarns; testing equipment for measurement test methods of fabric properties like thickness, compressibility, air permeability, drape, crease recovery, tear strength bursting strength and abrasion resistance. Correlation analysis, significance tests and analysis of variance; frequency distributions and control charts.

Yarn Manufacture and Yarn Structure: Modern methods of opening, cleaning and blending of fibrous materials; the technology of carding with particular reference to modern developments; causes of irregularity introduced by drafting, the development of modern drafting systems; principles and techniques of preparing material for combing; recent development in combers; functions and synchronization of various mechanisms concerned with roving production; forces acting on yarn and traveller, ring and traveller designs; causes of end breakages; properties of doubles yarns; new methods of yarn production such as rotor spinning, air jet spinning and friction spinning.

Yarn diameter; specific volume, packing coefficient; twist-strength relationship; fibre orientation in yarn; fibre migration.

Fabric Manufacture and Fabric Structure: Principles of cheese and cone winding processes and machines; random and precision winding; package faults and their remedies; yarn clearers and tensioners; different systems of yarn splicing; features of modern cone winding machines; different types of warping creels; features of modern beam and sectional warping machines; different sizing systems, sizing of spun and filament yarns, modern sizing machines; principles of pirn winding processes and machines; primary and secondary motions of loom, effect of their settings and timings on fabric formation, fabric appearance and weaving performance; dobby and jacquard shedding; mechanics of weft insertion with shuttle; warp and weft stop motions, warp protection, weft replenishment; functional principles of weft insertion systems of shuttleless weaving machines, principles of multiphase and circular looms. Principles of weft and warp knitting; basic weft and warp knitted structures; classification, production and areas of application of nonwoven fabrics.

Basic woven fabric constructions and their derivatives; crepe, cord, terry, gauze, lino and double cloth constructions.

Peirce's equations for fabric geometry; thickness, cover and maximum sett of woven fabrics

Textile Chemical Processing: Preparatory processes for natural-and and their blends; mercerization of cotton; machines for yarn and fabric mercerization.

Dyeing and printing of natural- and synthetic- fibre fabrics and their blends with different dye classes; dyeing and printing machines; styles of printing; fastness properties of dyed and printed textile materials.

Finishing of textile materials, wash and wear, durable press, soil release, water repellent, flame retardant and antistatic finishes; shrink-resistance finish for wool; heat setting of synthetic-fibre fabrics, finishing machines; energy efficient processes; pollution control.

XE - ENGINERING SCIENCES

The syllabi of the sections of this paper are as follows:

SECTION A. ENGINEERING MATHEMATICS (Compulsory)

Linear Algebra : Determinates, algebra of matrices, rank, inverse, system of linear equations, symmetric, skew-symmetric and orthogonal matrices. Hermitian, skew-hermitian and unitary matrices. eigenvalues and eigenvectors, diagonalisation of matrices, Cayley-Hamiltonian, quadratic forms.

Calculus : Functions of single variables, limit, continuity and differentiability, Mean value theorems, Intermediate forms and L'Hospital rule, Maxima and minima, Taylor's series, Fundamental and mean value-theorems of integral calculus. Evaluation of definite and improper integrals, Beta and Gamma functions, Functions of two variables, limit, continuity, partial derivatives, Euler's theorem for homogeneous functions, total derivatives, maxima and minima, Lagrange method of multipliers, double and triple integrals and their applications, sequence and series, tests for convergence, power series, Fourier Series, Fourier integrals.

Complex variable: Analytic functions, Cauchy's integral theorem and integral formula without proof. Taylor's and Laurent' series, Residue theorem (without proof) with application to the evaluation of real integarls.

Vector Calculus: Gradient, divergence and curl, vector identities, directional derivatives, line, surface and volume integrals, Stokes, Gauss and Green's theorems (without proofs) with applications.

Ordinary Differential Equations: First order equation (linear and nonlinear), higher order linear differential equations with constant coefficients, method of variation of paramaters, Cauchy's and Euler's equations, initial and boundary value problems, power series solutions, Legendre polynomials and Bessel's functions of the first kind.

Partial Differential Equations: Variables separable method, solutions of one dimensional heat, wave and Laplace equations.

Probability and Statistics: Definitions of probability and simple theorems, conditional probability, mean, mode and standard deviation, random variables, discrete and continuous distributions, Poisson, normal and Binomial distribution, correlation and regression

Numerical Methods: L-U decomposition for systems of linear equations,Newton-Raphson method, numerical integration(trapezoidal and Simpson's rule), numerical methods for first order differential equation (Euler method)

SECTION B. COMPUTATIONAL SCIENCE

Numerical Methods: Truncation errors, round off errors and their propagation; Interpolation; Lagrange, Newton's forward, backward and divided difference formulas, least square curve fitting, solution of non-linear equations of one variables using bisection, false position, secant and Newton Raphson methods; Rate of convergence of these methods, general iterative methods. Simple and multiple roots of polynomials. Solutions of system of linear algebraic equations using Gauss elimination methods, Jacobi and Gauss-Seidel iterative methods and their rate of convergence; ill conditioned and well conditioned system. eigen values and eigen vectors using power methods. Numerical integration using trapezoidal, Simpson's rule and other quadrature formulas. Numerical Differentiation. Solution of boundary value problems. Solution of initial value problems of ordinary differential equations using Euler's method, predictor corrector and Runge Kutta method.

Programming : Elementary concepts and terminology of a computer system and system software, Fortran77 and C programming.

Fortran : Program organization, arithmetic statements, transfer of control, Do loops, subscripted variables, functions and subroutines.

C language : Basic data types and declarations, flow of control- iterative statement, conditional statement, unconditional branching, arrays, functions and procedures.

SECTION C. ELECTRICAL SCIENCES

Electric Circuits: Ideal voltage and current sources; RLC circuits, steady state and transient analysis of DC circuits, network theorems; alternating currents and voltages, single-phase AC circuits, resonance; three-phase circuits.

Magnetic circuits: Mmf and flux, and their relationship with voltage and current; transformer, equivalent circuit of a practical transformer, three-phase transformer connections.

Electrical machines: Principle of operation, characteristics, efficiency and regulation of DC and synchronous machines; equivalent circuit and performance of three-phase and single-phase induction motors.

Electronic Circuits: Characteristics of p-n junction diodes, zener diodes, bipolar junction transistors (BJT) and junction field effect transistors (JFET); MOSFET's structure, characteristics, and operations; rectifiers, filters, and regulated power supplies; biasing circuits, different configurations of transistor amplifiers, class A, B and C of power amplifiers; linear applications of operational amplifiers; oscillators; tuned and phase shift types.

Digital circuits: Number systems, Boolean algebra; logic gates, combinational circuits, flip-flops (RS, JK, D and T) counters.

Measuring instruments: Moving coil, moving iron, and dynamometer type instruments; shunts, instrument transformers, cathode ray oscilloscopes; D/A and A/D converters.

SECTION D. FLUID MECHANICS

Fluid Properties: Relation between stress and strain rate for Newtonian fluids

Hydrostatics, buoyancy, manometry

Concept of local and convective accelerations; control volume analysis for mass, momentum and energy conservation.

Differential equations of continuity and momentum (Euler's equation of motion); concept of fluid rotation, stream function, potential function; Bernoulli's equation and its applications.

Qualitative ideas of boundary layers and its separation; streamlined and bluff bodies; drag and lift forces.

Fully-developed pipe flow; laminar and turbulent flows; friction factor; Darcy Weisbach relation; Moody's friction chart; losses in pipe fittings; flow measurements using venturimeter and orifice plates.

Dimensional analysis; similitude and concept of dynamic similarity; importance of dimensionless numbers in model studies.

SECTION E. MATERIALS SCIENCE

Atomic structure and bonding in materials: metals, ceramics and polymers.

Structure of materials: Crystal systems, unit cells and space lattice; determination of structures of simple crystals by X-ray diffraction; Miller indices for planes and directions. Packing geometry in metallic, ionic and covalent solids.

Concept of amorphous, single and polycrystalline structures and their effects on properties of materials.

Imperfections in crystalline solids and their role in influencing various properties.

Fick´s laws of diffusion and applications of diffusion in sintering, doping of semiconductors and surface hardening of metals.

Alloys: solid solution and solubility limit. Binary phase diagram, intermediate phases and intermetallic compounds; iron-iron carbide phase diagram. Phase transformation in steels. Cold and hot working of metals, recovery, recrystallization and grain growth.

Properties and applications of ferrous and nonferrous alloys.

Structure, properties, processing and applications of traditional and advanced ceramics.

Polymers: classification, polymerization, structure and properties, additives for polymer products, processing and application.

Composites: properties and application of various composites.

Corrosion and environmental degradation of materials (metals, ceramics and polymers).

Mechanical properties of materials: Stress-strain diagrams of metallic, ceramic and polymeric materials, modulus of elasticity, yield strength, plastic deformation and toughness, tensile strength and elongation at break; viscoelasticity, hardness, impact strength. ductile and brittle fracture. creep and fatigue properties of materials.

Heat capacity, thermal conductivity, thermal expansion of materials.

Concept of energy band diagram for materials; conductors, semiconductors and insulators in terms of energy bands. Electrical conductivity, effect of temperature on conductivity in materials, intrinsic and extrinsic semiconductors, dielectric properties of materials.

Refraction, reflection, absorption and transmission of electromagnetic radiation in solids.

Origin of magnetism in metallic and ceramic materials, paramagnetism, diamagnetism, antiferromagnetism, ferromagnetism, ferrimagnetism in materials and magnetic hysteresis.

Advanced materials: Smart materials exhibiting ferroelectric, piezoelectric, optoelectronic, semiconducting behaviour; lasers and optical fibers; photoconductivity and superconductivity in materials.

SECTION F. SOLID MECHANICS

Equivalent force systems; free-body diagrams; equilibrium equations; analysis of determinate and indeterminate trusses and frames; friction.

Simple relative motion of particles; force as function of position, time and speed; force acting on a body in motion; laws of motion; law of conservation of energy; law of conservation of momentum

Stresses and strains; principal stresses and strains; Mohr's circle; generalized Hooke's Law; equilibrium equations; compatibility conditions; yield criteria.

Axial, shear and bending moment diagrams; axial, shear and bending stresses; deflection (for symmetric bending); torsion in circular shafts; thin cylinders; energy methods (Castigliano's Theorems); Euler buckling.

SECTION G. THERMODYNAMICS

Basic Concepts: Continuum, macroscopic approach, thermodynamic system (closed and open or control volume); thermodynamic properties and equilibrium; state of a system, state diagram, path and process; different modes of work; Zeroth law of thermodynamics; concept of temperature; heat.

First Law of Thermodynamics: Energy, enthalpy, specific heats, first law applied to systems and control volumes, steady and unsteady flow analysis.

Second Law of Thermodynamics: Kelvin-Planck and Clausius statements, reversible and irreversible processes, Carnot theorems, thermodynamic temperature scale, Clausius inequality and concept of entropy, principle of increase of entropy; availability and irreversibility.

Properties of Pure Substances: Thermodynamic properties of pure substances in solid, liquid and vapour phases, P-V-T behaviour of simple compressible substances, phase rule, thermodynamic property tables and charts, ideal and real gases, equations of state, compressibility chart.

Thermodynamic Relations: T-ds relations, Maxwell equations, Joule-Thomson coefficient, coefficient of volume expansion, adiabatic and isothermal compressibilities, Clapeyron equation.

Ideal Gas Mixtures: Dalton's and Amagat's laws, calculations of properties, air-water vapour mixtures.

XL - LIFE SCIENCES

The syllabi of the Sections of this paper are as follows:

SECTION H. CHEMISTRY (Compulsory)

Atomic structure and periodicity: Quantum chemistry; Planck's quantum theory, wave particle duality, uncertainty principle, quantum mechanical model of hydrogen atom; electronic configuration of atoms; periodic table and periodic properties; ionization energy, election affinity, electronegativity, atomic size.

Structure and bonding: Ionic and covalent bonding M.O. and V.B. approaches for diatomic molecules, VSEPR theory and shape of molecules, hybridisation, resonance, dipole moment, structure parameters such as bond length, bond angle and bond energy, hydrogen bonding, van der Waals interactions. Ionic solids; ionic radii, lattice energy (Born-Haber Cycle).

s.p. and d Block Elements: Oxides, halides and hydrides of alkali and alkaline earth metals, B, Al, S, N, P and S, silicones, general characteristics of 3d elements, coordination complexes: valence bond and crystal field theory, color, geometry and magnetic properties.

Chemical Equilibria: Colligative properties of solutions, ionic equilibria in solution, solubility product, common ion effect, hydrolysis of salts, pH, buffer and their applications in chemical analysis.

Electrochemistry: Conductance, Kohlrausch law, Half Cell potentials, emf, Nernst equation, galvanic cells, thermodynamic aspects and their applications.

Reaction Kinetics: Rate constant, order of reaction, molecularity, activation energy, zero, first and second order kinetics, equilibrium constants (Kc, Kp and Kx) for homogeneous reactions, catalysis and elementary enzyme reactions.

Thermodynamics: First law, reversible and irreversible processes, internal energy, enthalpy, Kirchoff's equation, heat of reaction, Hess law, heat of formation, Second law, entropy, free energy, and work function. Gibbs-Helmholtz equation, Clausius-Clapeyron equation, free energy change and equilibrium constant, Troutons rule, Third law of thermodynamics.

Mechanistic Basis of Organic Reactions: Elementary treatment of SN1, SN2, E1 and E2 reactions, Hoffmann and Saytzeff rules, Addition reactions, Markonikoff rule and Kharash effect, Diels-Alder reaction, aromatic electrophilic substitution, orientation effect as exemplified by various functional groups.

Structure-Reactivity Correlations: Acids and bases, electronic and steric effects, optical and geometrical isomerism, tautomerism, concept of aromaticity

SECTION I. BIOCHEMISTRY

Organization of life. Importance of water. Cell structure and organelles. Structure and function of biomolecules: Carbohydrates, Lipids, Proteins and Nucleic acids. Biochemical separation techniques. Spectroscopic methods; UV-visible and fluorescence. Protein structure, folding and function: Myoglobin, Hemoglobin, Lysozyme, ribonuclease A, Carboxypeptidase and Chymotrypsin. Enzyme kinetics and regulation, Coenzymes.

Metabolism and bioenergitics. Generation and utilization of ATP. Photosynthesis. Major metabolic pathways and their regulation. Biological membranes. Transport across membranes. Signal transduction; hormones and neurotransmitters.

DNA replication, transcription and translation. Biochemical regulation of gene expression. Recombinant DNA technology and applications. Genomics and Proteomics.

The immune system. Active and passive immunity. Complement system. Antobody structure, function and diversity. Cells of the immune system: T, B and macrophages. T and B cell activation. Major histocompatibilty complex. T cell receptor. Immunological techniques: Immunodiffusion, immunoelectrophoresis, RIA and ELISA.

SECTION J. BIOTECHNOLOGY

Recombinant DNA technology for the production of therapeutic proteins. Micro array technology. Heterologous protein expression systems in bacteria, yeast etc.

Architecture of plant genome; plant tissue culture techniques; methods of gene transfer into plant cells; manipulation of phenotypic traits in plants; plant cell fermentations and production of secondary metabolites using suspension/ immobilized cell culture; methods for plant micro propagation; crop improvement and development of transgenic plants. Expression of animal proteins in plants.

Animal cell metabolism and regulation; cell cycle; primary cell culture; nutritional requirements for animal cell culture; techniques for the mass culture of animal cell lines; production of vaccines; growth hormones and interferons using animal cell culture; cytokines-production and therapeutic uses; hybridoma technology; vectors for gene transfer and expression in animal cells. Transgenic animals and molecular pharming.

Microbial production of industrial enzymes; methods for immobilization of enzymes; kinetics of soluble and immobilized enzymes; application of soluble and immobilized enzymes; enzyme-based sensors.

Microbial growth kinetics; batch, fed batch and continuous culture of microbial cells; media for industrial fermentations; sterilization of air and media; design features and operation of stirred tank, air-lift and fluidized bed reactors; aeration and agitation in aerobic fermentations; recovery and purification of fermentation products- filtration, centrifugation, cell disintegration, solvent extraction and chromatographic separations; industrial fermentations for the production of ethanol, citric acid, lysine, penicillin and other biomolecules; simple calculations based on material and energy balance of fermentation processes; application of microbes in the management of domestic and industrial wastes.

SECTION K. BOTANY

Anatomy: Roots, stem and leaves of land plants, meristems, vascular system, their ontogeny, structure and functions. Plant cell structure, organisation, organelles, cytoskeleton, cell wall and membranes.

Development: Cell cycle, cell division, senescence, hormonal regulation of growth; life cycle of an angiosperm, pollination, fertilization, embryogenesis, seed formation, seed storage proteins, seed dormancy and germination. Concept of cellular totipotency, organogenesis and somatic embryogenesis, somaclonal variation, embryo culture, in vitro fertilization.

Physiology and Biochemistry: Plant water relations, transport of minerals and solutes, N2 metabolism, proteins and nucleic acid, respiration, photophysiology, photosynthesis, photorespiration; biosynthesis, mechanism of action and physiological effects of plant growth regulators.

Genetics: Principles of Mendelian inheritance, linkage, recombination and genetic mapping; extrachromosomal inheritance; eukaryotic genome organization (chromatin structure) and regulation of gene expression, gene mutation, chromosome aberrations (numerical and structural), transposons.

Plant Breeding: Principles, methods - selection, hybridization, heterosis; male sterility, self and inter-specific incompatibility; haploidy; somatic cell hybridization; molecular marker-assisted selection; gene transfer methods viz. direct and vector-mediated, transgenic plants and their applications in agriculture.

Economic Botany: Economically important plants - cereals, pulses, plants yielding fiber, timber, sugar, beverages, oils, rubber, dyes, gums, drugs and narcotics - a general account.

Systematics: Systems of classification (non-phylogenetic vs. phylogenetic - outline), plant groups, molecular systematics.

Plant Pathology: Nature and classification of plant diseases, diseases of important crops caused by fungi, bacteria and viruses, and their control measures, mechanism(s) of pathogenesis and resistance, molecular detection of pathogens; plant-microbe beneficial interactions.

Ecology and Plant Geography: Ecosystems - types, dynamics, degradation, ecological succession; food chains; vegetation types of the world; pollution and global warming; speciation and extinction, conservation strategies, cryopreservation.

SECTION L. MICROBIOLOGY

Historical perspective - Discovery of the microbial world; Controversy over spontaneous generation; Role of microorganisms in transformation of organic matter and in the causation of diseases.

Methods in microbiology - Pure culture techniques; Theory and practice of sterilization; Principles of microbial nutrition; Construction of culture media; Enrichment culture techniques for isolation of chemoautotrophs, chemoheterotrophs and photosynthetic microorganisms.

Microbial evolution, systematics and taxonomy - Evolution of earth and earliest life forms; Primitive organisms and their metabolic strategies; New approaches to bacterial taxonomic classification including ribotyping; Nomenclature.

Microbial diversity - Bacteria, archea and their broad classification; Eukaryotic microbes, yeast, fungi, slime mold and protozoa; Viruses and their classification.

Microbial growth -The definition of growth, mathematical expression of growth, growth curve, measurement of growth and growth yields; Synchronous growth; Continuous culture.

Nutrition and metabolism - Overview of metabolism; Microbial nutrition; Energy classes of microorganisms; Culture media; Energetics, modes of ATP generation; ATP generation by heterotrophs; Fermentation; Glycolysis; Respiration; The citric acid cycle; Electron transport systems; Alternate modes of energy generation; Pathways (anabolism) in the biosynthesis of amino acids, purines, pyrimidines and fatty acids.

Metabolic diversity among microorganisms - Photosynthesis in microorganisms; Role of chlorophylls, carotenoids and phycobilins; Calvin cycle; Chemolithotrophy; Hydrogen- iron- nitrite-oxidizing bacteria; Nitrate and sulfate reduction; Methanogenesis and acetogenesis.

Prokaryotic cells: structure-function - Cells walls of eubacteria (peptidoglycan) and related molecules; Outer-membrane of gram-negative bacteria; Cell wall and cell membrane synthesis; Flagella and motility; Cell inclusions like endospores, gas vesicles.

Microbial diseases and host parasite relationships - Normal microflora of skin; Oral cavity; Gastrointestinal tract; Entry of pathogens into the host; Infectious disease transmission; Respiratory infections caused by bacteria and viruses; Tuberculosis; Sexually transmitted diseases including AIDS; Diseases transmitted by animals (Rabies, plague), insects and ticks (rikettsias, Lyme disease, malaria); Food and water borne diseases; Public health and water quality; Pahtogenic fungi; Emerging and resurgent infectious diseases.

Chemotherapy/Antibiotics - Antimicrobial agents; Sulfa drugs; Antibiotics; Pencillins and cephalosporins; Broad-spectrum antibiotics; Antibiotics from prokaryotes; Antifungal antibiotics; Mode of action; Resistance to antibiotics.

Microbial genetics - Genes, mutation and mutagenesis - UV and chemical mutagnes; Types of mutations; Ames test for mutagenesis; Methods of genetic analysis. Bacterial genetic system - Transformation; Conjugation; Transduction; Recombination; Plasmids and Transposons; Bacterial genetic map with reference to E. coli. Viruses and their genetic system - Phage ? and its life cycle; RNA phages; RNA viruses; Retroviruses; Genetic systems of yeast and Neurospora; Extrachromosomal inheritance and mitochondrial genetics; Basic concept of genomics.

SECTION M. ZOOLOGY

Animal world: Animal diversity, distribution, systematic and classification of animals, the phylogenetic relationship.

Evolution: Origin of life, history of life on earth, evolutionary theories, natural selection, adaptation, speciation.

Genetics: Principles of inheritance, molecular basis of heredity, the genetic material, transmission of genetic material, mutations, cytoplasmic inheritance.

Biochemistry and Molecular Biology: Nucleic acids, proteins and other biological macromolecules. Replication, transcription and translation, regulation of gene expression, organization of genome, Kreb's cycle, glycolysis, enzyme catalysis, hormones and their action.

Cell Biology: Structure of cell, cellular organelles and their structure and function, cell cycle, cell division, cellular differentiation, chromosome and chromatin structure. Eukaryotic gene organisation and expression.

Animal Anatomy and Physiology: Comparative physiology, the respiratory system, circulatory system, digestive system, the nervous system, the excretory system, the endocrine system, the reproductive system, the skeletal system, osmoregulation.

Parasitology and Immunology: Nature of parasite, host-parasite relation, protozoan and helminthic parasites, the immune response, cellular and humoral immune response, evolution of the immune system.

Development Biology: Embryonic development, cellular differentiation, organogenesis, metamorphosis, genetic basis of development.

Ecology: The ecosystem, habitats the food chain, population dynamics, species diversity, zoogeography, biogeochemical cycles, conservation biology.

Animal Behaviour: Types of behaviours, courtship, mating and territoriality, instinct, learning and memory, social behaviour across the animal taxa, communication, pheromones, evolution of animal behaviour.

IT - INFORMATION TECHNOLOGY

ENGINEERING MATHEMATICS

Mathematical Logic: Propositional Logic; First Order Logic.

Probability: Conditional Probability; Mean, Median, Mode and Standard Deviation; Random Variables; Distributions; uniform, normal, exponential, Poisson, Binomial.

Set Theory & Algebra: Sets; Relations; Functions; Groups; Partial Orders; Lattice; Boolean Algebra.

Combinatorics: Permutations; Combinations; Counting; Summation; generating functions; recurrence relations; asymptotics.

Graph Theory: Connectivity; spanning trees; Cut vertices & edges; covering; matching; independent sets; Colouring; Planarity; Isomorphism.

Linear Algebra: Algebra of matrices, determinants, systems of linear equations, Eigen values and Eigen vectors.

Numerical Methods: LU decomposition for systems of linear equations; numerical solutions of non linear algebraic equations by Secant, Bisection and Newton-Raphson Methods; Numerical integration by trapezoidal and Simpson's rules.

Calculus: Limit, Continuity & differentiability, Mean value Theorems, Theorems of integral calculus, evaluation of definite & improper integrals, Partial derivatives, Total derivatives, maxima & minima.

FORMAL LANGUAGES AND AUTOMATA

Regular Languages: finite automata, regular expressions, regular grammar.

Context free languages: push down automata, context free grammars

COMPUTER HARDWARE

Digital Logic: Logic functions, minimization, design and synthesis of combinatorial and sequential circuits, number representation and computer arithmetic (fixed and floating point)

Computer organization: Machine instructions and addressing modes, ALU and data path, hardwired and microprogrammed control, memory interface, I/O interface (interrupt and DMA mode), serial communication interface, instruction pipelining, cache, main and secondary storage

SOFTWARE SYSTEMS

Data structures and Algorithms: the notion of abstract data types, stack, queue, list, set, string, tree, binary search tree, heap, graph, tree and graph traversals, connected components, spanning trees, shortest paths, hashing, sorting, searching, design techniques (greedy, dynamic, divide and conquer), asymptotic analysis (best, worst, average cases) of time and space, upper and lower bounds, intractability

Programming Methodology: C programming, program control (iteration, recursion, functions), scope, binding, parameter passing, elementary concepts of object oriented programming

Operating Systems (in the context of Unix): classical concepts (concurrency, synchronization, deadlock), processes, threads and interprocess communication, CPU scheduling, memory management, file systems, I/O systems, protection and security

Information Systems and Software Engineering: information gathering, requirement and feasibility analysis, data flow diagrams, process specifications, input/output design, process life cycle, planning and managing the project, design, coding, testing, implementation, maintenance.

Databases: relational model, database design, integrity constraints, normal forms, query languages (SQL), file structures (sequential, indexed), b-trees, transaction and concurrency control

Data Communication: data encoding and transmission, data link control, multiplexing, packet switching, LAN architecture, LAN systems (Ethernet, token ring), Network devices: switches, gateways, routers

Networks: ISO/OSI stack, sliding window protocols, routing protocols, TCP/UDP, application layer protocols & systems (http, smtp, dns, ftp), network security

Web technologies: three tier web based architecture; JSP, ASP, J2EE, .NET systems; html, XML

AG - AGRICULTURAL ENGINEERING

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

FARM MACHINERY AND POWER:

Sources of power on the farm-human, animal, mechanical, electrical, wind, solar and biomass; design and selection of machine elements - gears, pulleys, chains and sprockets and belts; overload safety devices used in farm machinery; measurement of force, torque, speed, displacement and acceleration on machine elements.

Soil tillage; forces acting on a tillage tool; hitch systems and hitching of tillage implements; functional requirements, principles of working, construction and operation of manual, animal and power operated equipment for tillage. sowing, planting, fertilizer application, inter-cultivation, spraying, mowing, chaff cutting, harvesting, threshing and transport; testing of agricultural machinery and equipment; calculation of performance parameters -field capacity, efficiency, application rate and losses; cost analysis of implements and tractors.

Thermodynamic principles of I.C. engines; I.C. engine cycles; engine components; fuels and combustion; lubricants and their properties; I.C. engine systems - fuel, cooling, lubrication, ignition, electrical, intake and exhaust; selection, operation, maintenance and repair of I.C. engines; power efficiencies and measurement; calculation of power, torque, fuel consumption, heat load and power losses.

Tractors and power tillers - type, selection, maintenance and repair; tractor clutches and brakes; power transmission systems - gear trains, differential, final drives and power take-off; mechanics of tractor chassis; traction theory; three point hitches- free link and restrained link operations; mechanical steering and hydraulic control systems used in tractors; human engineering and safety in tractor design; tractor tests and performance.

SOIL AND WATER CONSERVATION ENGINEERING:

Ideal and real fluids, properties of fluids; hydrostatic pressure and its measurement; hydrostatic forces on plane and curved surface; continuity equation; Bernoulli's theorem; laminar and turbulent flow in pipes, Darcy-Weisbach and Hazen-Williams equations, Moody's diagram; flow through orifices and notches; flow in open channels.

Engineering properties of soils, fundamental definitions and relationships; index properties of soils; permeability and seepage analysis; shear strength, Mohr's circle of stresses; active and passive earth pressures; stability of slopes.

Hydrological cycle; precipitation measurement, analysis of precipitation data; abstraction from precipitation; runoff; hydrograph analysis, unit hydrograph theory and application; stream flow measurement; flood routing, hydrological reservoir and channel routing.

Mechanics of soil erosion, factors affecting erosion; soil loss estimation; biological and engineering measures to control erosion, terraces and bunds; vegetative waterways; gully control structures, drop, drop inlet and chute spillways; farm ponds; earthen dams; principles of watershed management.

Water requirement of crops; consumptive use and evapo-transpiration; irrigation scheduling; irrigation efficiencies; design of prismatic and silt loaded channels; methods of irrigation water application; design and evaluation of irrigation methods; drainage coefficient; surface and subsurface drainage systems; leaching requirement and salinity control; irrigation and drainage water quality; classification of pumps; pump characteristics; pump selection; types of aquifer; evaluation of aquifer properties; well hydraulics; ground water recharge.

AGRICULTURAL PROCESSING AND FOOD ENGINEERING:

Steady state heat transfer in conduction, convection and radiation; transient heat transfer in simple geometry; condensation and boiling heat transfer; working principles of heat exchangers; diffusive and convective mass transfer; simultaneous heat and mass transfer in agricultural processing operations.

Material and energy balances in food processing systems; water activity, sorption and desorption isotherms; centrifugal separation of solids, liquids and gases; kinetics of microbial death - pasteurisation and sterilization of liquid foods; preservation of food by cooling and freezing; psychrometry - properties of air-vapour mixture; concentration and dehydration of liquid foods - evaporators, tray, drum and spray dryers.

Mechanics and energy requirement in size reduction of granular solids; particle size analysis for comminuted solids; size separation by screening; fluidisation of granular solids; cleaning and grading efficiency and effectiveness of grain cleaners; conditioning and hydrothermal treatments for grains; dehydration of food grains; processes and machines for processing of cereals, pulses and oilseeds; design considerations for grain silos.

AR - ARCHITECTURE AND PLANNING

City planning: Historical development of cities; principles of city planning; new towns; survey methods, site planning, planning regulations and building bye-laws.

Housing: Concept of shelter; housing policies and design; community planning; role of government agencies; finance and management.

Landscape Design: Principles of landscape design and site planning; history and landscape styles; landscape elements and materials; planting design.

Computer Aided Design: Application of computers in architecture and planning; understanding elements of hardware and software; computer graphics; programming languages - C and Visual Basic and usage of packages such as AutoCAD.

Environmental and Building Science: Elements of environmental science; ecological principles concerning environment; role of micro-climate in design; climatic control through design elements; thermal comfort; elements of solar architecture; principles of lighting and illumination; basic principles of architectural acoustics; air pollution, noise pollution and their control.

Visual and Urban Design: Principles of visual composition; proportion, scale, rhythm, symmetry, harmony, balance, form and colour; sense of place and space, division of space; focal point, vista, imageability, visual survey.

History of Architecture: Indian - Indus valley, Vedic, Buddhist, Indo-Aryan, Dravidian and Mughal periods; European - Egyptian, Greek, Roman, medieval and renaissance periods.

Development of Contemporary Architecture: Architectural developments and impacts on society since industrial revolution; influence of modern art on architecture; works of national and international architects; post modernism in architecture.

Building Services: Water supply, Sewerage and Drainage systems; Sanitary fittings and fixtures; principles of electrification of buildings; elevators, their standards and uses; air-conditioning systems; fire fighting systems.

Building Construction and Management: Building construction techniques, methods and details; building systems and prefabrication of building elements; principles of modular coordination; estimation, specification, valuation, professional practice; project management, PERT, CPM.

Materials and Structural Systems: Behavioural characteristics of all types of building materials e.g. mud, timber, bamboo, brick, concrete, steel, glass, FRP; principles of strength of materials; design of structural elements in wood, steel and RCC; elastic and limit state design; complex structural systems; principles of pre-stressing.

Planning Theory: Planning process; multilevel planning; comprehensive planning; central place theory; settlement pattern; land use and land utilization.

Techniques of Planning: Planning surveys; Preparation of urban and regional structure plans, development plans, action plans; site planning principles and design; statistical methods; application of remote sensing techniques in urban and regional planning.

Traffic and Transportation Planning: Principles of traffic engineering and transportation planning; methods of conducting surveys; design of roads, intersections and parking areas; hierarchy of roads and levels of services; traffic and transport management in urban areas; traffic safety and traffic laws; public transportation planning; modes of transportation.

Services and Amenities: Principles and design of water supply systems, sewerage systems, solid waste disposal systems, power supply and communication systems; Health, education, recreation and demography related standards at various levels of the settlements.

Development Administration and Management: Planning laws; development control and zoning regulations; laws relating to land acquisition; development enforcements, land ceiling; regional and urban plan preparations; planning and municipal administration; taxation, revenue resources and fiscal management; public participation and role of NGO.

CE - CIVIL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

STRUCTURAL ENGINEERING

Mechanics: Bending moments and shear forces in statically determinate beams; simple stress and strain: relationship; stress and strain in two dimensions, principal stresses, stress transformation, Mohr's circle; simple bending theory; flexural shear stress; thin-walled pressure vessels; uniform torsion.

Structural Analysis: Analysis of statically determinate trusses, arches and frames; displacements in statically determinate structures and analysis of statically indeterminate structures by force/energy methods; analysis by displacement methods (slope-deflection and moment-distribution methods); influence lines for determinate and indeterminate structures; basic concepts of matrix methods of structural analysis.

Concrete Structures: Basic working stress and limit states design concepts; analysis of ultimate load capacity and design of members subject to flexure, shear, compression and torsion (beams, columns and isolated footings); basic elements of prestressed concrete: analysis of beam sections at transfer and service loads.

Steel Structures: Analysis and design of tension and compression members, beams and beam-columns, column bases; connections - simple and eccentric, beam-column connections, plate girders and trusses; plastic analysis of beams and frames.

GEOTECHNICAL ENGINEERING

Soil Mechanics: Origin of soils; soil classification; three-phase system, fundamental definitions, relationship and inter-relationships; permeability and seepage; effective stress principle: consolidation, compaction; shear strength.

Foundation Engineering: Sub-surface investigation - scope, drilling bore holes, sampling, penetrometer tests, plate load test; earth pressure theories, effect of water table, layered soils; stability of slopes - infinite slopes, finite slopes; foundation types - foundation design requirements; shallow foundations; bearing capacity, effect of shape, water table and other factors, stress distribution, settlement analysis in sands and clays; deep foundations - pile types, dynamic and static formulae, load capacity of piles in sands and clays.

WATER RESOURCES ENGINEERING

Fluid Mechanics and Hydraulics: Hydrostatics, applications of Bernoulli equation, laminar and turbulent flow in pipes, pipe networks; concept of boundary layer and its growth; uniform flow, critical flow and gradually varied flow in channels, specific energy concept, hydraulic jump; forces on immersed bodies; flow measurement in channels; tanks and pipes; dimensional analysis and hydraulic modeling. Applications of momentum equation, potential flow, kinematics of flow; velocity triangles and specific speed of pumps and turbines.

Hydrology: Hydrologic cycle; rainfall; evaporation infiltration, unit hydrographs, flood estimation, reservoir design, reservoir and channel routing, well hydraulics.

Irrigation: Duty, delta, estimation of evapo-transpiration; crop water requirements; design of lined and unlined canals; waterways; head works, gravity dams and Ogee spillways. Designs of weirs on permeable foundation, irrigation methods.

ENVIRONMENTAL ENGINEERING

Water requirements; quality and standards, basic unit processes and operations for water treatment, distribution of water. Sewage and sewerage treatment: quantity and characteristic of waste water sewerage; primary and secondary treatment of waste water; sludge disposal; effluent discharge standards.

TRANSPORTATION ENGINEERING

Highway planning; geometric design of highways; testing and specifications of paving materials; design of flexible and rigid pavements.

CH - CHEMICAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

CHEMICAL ENGINEERING

Process Calculations and Thermodynamics: Laws of conservation of mass and energy; use of tie components; recycle, bypass and purge calculations; degree of freedom analysis.

First and Second laws of thermodynamics and their applications; equations of state and thermodynamic properties of real systems; phase equilibria; fugacity, excess properties and correlations of activity coefficients; chemical reaction equilibria.

Fluid Mechanics and Mechanical Operations: Fluid statics, Newtonian and non-Newtonian fluids, Bernoulli equation, Macroscopic friction factors, energy balance, dimensional analysis, shell balances, flow through pipeline systems, flow meters, pumps and compressors, packed and fluidized beds, elementary boundary layer theory, size reduction and size separation; free and hindered settling; centrifuge and cyclones; thickening and classification, filtration, mixing and agitation; conveying of solids.

Heat Transfer: Conduction, convection and radiation, heat transfer coefficients, steady and unsteady heat conduction, boiling, condensation and evaporation; types of heat exchangers and evaporators and their design.

Mass Transfer: Fick's law, molecular diffusion in fluids, mass transfer coefficients, film, penetration and surface renewal theories; momentum, heat and mass transfer analogies; stagewise and continuous contacting and stage efficiencies; HTU & NTU concepts design and operation of equipment for distillation, absorption, leaching, liquid-liquid extraction, crystallization, drying, humidification, dehumidification and adsorption.

Chemical Reaction Engineering: Theories of reaction rates; kinetics of homogeneous reactions, interpretation of kinetic data, single and multiple reactions in ideal reactors, non-ideal reactors; residence time; non-isothermal reactors; kinetics of heterogeneous catalytic reactions; diffusion effects in catalysis.

Instrumentation and Process Control: Measurement of process variables; sensors, transducers and their dynamics, dynamics of simple systems, dynamics such as CSTRs, transfer functions and responses of simple systems, process reaction curve, controller modes (P, PI, and PID); control valves; analysis of closed loop systems including stability, frequency response (including Bode plots) and controller tuning, cascade, feed forward control.

Plant Design and Economics: Design and sizing of chemical engineering equipment such as compressors, heat exchangers, multistage contactors; principles of process economics and cost estimation including total annualized cost, cost indexes, rate of return, payback period, discounted cash flow, optimization in Design.

Chemical Technology: Inorganic chemical industries; sulfuric acid, NaOH, fertilizers (Ammonia, Urea, SSP and TSP); natural products industries (Pulp and Paper, Sugar, Oil, and Fats); petroleum refining and petrochemicals; polymerization industries; polyethylene, polypropylene, PVC and polyester synthetic fibers.

CS - COMPUTER SCIENCE AND ENGINEERING

ENGINEERING MATHEMATICS

Mathematical Logic: Propositional Logic; First Order Logic.

Probability: Conditional Probability; Mean, Median, Mode and Standard Deviation; Random Variables; Distributions; uniform, normal, exponential, Poisson, Binomial.

Set Theory & Algebra: Sets; Relations; Functions; Groups; Partial Orders; Lattice; Boolean Algebra.

Combinatorics: Permutations; Combinations; Counting; Summation; generating functions; recurrence relations; asymptotics.

Graph Theory: Connectivity; spanning trees; Cut vertices & edges; covering; matching; independent sets; Colouring; Planarity; Isomorphism.

Linear Algebra: Algebra of matrices, determinants, systems of linear equations, Eigen values and Eigen vectors.

Numerical Methods: LU decomposition for systems of linear equations; numerical solutions of non linear algebraic equations by Secant, Bisection and Newton-Raphson Methods; Numerical integration by trapezoidal and Simpson's rules.

Calculus: Limit, Continuity & differentiability, Mean value Theorems, Theorems of integral calculus, evaluation of definite & improper integrals, Partial derivatives, Total derivatives, maxima & minima.

THEORY OF COMPUTATION

Formal Languages and Automata Theory: Regular languages and finite automata, Context free languages and Push-down automata, Recursively enumerable sets and Turing machines, Un-decidability;

Analysis of Algorithms and Computational Complexity: Asymptotic analysis (best, worst, average case) of time and space, Upper and lower bounds on the complexity of specific problems, NP-completeness.

COMPUTER HARDWARE

Digital Logic: Logic functions, Minimization, Design and synthesis of Combinational and Sequential circuits; Number representation and Computer Arithmetic (fixed and floating point);

Computer Organization: Machine instructions and addressing modes, ALU and Data-path, hardwired and micro-programmed control, Memory interface, I/O interface (Interrupt and DMA mode), Serial communication interface, Instruction pipelining, Cache, main and secondary storage.

SOFTWARE SYSTEMS

Data structures: Notion of abstract data types, Stack, Queue, List, Set, String, Tree, Binary search tree, Heap, Graph;

Programming Methodology: C programming, Program control (iteration, recursion, Functions), Scope, Binding, Parameter passing, Elementary concepts of Object oriented, Functional and Logic Programming;

Algorithms for problem solving: Tree and graph traversals, Connected components, Spanning trees, Shortest paths; Hashing, Sorting, Searching; Design techniques (Greedy, Dynamic Programming, Divide-and-conquer);

Compiler Design: Lexical analysis, Parsing, Syntax directed translation, Runtime environment, Code generation, Linking (static and dynamic); Operating Systems: Classical concepts (concurrency, synchronization, deadlock), Processes, threads and Inter-process communication, CPU scheduling, Memory management, File systems, I/O systems, Protection and security.

Databases: Relational model (ER-model, relational algebra, tuple calculus), Database design (integrity constraints, normal forms), Query languages (SQL), File structures (sequential files, indexing, B+ trees), Transactions and concurrency control;

Computer Networks: ISO/OSI stack, sliding window protocol, LAN Technologies (Ethernet, Token ring), TCP/UDP, IP, Basic concepts of switches, gateways, and routers.

CH - CHEMISTRY

PHYSICAL CHEMISTRY

Structure: Quantum theory - principles and techniques; applications to particle in a box, harmonic oscillator, rigid rotor and hydrogen atom; valence bond and molecular orbital theories and Huckel approximation, approximate techniques: variation and perturbation; symmetry, point groups; rotational, vibrational, electronic, NMR and ESR spectroscopy.

Equilibrium: First law of thermodynamics, heat, energy and work; second law of thermodynamics and entropy; third law and absolute entropy; free energy; partial molar quantities; ideal and non-ideal solutions; phase transformation: phase rule and phase diagrams- one, two, and three component systems; activity, activity coefficient, fugacity and fugacity coefficient ; chemical equilibrium, response of chemical equilibrium to temperature and pressure; colligative properties; kinetic theory of gases; thermodynamics of electrochemical cells; standard electrode potentials: applications - corrosion and energy conversion; molecular partition function (translational, rotational, vibrational and electronic).

Kinetics: Rates of chemical reactions, theories of reaction rates, collision and transition state theory; temperature dependence of chemical reactions; elementary reactions, consecutive elementary reactions; steady state approximation, kinetics of photochemical reactions and free radical polymerization, homogenous and heterogeneous catalysis.

INORGANIC CHEMISTRY

Non-Transition Elements: General characteristics, structure and reactions of simple and industrially important compounds, boranes, carboranes, silicates, silicones, diamond and graphite; hydrides, oxides and oxoacids of N, P, S and halogens; boron nitride, borazines and phosphazenes; xenon compounds. Shapes of molecules, hard-soft acid base concept.

Transition Elements: General characteristics of d and f block elements; coordination chemistry: structure and isomerism, stability, theories of metal-ligand bonding (CFT and LFT), electronic spectra and magnetic properties of transition metal complexes and lanthanides; metal carbonyls, metal-metal bonds and metal atom clusters, metallocenes; transition metal complexes with bonds to hydrogen, alkyls, alkenes, and arenes; metal carbenes; use of organometallic compounds as catalysts in organic synthesis; mechanisms of substitution and electron transfer reactions of coordination complexes. Role of metals with special reference to Na, K, Mg, Ca, Fe, Co, Zn, and Mo in biological systems.

Solids: Crystal systems and lattices, Miller planes, crystal packing, crystal defects; Bragg's Law; ionic crystals, band theory, metals and semiconductors. Spinels.

Instrumental methods of analysis: atomic absorption, UV-visible spectrometry, chromatographic and electro-analytical methods.

ORGANIC CHEMISTRY

Synthesis, reactions and mechanisms involving the following: Alkenes, alkynes, arenes, alcohols, phenols, aldehydes, ketones, carboxylic acids and their derivatives; halides, nitro compounds and amines; stereochemical and conformational effects on reactivity and specificity; reactions with diborane and peracids. Michael reaction, Robinson annulation, reactivity umpolung, acyl anion equivalents; molecular rearrangements involving electron deficient atoms.

Photochemistry: Basic principles, photochemistry of olefins, carbonyl compounds, arenes, photo oxidation and reduction.

Pericyclic reactions: Cycloadditions, electrocyclic reactions, sigmatropic reactions; Woodward-Hoffmann rules.

Heterocycles: Structural properties and reactions of furan, pyrrole, thiophene, pyridine, indole.

Biomolecules: Structure, properties and reactions of mono- and di-saccharides, physico-chemical properties of amino acids, structural features of proteins and nucleic acids.

Spectroscopy: Principles and applications of IR, UV-visible, NMR and mass spectrometry in the determination of structures of organic compounds.

EC - ELECTRONICS AND COMMUNICATION ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix Algebra, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Mean value theorems, Theorems of integral calculus, Evaluation of definite and improper integrals, Partial Derivatives, Maxima and minima, Multiple integrals, Fourier series. Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equation (linear and nonlinear), Higher order linear differential equations with constant coefficients, Method of variation of parameters, Cauchy's and Euler's equations, Initial and boundary value problems, Partial Differential Equations and variable separable method.

Complex variables: Analytic functions, Cauchy's integral theorem and integral formula, Taylor's and Laurent' series, Residue theorem, solution integrals.

Probability and Statistics: Sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Discrete and continuous distributions, Poisson, Normal and Binomial distribution, Correlation and regression analysis.

Numerical Methods: Solutions of non-linear algebraic equations, single and multi-step methods for differential equations.

Transform Theory: Fourier transform, Laplace transform, Z-transform.

ELECTRONICS & COMMUNICATION ENGINEERING

Networks: Network graphs: matrices associated with graphs; incidence, fundamental cut set and fundamental circuit matrices. Solution methods: nodal and mesh analysis. Network theorems: superposition, Thevenin and Norton's maximum power transfer, Wye-Delta transformation. Steady state sinusoidal analysis using phasors. Linear constant coefficient differential equations; time domain analysis of simple RLC circuits, Solution of network equations using Laplace transform: frequency domain analysis of RLC circuits. 2-port network parameters: driving point and transfer functions. State equations for networks.

Electronic Devices: Energy bands in silicon, intrinsic and extrinsic silicon. Carrier transport in silicon: diffusion current, drift current, mobility, resistivity. Generation and recombination of carriers. p-n junction diode, Zener diode, tunnel diode, BJT, JFET, MOS capacitor, MOSFET, LED, p-I-n and avalanche photo diode, LASERs. Device technology: integrated circuits fabrication process, oxidation, diffusion, ion implantation, photolithography, n-tub, p-tub and twin-tub CMOS process.

Analog Circuits: Equivalent circuits (large and small-signal) of diodes, BJTs, JFETs, and MOSFETs. Simple diode circuits, clipping, clamping, rectifier. Biasing and bias stability of transistor and FET amplifiers. Amplifiers: single-and multi-stage, differential, operational, feedback and power. Analysis of amplifiers; frequency response of amplifiers. Simple op-amp circuits. Filters. Sinusoidal oscillators; criterion for oscillation; single-transistor and op-amp configurations. Function generators and wave-shaping circuits. Power supplies.

Digital circuits: Boolean algebra, minimization of Boolean functions; logic gates digital IC families (DTL, TTL, ECL, MOS, CMOS). Combinational circuits: arithmetic circuits, code converters, multiplexers and decoders. Sequential circuits: latches and flip-flops, counters and shift-registers. Sample and hold circuits, ADCs, DACs. Semiconductor memories. Microprocessor(8085): architecture, programming, memory and I/O interfacing.

Signals and Systems: Definitions and properties of Laplace transform, continuous-time and discrete-time Fourier series, continuous-time and discrete-time Fourier Transform, z-transform. Sampling theorems. Linear Time-Invariant (LTI) Systems: definitions and properties; casuality, stability, impulse response, convolution, poles and zeros frequency response, group delay, phase delay. Signal transmission through LTI systems. Random signals and noise: probability, random variables, probability density function, autocorrelation, power spectral density.

Controls Systems: Basic control system components; block diagrammatic description, reduction of block diagrams. Open loop and closed loop (feedback) systems and stability analysis of these systems. Signal flow graphs and their use in determining transfer functions of systems; transient and steady state analysis of LTI control systems and frequency response. Tools and techniques for LTI control system analysis: root loci, Routh-Hurwitz criterion, Bode and Nyquist plots. Control system compensators: elements of lead and lag compensation, elements of Proportional-Integral-Derivative(PID) control. State variable representation and solution of state equation of LTI control systems.

Communications: Analog communication systems: amplitude and angle modulation and demodulation systems, spectral analysis of these operations, superheterodyne receivers; elements of hardware, realizations of analog communication systems; signal-to-noise ratio (SNR) calculations for amplitude modulation (AM) and frequency modulation (FM) for low noise conditions. Digital communication systems: pulse code modulation (PCM), differential pulse code modulation (DPCM), delta modulation (DM); digital modulation schemes-amplitude, phase and frequency shift keying schemes (ASK, PSK, FSK), matched filter receivers, bandwith consideration and probability of error calculations for these schemes.

Electromagnetics: Elements of vector calculus: divergence and curl; Gauss' and Stokes' theorems, Maxwell's equations: differential and integral forms. Wave equation, Poynting vector. Plane waves: propagation through various media; reflection and refraction; phase and group velocity; skin depth. Transmission lines: characteristic impedance; impedance transformation; Smith chart; impedance matching; pulse excitation. Waveguides: modes in rectangular waveguides; boundary conditions; cut-off frequencies; dispersion relations. Antennas: Dipole antennas; antenna arrays; radiation pattern; reciprocity theorem, antenna gain.

EE - ELECTRICAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix Algebra, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Mean value theorems, Theorems of integral calculus, Evaluation of definite and improper integrals, Partial Derivatives, Maxima and minima, Multiple integrals, Fourier series. Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equation (linear and nonlinear), Higher order linear differential equations with constant coefficients, Method of variation of parameters, Cauchy's and Euler's equations, Initial and boundary value problems, Partial Differential Equations and variable separable method.

Complex variables: Analytic functions, Cauchy's integral theorem and integral formula, Taylor's and Laurent' series, Residue theorem, solution integrals.

Probability and Statistics: Sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Discrete and continuous distributions, Poisson, Normal and Binomial distribution, Correlation and regression analysis.

Numerical Methods: Solutions of non-linear algebraic equations, single and multi-step methods for differential equations.

Transform Theory: Fourier transform, Laplace transform, Z-transform.

ELECTRICAL ENGINEERING

Electrical Circuits and Fields: Network graph, KCL, KVL, node/ cut set, mesh/ tie set analysis, transient response of d.c. and a.c. networks; sinusoidal steady-state analysis; resonance in electrical circuits; concepts of ideal voltage and current sources, network theorems, driving point, immittance and transfer functions of two port networks, elementary concepts of filters; three phase circuits; Fourier series and its application; Gauss theorem, electric field intensity and potential due to point, line, plane and spherical charge distribution, dielectrics, capacitance calculations for simple configurations; Ampere's and Biot-Savart's law, inductance calculations for simple configurations.

Electrical Machines: Single phase transformer - equivalent circuit, phasor diagram, tests, regulation and efficiency; three phase transformers - connections, parallel operation; auto transformer and three-winding transformer; principles of energy conversion, windings of rotating machines: D. C. generators and motors - characteristics, starting and speed control, armature reaction and commutation; three phase induction motors-performance characteristics, starting and speed control; single-phase induction motors; synchronous generators-performance, regulation, parallel operation; synchronous motors - starting, characteristics, applications, synchronous condensers; fractional horse power motors; permanent magnet and stepper motors.

Power Systems: Electric power generation - thermal, hydro, nuclear; transmission line parameters; steady-state performance of overhead transmission lines and cables and surge propagation; distribution systems, insulators, bundle conductors, corona and radio interference effects; per-unit quantities; bus admittance and impedance matrices; load flow; voltage control and power factor correction; economic operation; symmetrical components, analysis of symmetrical and unsymmetrical faults; principles of over current, differential and distance protections; concept of solid state relays and digital protection; circuit breakers; concept of system stability-swing curves and equal area criterion; basic concepts of HVDC transmission.

Control Systems: Principles of feedback; transfer function; block diagrams: steady-state errors; stability-Routh and Nyquist criteria; Bode plots; compensation; root loci; elementary state variable formulation; state transition matrix and response for Linear Time Invariant systems.

Electrical and Electronic Measurements: Bridges and potentiometers, PMMC, moving iron, dynamometer and induction type instruments; measurement of voltage, current, power, energy and power factor; instrument transformers; digital voltmeters and multimeters; phase, time and frequency measurement; Q-meter, oscilloscopes, potentiometric recorders, error analysis.

Analog and Digital Electronics: Characteristics of diodes, BJT, FET, SCR; amplifiers-biasing, equivalent circuit and frequency response; oscillators and feedback amplifiers, operational amplifiers- characteristics and applications; simple active filters; VCOs and timers; combinational and sequential logic circuits, multiplexer, Schmitt trigger, multivibrators, sample and hold circuits, A/D and D/A converters; microprocessors and their applications.

Power Electronics and Electric Drives: Semiconductor power devices-diodes, transistors, thyristors, triacs, GTOs, MOSFETs and IGBTs - static characteristics and principles of operation; triggering circuits; phase control rectifiers; bridge converters-fully controlled and half controlled; principles of choppers and inverters, basic concepts of adjustable speed dc and ac drives.

GG - GEOLOGY AND GEOPHYSICS

PART - I

Earth and planetary system; size, shape, internal structure and composition of the earth; atmosphere and greenhouse effect; isostasy; elements of seismology; continents and continental processes; physical oceanography; palaeomagnetism, continental drift plate tectonics, geothermal energy.

Weathering; soil formation; action of river, wind and glacier; oceans and oceanic features; earthquakes, volcanoes, orogeny and mountain building; elements of structural geology; crystallography; classification, composition and properties of minerals and rocks; engineering properties of rocks and soils, role of geology in the construction of engineering structures.

Processes of ore formation, occurrence and distribution of ores on land and on ocean floor; coal and petroleum resources in India; ground water geology including well hydraulics, geological time scale and geochronology; stratigraphic principles and stratigraphy of India; basics concepts of gravity, magnetic and electrical prospecting for ores and ground water.

PART - IIA: GEOLOGY

Crystal symmetry, forms, twinning; crystal chemistry; optical mineralogy, classification of minerals, diagnostic properties of rock minerals.

Mineralogy, structure, texture and classification of igneous, sedimentary and metamorphic rock, their origin and evolution; application of thermodynamics; structure and petrology of sedimentary rocks; sedimentary processes and environments, sedimentary facies, basin studies; basement cover relationship;

Primary and secondary structures; geometry and genesis of folds, faults, joints, unconformities, cleavage, schistosity and lineation; methods of projection. Tectonites and their significance; shear zone; superposed folding.

Morphology, classification and geological significance of important invertebrates, vertebrates, microfossils and palaeoflora; stratigraphic principles and Indian stratigraphy; geomorphic processes and agents; development and evolution of landforms; slope and drainage; processes on deep oceanic and near-shore regions; quantitative and applied geomorphology; air photo interpretation and remote sensing; chemical and optical properties of ore minerals; formation and localization of ore deposits; prospecting and exploration of economic minerals; coal and petroleum geology; origin and distribution of mineral and fuel deposits in India; ore dressing and mineral economics.

Cosmic abundance; meteorites; geochemical evolution of the earth; geochemical cycles; distribution of major, minor and trace elements; isotope geochemistry; geochemistry of waters including solution equilibria and water rock interaction.

Engineering properties of rocks and soils; rocks as construction material; geology of dams, tunnels and excavation sites; natural hazards; the fly ash problem; ground water geology and exploration; water quality; impact of human activity; Remote sensing techniques for the interpretation of landforms and resource management.

PART - II B: GEOPHYSICS

The earth as a planet; different motions of the earth; gravity filed of the earth and its shape; geochronology; isostasy, seismology and interior of the earth; variation of density, velocity, pressure, temperature, electrical and magnetic properties inside the earth; earthquakes-causes and measurements; zonation and seismic hazards; geomagnetic field, palaeomagnetism; oceanic and continental lithosphere; plate tectonics; heat flow; upper and lower atmospheric phenomena.

Theories of scalar and vector potential fields; Laplace, Maxwell and Helmholtz equations for solution of different types of boundary value problems for Cartesian, cylindrical and spherical polar coordinates; Green's theorem; Image theory; integral equations and conformal transformations in potential theory; Eikonal equation and ray theory.

'G' and 'g' units of measurement, density of rocks, gravimeters, preparation, analysis and interpretation of gravity maps; derivative maps, analytical continuation; gravity anomaly type curves; calculation of mass.

Earth's magnetic field, units of measurement, magnetic susceptibility of rocks, magnetometers, corrections, preparation of magnetic maps, magnetic anomaly type curve, analytical continuation, interpretation and application; magnetic well logging.

Conduction of electricity through rocks, electrical conductivities of metals, metallic, non-metallic and rock forming minerals, D.C. resistivity units and methods of measurement, electrode configuration for sounding and profiling, application of filter theory, interpretation of resistivity field data, application; self potential origin, classification, field measurement, interpretation of induced polarization time frequency, phase domain; IP units and methods of measurement, interpretation and application; ground-water exploration.

Origin of electromagnetic field elliptic polarization, methods of measurement for different source-receiver configuration components in EM measurements, interpretation and applications; earth's natural electromagnetic field, tellurics, magneto-tellurics; geomagnetic depth sounding principles, methods of measurement, processing of data and interpretation.

Seismic methods of prospecting: Reflection, refraction and CDP surveys; land and marine seismic sources, generation and propagation of elastic waves, velocity increasing with depth, geophones, hydrophones, recording instruments (DFS), digital formats, field layouts, seismic noises and noise profile analysis, optimum geophone grouping, noise cancellation by shot and geophone arrays, 2D and 3D seismic data acquisition and processing, CDP stacking charts, binning, filtering, dip-moveout, static and dynamic corrections, deconvolution, migration, signal processing, Fourier and Hilbert transforms, attribute analysis, bright and dim spots, seismic stratigraphy, high resolution seismics, VSP.

Principles and techniques of geophysical well-logging, SP, resistivity, induction, micro gamma ray, neutron, density, sonic, temperature, dip meter, caliper, nuclear magnetic, cement bond logging. Quantitative evaluation of formations from well logs; well hydraulics and application of geophysical methods for groundwater study; application of bore hole geophysics in ground water, mineral and oil exploration. Remote sensing techniques and application of remote sensing methods in geophysics.

IN - INSTRUMENTATION ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix Algebra, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Mean value theorems, Theorems of integral calculus, Evaluation of definite and improper integrals, Partial Derivatives, Maxima and minima, Multiple integrals, Fourier series. Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equation (linear and nonlinear), Higher order linear differential equations with constant coefficients, Method of variation of parameters, Cauchy's and Euler's equations, Initial and boundary value problems, Partial Differential Equations and variable separable method.

Complex variables: Analytic functions, Cauchy's integral theorem and integral formula, Taylor's and Laurent' series, Residue theorem, solution integrals.

Probability and Statistics: Sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Discrete and continuous distributions, Poisson, Normal and Binomial distribution, Correlation and regression analysis.

Numerical Methods: Solutions of non-linear algebraic equations, single and multi-step methods for differential equations.

Transform Theory: Fourier transform, Laplace transform, Z-transform.

INSTRUMENTATION ENGINEERING

Measurement Basics and Metrology: Static and dynamic characteristics of measurement systems. Standards and calibration. Error and uncertainty analysis, statistical analysis of data, and curve fitting. Linear and angular measurements; Measurement of straightness, flatness, roundness and roughness.

Transducers, Mechanical Measurements and Industrial Instrumentation: Transducers - elastic, resistive, inductive, capacitive, thermo-electric, piezoelectric, photoelectric, electro-mechanical, electro-chemical, and ultrasonic. Measurement of displacement, velocity (linear and rotational), acceleration, shock, vibration, force, torque, power, strain, stress, pressure, flow, temperature, humidity, viscosity, and density. energy storing elements, suspension systems and dampers.

Analog Electronics: Characteristics of diodes, BJTs, JFETs and MOSFETs; Diode circuits; Amplifiers: single and multi-stage, feedback; Frequency response; Operational amplifiers - design, characteristic, linear and non-linear applications: difference amplifiers; instrumentation amplifiers; precision rectifiers, I-to-V converters, active filters, oscillators, comparators, signal generators, wave shaping circuits.

Digital Electronics: Combinational logic circuits, minimization of Boolean functions; IC families (TTL, MOS, CMOS), arithmetic circuits, multiplexer and decoders. Sequential circuits: flip-flops, counters, shift registers. Schmitt trigger, timers, and multivibrators. Analog switches, multiplexers, S/H circuits. Analog-to-digital and digital-to-analog converters. Basics of computer organization and architecture. 8-bit microprocessor (8085), applications, memory, I/O interfacing, and microcontrollers.

Signals and Systems: Vectors and matrices; Fourier series; Fourier transforms; Ordinary differential equations. Impulse and frequency responses of first and second order systems. Laplace transform and transfer function, convolution and correlation. Amplitude and frequency modulations and demodulations. Discrete time systems, difference equations, impulse and frequency responses; Z-transforms and transfer functions; IIR and FIR filters.

Electrical and Electronic Measurements: Measurement of R, L and C; bridges and potentiometers. Measurement of voltage, current, power, power factor, and energy; Instrument transformers; Q meter, waveform analyzers. Digital volt-meters and multi-meters. Time, phase and frequency measurements; Oscilloscope. Noise and interference in instrumentation.

Control Systems & Process Control: Principles of feedback; transfer function, signal flow graphs. Stability criteria, Bode plots, root-loci, Routh and Nyquist criteria. Compensation techniques; State space analysis. System components: mechanical, hydraulic, pneumatic, electrical and electronic; Servos and synchros; Stepper motors. On-off, cascade, P, PI, PID and feed-forward controls. Controller tuning and general frequency response.

Analytical, Optical and Biomedical Instrumentation: Principles of spectrometry, UV, visible, IR mass spectrometry, X-ray methods; nuclear radiation measurements, gas, solid and semi conductor lasers and their characteristics, interferometers, basics of fibre optics, transducers in biomedical applications, cardiovascular system measurements, instrumentation for clinical laboratory.

MA - MATHEMATICS

Linear Algebra: Finite dimensional vector spaces. Linear transformations and their matrix representations, rank; systems of linear equations, eigenvalues and eigenvectors, minimal polynomial, Cayley-Hamilton theorem, diagonalisation, Hermitian, Skew-Hermitian and unitary matrices. Finite dimensional inner product spaces, self-adjoint and Normal linear operators, spectral theorem, Quadratic forms.

Complex Analysis: Analytic functions, conformal mappings, bilinear transformations, complex integration: Cauchy's integral theorem and formula, Liouville's theorem, maximum modulus principle, Taylor and Laurent's series, residue theorem and applications for evaluating real integrals.

Real Analysis: Sequences and series of functions, uniform convergence, power series, Fourier series, functions of several variables, maxima, minima, multiple integrals, line, surface and volume integrals, theorems of Green, Stokes and Gauss; metric spaces, completeness, Weierstrass approximation theorem, compactness. Lebesgue measure, measurable functions; Lebesgue integral, Fatou's lemma, dominated convergence theorem.

Ordinary Differential Equations: First order ordinary differential equations, existence and uniqueness theorems, systems of linear first order ordinary differential equations, linear ordinary differential equations of higher order with constant coefficients; linear second order ordinary differential equations with variable coefficients, method of Laplace transforms for solving ordinary differential equations, series solutions; Legendre and Bessel functions and their orthogonality, Sturm Liouville system, Greeen's functions.

Algebra: Normal subgroups and homomorphisms theorems, automorphisms. Group actions, sylow's theorems and their applications groups of order less than or equal to 20, Finite p-groups. Euclidean domains, Principal ideal domains and unique factorizations domains. Prime ideals and maximal ideals in commutative rings.

Functional Analysis: Banach spaces, Hahn-Banach theorems, open mapping and closed graph theorems, principle of uniform boundedness; Hilbert spaces, orthonormal sets, Riesz representation theorem, self-adjoint, unitary and normal linear operators on Hilbert Spaces.

Numerical Analysis: Numerical solution of algebraic and transcendental equations; bisection, secant method, Newton-Raphson method, fixed point iteration, interpolation: existence and error of polynomial interpolation, Lagrange, Newton, Hermite(osculatory)interpolations; numerical differentiation and integration, Trapezoidal and Simpson rules; Gaussian quadrature; (Gauss-Legendre and Gauss-Chebyshev), method of undetermined parameters, least square and orthonormal polynomial approximation; numerical solution of systems of linear equations: direct and iterative methods, (Jacobi Gauss-Seidel and SOR) with convergence; matrix eigenvalue problems: Jacobi and Given's methods, numerical solution of ordinary differential equations: initial value problems, Taylor series method, Runge-Kutta methods, predictor-corrector methods; convergence and stability.

Partial Differential Equations: Linear and quasilinear first order partial differential equations, method of characteristics; second order linear equations in two variables and their classification; Cauchy, Dirichlet and Neumann problems, Green's functions; solutions of Laplace, wave and diffusion equations in two variables Fourier series and transform methods of solutions of the above equations and applications to physical problems.

Mechanics: Forces in three dimensions, Poinsot central axis, virtual work, Lagrange's equations for holonomic systems, theory of small oscillations, Hamiltonian equations;

Topology: Basic concepts of topology, product topology, connectedness, compactness, countability and separation axioms, Urysohn's Lemma, Tietze extension theorem, metrization theorems, Tychonoff theorem on compactness of product spaces.

Probability and Statistics: Probability space, conditional probability, Bayes' theorem, independence, Random variables, joint and conditional distributions, standard probability distributions and their properties, expectation, conditional expectation, moments. Weak and strong law of large numbers, central limit theorem. Sampling distributions, UMVU estimators, sufficiency and consistency, maximum likelihood estimators. Testing of hypotheses, Neyman-

Pearson tests, monotone likelihood ratio, likelihood ratio tests, standard parametric tests based on normal, X2 ,t, F-distributions. Linear regression and test for linearity of regression. Interval estimation.

Linear Programming: Linear programming problem and its formulation, convex sets their properties, graphical method, basic feasible solution, simplex method, big-M and two phase methods, infeasible and unbounded LPP's, alternate optima. Dual problem and duality theorems, dual simplex method and its application in post optimality analysis, interpretation of dual variables. Balanced and unbalanced transportation problems, unimodular property and u-v method for solving transportation problems. Hungarian method for solving assignment problems.

Calculus of Variations and Integral Equations: Variational problems with fixed boundaries; sufficient conditions for extremum, Linear integral equations of Fredholm and Volterra type, their iterative solutions. Fredholm alternative.

ME - MECHANICAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

APPLIED MECHANICS AND DESIGN

Engineering Mechanics: Equivalent force systems, free-body concepts, equations of equilibrium, trusses and frames, virtual work and minimum potential energy. Kinematics and dynamics of particles and rigid bodies, impulse and momentum (linear and angular), energy methods, central force motion.

Strength of Materials: Stress and strain, stress-strain relationship and elastic constants, Mohr's circle for plane stress and plane strain, shear force and bending moment diagrams, bending and shear stresses, deflection of beams, torsion of circular shafts, thin and thick cylinders, Euler's theory of columns, strain energy methods, thermal stresses.

Theory of Machines: Displacement, velocity and acceleration, analysis of plane mechanisms, dynamic analysis of slider-crank mechanism, planar cams and followers, gear tooth profiles, kinematics of gears, governors and flywheels, balancing of reciprocating and rotating masses.

Vibrations: Free and forced vibration of single degree freedom systems, effect of damping, vibration isolation, resonance, critical speed of rotors.

Design of Machine Elements: Design for static and dynamic loading, failure theories, fatigue strength; design of bolted, riveted and welded joints; design of shafts and keys; design of spur gears, rolling and sliding contact bearings; brakes and clutches; belt, rope and chain drives.

FLUID MECHANICS AND THERMAL SCIENCES

Fluid Mechanics: Fluid properties, fluid statics, manometry, buoyancy; control-volume analysis of mass, momentum and energy; fluid acceleration; differential equations of continuity and momentum; Bernoulli's equation; viscous flow of incompressible fluids; boundary layer; elementary turbulent flow; flow through pipes, head losses in pipes, bends etc.

Heat-Transfer: Modes of heat transfer; one dimensional heat conduction, resistance concept, electrical analogy, unsteady heat conduction, fins; dimensionless parameters in free and forced convective heat transfer, various correlations for heat transfer in flow over flat plates and through pipes; thermal boundary layer; effect of turbulence; radiative heat transfer, black and grey surfaces, shape factors, network analysis; heat exchanger performance, LMTD and NTU methods.

Thermodynamics: Zeroth, First and Second laws of thermodynamics; thermodynamic system and processes; irreversibility and availability; behaviour of ideal and real gases, properties of pure substances, calculation of work and heat in ideal processes; analysis of thermodynamic cycles related to energy conversion; Carnot, Rankine, Otto, Diesel, Brayton and vapour compression cycles.

Power Plant Engineering: Steam generators; steam power cycles; steam turbines; impulse and reaction principles, velocity diagrams, pressure and velocity compounding; reheating and reheat factor; condensers and feed heaters.

I.C. Engines: Requirements and suitability of fuels in IC engines, fuel ratings, fuel-air mixture requirements; normal combustion in SI and CI engines; engine performance calculations.

Refrigeration and air-conditioning: Refrigerant compressors, expansion devices, condensers and evaporators; properties of moist air, psychrometric chart, basic psychometric processes.

Turbomachinery: Components of gas turbines; compression processes, centrifugal and axial flow compressors; axial flow turbines, elementary theory; hydraulic turbines; Euler-turbine equation; specific speed, Pelton-wheel, Francis and Kaplan turbines; centrifugal pumps.

MANUFACTURING AND INDUSTRIAL ENGINEERING

Engineering Materials: Structure and properties of engineering materials and their applications, heat treatment.

Metal Casting: Casting processes (expendable and non-expendable) -pattern, moulds and cores, heating and pouring, solidification and cooling, gating design, design considerations, defects.

Forming Processes: Stress-strain diagrams for ductile and brittle material, Plastic deformation and yield criteria, fundamentals of hot and cold working processes, Bulk metal forming processes (forging, rolling, extrusion, drawing), sheet metal working processes (punching, blanking, bending, deep drawing, coining, spinning, load estimation using homogeneous deformation methods, defects). processing of powder metals- atomization, compaction, sintering, secondary and finishing operations. forming and shaping of plastics- extrusion, injection moulding.

Joining Processes: Physics of welding, fusion and non-fusion welding processes, brazing and soldering, adhesive bonding, design considerations in welding, weld quality defects.

Machining and Machine Tool Operations: Mechanics of machining, single and multi-point cutting tools, tool geometry and materials, tool life and wear, cutting fluids, machinability, economics of machining, non-traditional machining processes.

Metrology and Inspection: Limits, fits and tolerances, linear and angular measurements, comparators, gauge design, interferometry, form and finish measurement, measurement of screw threads, alignment and testing methods.

Tool Engineering: Principles of work holding, design of jigs and fixtures.

Computer Integrated Manufacturing: Basic concepts of CAD, CAM and their integration tools.

Manufacturing Analysis: Part-print analysis, tolerance analysis in manufacturing and assembly, time and cost analysis.

Work-Study: Method study, work measurement, time study, work sampling, job evaluation, merit rating.

Production Planning and Control: Forecasting models, aggregate production planning, master scheduling, materials requirements planning.

Inventory Control: Deterministic and probabilistic models, safety stock inventory control systems.

Operations Research: Linear programming, simplex and duplex method, transportation, assignment, network flow models, simple queuing models, PERT and CPM

MN - MINING ENGINEERING

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

MINING ENGINEERING

Mechanics: Equivalent force systems, equations of equilibrium, two dimensional frames and trusses, free body diagrams, friction forces, particle kinematics and dynamics.

Mine Development, Geomechanics and Strata Control: Drivages for underground mine development, drilling methods and machines, explosives, blasting devices and practices, shaft sinking. Physico-mechanical properties of rocks, rock mass classification, ground control instrumentation and stress measurement techniques, theories of rock failure, ground vibrations, stress distribution around mine openings, subsidence, design of supports in roadways and workings, stability of open pits, slopes.

Mining Methods and Machinery: Surface mining - layout, development, loading, transportation and mechanization, continuous surface mining systems. Underground coal mining - bord and pillar system, longwall mining, thick seam mining methods. Underground metal mining: different stoping methods, stope mechanization, ore handling systems, mine filling. Generation and transmission of mechanical, hydraulic, and pneumatic power. Materials handling - haulages, conveyors, ropeways, face and development machinery, hoisting systems, and pumps.

Ventilation, Underground Hazards and Surface Environment: Underground atmosphere, heat load sources and thermal environment, air cooling, mechanics of air flow distribution, natural and mechanical ventilation, mine fans and their usage, auxiliary ventilation. Subsurface hazards from fires, explosions, gases, dust, and inundation, rescue apparatus and practices, safety in mines, accident analysis, noise, mine lighting. Air and water pollution: causes, dispersion, quality standards, and control.

Surveying, Mine Planning and Systems Engineering: Fundamentals of engineering surveying, Levels and levelling, Theodolite, tacheometry, triangulation, contouring, errors and adjustments, correlation, underground surveying, curves, photogrammetry, field astronomy, GPS fundamentals. Principles of planning - Sampling methods and practices, reserve estimation techniques, basics of geostatistics, optimization of facility location, cash flow concepts and mine valuation, open pit design. Work study, concepts of reliability, reliability of series and parallel systems. Linear programming, transportation and assignment problems, queueing, network analysis, inventory control.

MT - METALLURGICAL ENGINEERING

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

METALLURGICAL ENGINEERING

Thermodynamics and Rate Processes: Laws of thermodynamics, activity, equilibrium constant, applications to metallurgical systems, solutions, phase equilibria, basic kinetic laws, order of reactions, rate constants and rate limiting steps principles of electro chemistry, aqueous, corrosion and protection of metals, oxidation and high temperature corrosion - characterization and control; momentum transfer - concepts of viscosity, shell balances, Bernoulli's equation; heat transfer - conduction, convection and heat transfer coefficient relations, radiation, mass transfer - diffusion and Fick's laws.

Extractive Metallurgy: Flotation, gravity and other methods of mineral processing; agglomeration, pyro-hydro-and electro-metallurgical processes; material and energy balances; principles and processes for the extraction of non-ferrous metals - aluminium, copper, zinc, lead, magnesium, nickel, titanium and other rare metals; iron and steel making - principles, blast furnace, direct reduction processes, primary and secondary steel making, deoxidation and inclusion in steel; ingot and continuous casting; stainless steel making, design of furnaces; fuels and refractories.

Physical Metallurgy: Crystal structure and bonding characteristics of metals, alloys, ceramics and polymers; solid solutions; solidification; phase transformation and binary phase diagrams; principles of heat treatment of steels, aluminum alloys and cast irons; recovery, recrystallization and grain growth; industrially important ferrous and non-ferrous alloys; elements of X-ray and electron diffraction; principles of scanning and transmission electron microscopy; elements of ceramics, composites and electronic materials; electronic basis of thermal, optical, electrical and magnetic properties of materials.

Mechanical Metallurgy: Elements of elasticity and plasticity; defects in crystals; elements of dislocation theory - types of dislocations, slip and twinning, stress fields of dislocations, dislocation interactions and reactions, methods of seeing dislocations; strengthening mechanisms; tensile, fatigue and creep behaviour; superplasticity; fracture - Griffith theory, ductile to brittle transition, fracture toughness; failure analysis; mechanical testing - tension, compression, torsion, hardness, impact, creep, fatigue, fracture toughness and formability tests.

Manufacturing Processes: Metal casting - patterns, moulds, melting, gating, feeding and casting processes, defects and castings, hot and cold working of metals; Metal forming - fundamentals of metal forming, rolling wire drawing, extrusion, forming, sheet metal forming processes, defects in forming; Metal joining - soldering, brazing and welding, common welding processes, welding metallurgy, problems associated with welding of steels and aluminium alloys, defects in welding, powder metallurgy; NDT methods - ultrasonic, radiography, eddy current, acoustic emission and magnetic.

PH - PHYSICS

Mathematical Physics: Linear vector space, matrices; vector calculus; linear differential equations; elements of complex analysis; Laplace transforms, Fourier analysis, elementary ideas about tensors.

Classical Mechanics: Conservation laws; central forces; collisions and scattering in laboratory and centre of mass reference frames; mechanics of system of particles; rigid body dynamics; moment of inertia tensor; noninertial frames and pseudo forces; variational principle; Lagrange's and Hamilton's formalisms; equation of motion, cyclic coordinates, Poisson bracket; periodic motion, small oscillations, normal modes; wave equation and wave propagation; special theory of relativity - Lorentz transformations, relativistic kinematics, mass-energy equivalence.

Electromagnetic Theory: Laplace and Poisson equations; conductors and dielectrics; boundary value problems; Ampere's and Biot-Savart's laws; Faraday's law; Maxwell's equations; scalar and vector potentials; Coulomb and Lorentz gauges; boundary conditions at interfaces; electromagnetic waves; interference, diffraction and polarization; radiation from moving charges.

Quantum Mechanics: Physical basis of quantum mechanics; uncertainty principle; Schrodinger equation; one and three dimensional potential problems; Particle in a box, harmonic oscillator, hydrogen atom; linear vectors and operators in Hilbert space; angular momentum and spin; addition of angular momentum; time independent perturbation theory; elementary scattering theory.

Atomic and Molecular Physics: Spectra of one-and many-electron atoms; LS and jj coupling; hyperfine structure; Zeeman and Stark effects; electric dipole transitions and selection rules; X-ray spectra; rotational and vibrational spectra of diatomic molecules; electronic transition in diatomic molecules, Franck-Condon principle; Raman effect; NMR and ESR; lasers.

Thermodynamics and Statistical Physics: Laws of thermodynamics; macrostates, phase space; probability ensembles; partition function, free energy, calculation of thermodynamic quantities; classical and quantum statistics; degenerate Fermi gas; black body radiation and Planck's distribution law; Bose-Einstein condensation; first and second order phase transitions, critical point.

Solid State Physics: Elements of crystallography; diffraction methods for structure determination; bonding in solids; elastic properties of solids; defects in crystals; lattice vibrations and thermal properties of solids; free electron theory; band theory of solids; metals, semiconductors and insulators; transport properties; optical, dielectric and magnetic properties of solids; elements of superconductivity.

Nuclear and Particle Physics: Rutheford scattering; basic properties of nuclei; radioactive decay; nuclear forces; two nucleon problem; nuclear reactions; conservation laws; fission and fusion; nuclear models; particle accelerators, detectors; elementary particles; photons, baryons, mesons and leptons; Quark model.

Electronics: Network analysis; semiconductor devices; bipolar transistors; FETs; power supplies, amplifier, oscillators; operational amplifiers; elements of digital electronics; logic circuits.

PI - PRODUCTION AND INDUSTRIAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

GENERAL ENGINEERING:

Engineering Materials: Structure and properties of engineering materials and their applications; effect of strain, strain rate and temperature on mechanical properties of metals and alloys; heat treatment of metals and alloys.

Applied Mechanics: Engineering mechanics - equivalent force systems, free body concepts, equations of equilibrium, virtual work and minimum potential energy; strength of materials-stress, strain and their relationship, Mohr's circle, deflection of beams, bending and shear stress, Euler's theory of columns.

Theory of Machines and Design: Analysis of planar mechanisms, plane cams and followers; governers and fly wheels; design of elements-failure theories; design of bolted, riveted and welded joints; design of shafts, keys, belt drives, brakes and clutches.

Thermal Engineering: Fluid machines - fluid statics, Bernoulli's equation, flow through pipes, equations of continuity and momentum; Thermodynamics - zeroth, First and Second laws of thermodynamics, thermodynamic system and processes, calculation of work and heat for systems and control volumes; Heat transfer - fundamentals of conduction, convection and radiation.

PRODUCTION ENGINEERING

Metal Casting: Casting processes; patterns-materials; allowances; moulds and cores - materials, making and testing; melting and founding of cast iron, steels and nonferrous metals and alloys; solidification; design of casting, gating and risering; casting defects and inspection.

Metal working: Stress-strain in elastic and plastic deformation; deformation mechanisms; hot and cold working-forging, rolling, extrusion, wire and tube drawing; sheet metal working; analysis of rolling, forging, extrusion and wire /rod drawing; metal working defects, high energy rate forming processes-explosive, magnetic, electro and electrohydraulic.

Metal Joining Processes: Welding processes - gas shielded metal arc, TIG, MIG, submerged arc, electroslag, thermit, resistance, pressure and forge welding; thermal cutting; other joining processes - soldering, brazing, braze welding; welding codes, welding symbols, design of welded joints, defects and inspection; introduction to modern welding processes - friction, ultrasonic, explosive, electron beam, laser and plasma.

Machining and Machine Tool Operations: Machining processes-turning, drilling, boring, milling, shaping, planing, sawing, gear cutting, thread production, broaching, grinding, lapping, honing super finishing; mechanics of cutting- Merchant's analysis, geometry of cutting tools, cutting forces, power requirements; selection of process parameters; tool materials, tool wear and tool life, cutting fluids, machinability; nontraditional machining processes and hybrid processes- EDM, CHM, ECM, USM, LBM, EBM, AJM, PAM AND WJM; economics of machining.

Metrology and Inspection: Limits and fits, linear and angular measurements by mechanical and optical methods, comparators; design of limit gauges; interferometry; measurement of straightness, flatness, roundness, squareness and symmetry; surface finish measurement; inspection of screw threads and gears; alignment testing.

Powder Metallurgy and Processing of Plastics: Production of powders, compaction, sintering; Polymers and composites; injection, compression and blow molding, extrusion, calendaring and thermoforming; molding of composites.

Tool Engineering: Work-holding-location and clamping; principles and methods; design of jigs and fixtures; design of press working tools, forging dies.

Manufacturing Analysis: Sources of errors in manufacturing; process capability; part-print analysis; tolerance analysis in manufacturing and assembly; process planning; parameter selection and comparison of production alternatives; time and cost analysis; Issues in choosing manufacturing technologies and strategies.

Computer Integrated Manufacturing: Basic concepts of CAD, CAM, CAPP, group technology, NC, CNC, DNC, FMS, Robotics and CIM.

INDUSTRIAL ENGINEERING

Product Design and Development: Principles of good product design, component and tolerance design; efficiency, quality and cost considerations; product life cycle; standardization, simplification, diversification, value analysis, concurrent engineering.

Engineering Economy and Costing: Financial statements; elementary cost accounting, methods of depreciation; break-even analysis, techniques for evaluation of capital investments.

Work System Design: Taylor's scientific management, Gilbreths's contributions; productivity concepts and measurements; method study, micro-motion study, principles of motion economy; human factors engineering, ergonomics; work measurement - time study, PMTS, work sampling; job evaluation, merit rating, wage administration, incentive systems; business process reengineering.

Logistics and Facility Design: Facility location factors, evaluation of alternatives, types of plant layout, evaluation; computer aided layout; assembly line balancing; material handling systems; supply chain management.

Production Planning and Inventory Control: Inventory Function costs, classifications - deterministic and probabilistic models; quantity discount; safety stock; inventory control system; Forecasting techniques - causal and time series models, moving average, exponential smoothing; trend and seasonality; aggregate production planning; master scheduling; bill of materials and material requirement planning; order control and flow control, routing, scheduling and priority dispatching; JIT; Kanban PULL systems; bottleneck scheduling and theory of constraints.

Operation Research: Linear programming - problem formulation, simplex method, duality and sensitivity analysis; transportation; assignment; network flow models, constrained optimization and Lagrange multipliers; simple queuing models; dynamic programming; simulation; PERT and CPM, time-cost trade-off, resource leveling.

Quality Control: Taguchi method; design of experiments; quality costs, statistical quality assurance, process control charts, acceptance sampling, zero defects; quality circles, total quality management.

Reliability and Maintenance: Reliability, availability and maintainability; probabilistic failure and repair times; system reliability; preventive maintenance and replacement, TPM.

Management Information System: Value of information; information storage and retrieval system - database and data structures; interactive systems; knowledge based systems.

Intellectual Property System: Definition of intellectual property, importance of IPR; TRIPS, and its implications, WIPO and Global IP structure, and IPS in India; patent, copyright, industrial design and trademark; meanings, rules and procedures, terms, infringements and remedies.

PY - PHARMACEUTICAL SCIENCES

Natural Products: Pharmacognosy & Phytochemistry - Chemistry, tests, isolation, characterization and estimation of phytopharmaceuticals belonging to the group of Alkaloids, Glycosides, Terpenoids, Steroids, Bioflavanoids, Purines, Guggul lipids. Pharmacognosy of crude drugs which contain the above constituents. Standardisation of raw materials and herbal products. WHO guide lines. Quantitative microscopy including modern techniques used for evaluation. Biotechnological principles and techniques for plant development Tissue culture.

Pharmacology: General pharmacological principles including Toxicology. Drug interaction. Pharmacology of drugs acting on Central nervous system, Cardiovascular system, Autonomic nervous system, Gastro intestinal system and Respiratory system. Pharmacology of Autocoids, Hormones, Chemotherapeutic agents including anticancer drugs. Bioassays. Immuno Pharmacology.

Medicinal Chemistry: Structure, nomenclature, classification, synthesis, SAR and metabolism of the following category of drugs which are official in Indian Pharmacopoeia and British Pharmacopoeia Hypnotics and Sedatives, Analgesics, NSAIDS, Neuroleptics, Antidepressants, Anxiolytics, Anticonvulsants, Antihistaminics, Local anaesthetics, Cardio Vascular drugs - Antianginal agents Vasodilators, Adrenergic & cholinergic drugs, Cardiotonic agents, Diuretics, Antihypertensive drugs, Hypoglycemic agents, Antilipedmic agents, Coagulants, Anticoagulants, Antiplatelet agents. Chemotherapeutic agents - Antibiotics, Antibacterials, Sulphadrugs. Antiproliozoal drugs, Antiviral, Antitubercular, Antimalarial, Anticancer, Antiamoebic drugs. Diagnostic agents. Preparation and storage and uses of official Radiopharmaceuticals. Vitamins and Hormones.

Pharmaceutics: Development, manufacturing standards, labeling, packing as per the pharmacopoeal requirements, Storage of different dosage forms and new drug delivery systems. Biopharmaceutics and Pharmacokinetics and their importance in formulation. Formulation and preparation of cosmetics - lipstick, shampoo, creams, nail preparations and dentifrices. Pharmaceutical calculations.

Pharmaceutical Jurisprudence: Legal aspects of manufacture, storage, sale of drugs. D and C act and rules. Pharmacy act.

Pharmaceutical Analysis: Principles, instrumentation and applications of the following. Absorption spectroscopy (UV, visible & IR), Fluorimetry, Flame photometry, Potentiometry, Conductometry and Plarography. Pharmacopoeial assays. Principles of NMR, ESR, Mass spectroscopy, X-ray diffraction analysis and different chromatographic methods.

Biochemistry and Clinical Pharmacy: Biochemical role of hormones, Vitamins, Enzymes, Nucleic acids. Bioenergetics. General principles of immunology. Immunological techniques. Adverse drug interaction.

Microbiology: Principles and methods of microbiological assays of the Pharmacopoeia. Methods of preparation of official sera and vaccines. Serological and diagnostic tests. Applications of microorganisms in Bio Conversions and in Pharmaceutical industry.

TF - TEXTILE ENGINEERING AND FIBRE SCIENCE

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

TEXTILE ENGINEERING & FIBRE SCIENCE

Textile Fibres: Classification of textile fibres according to their nature and origin; general characteristics of textile fibres-their chemical and physical structures and their properties; essential characteristics of fibre forming polymers; uses of natural and man-made fibres; physical and chemical methods of fibre and blend identification and blend analysis.

Melt Spinning processes with special reference to polyamide and polyester fibres; wet and dry spinning of viscose and acrylic fibres; post spinning operations-drawing, heat setting, texturing- false twist and air-jet, tow-to-top conversion. Methods of investigating fibre structure e.g. X-ray diffraction, birefringence, optical and electron microscopy, I.R. absorption, thermal methods; structure and morphology and principal natural and man-made fibres, mechanical properties of fibres, moisture sorption in fibres; fibre structure and property correlation.

Textile Testing: Sampling techniques, sample size and sampling errors; measurement of fibre length, fineness, crimp, strength and reflectance; measurement of cotton fibre maturity ad trash content; HVI and AFIS for fibre testing. Measurement of yarn count, twist and hairiness; tensile testing of fibres, yarn and fabrics; evenness testing of slivers, rovings and yarns; testing equipment for measurement test methods of fabric properties like thickness, compressibility, air permeability, drape, crease recovery, tear strength bursting strength and abrasion resistance. Correlation analysis, significance tests and analysis of variance; frequency distributions and control charts.

Yarn Manufacture and Yarn Structure: Modern methods of opening, cleaning and blending of fibrous materials; the technology of carding with particular reference to modern developments; causes of irregularity introduced by drafting, the development of modern drafting systems; principles and techniques of preparing material for combing; recent development in combers; functions and synchronization of various mechanisms concerned with roving production; forces acting on yarn and traveller, ring and traveller designs; causes of end breakages; properties of doubles yarns; new methods of yarn production such as rotor spinning, air jet spinning and friction spinning.

Yarn diameter; specific volume, packing coefficient; twist-strength relationship; fibre orientation in yarn; fibre migration.

Fabric Manufacture and Fabric Structure: Principles of cheese and cone winding processes and machines; random and precision winding; package faults and their remedies; yarn clearers and tensioners; different systems of yarn splicing; features of modern cone winding machines; different types of warping creels; features of modern beam and sectional warping machines; different sizing systems, sizing of spun and filament yarns, modern sizing machines; principles of pirn winding processes and machines; primary and secondary motions of loom, effect of their settings and timings on fabric formation, fabric appearance and weaving performance; dobby and jacquard shedding; mechanics of weft insertion with shuttle; warp and weft stop motions, warp protection, weft replenishment; functional principles of weft insertion systems of shuttleless weaving machines, principles of multiphase and circular looms. Principles of weft and warp knitting; basic weft and warp knitted structures; classification, production and areas of application of nonwoven fabrics.

Basic woven fabric constructions and their derivatives; crepe, cord, terry, gauze, lino and double cloth constructions.

Peirce's equations for fabric geometry; thickness, cover and maximum sett of woven fabrics

Textile Chemical Processing: Preparatory processes for natural-and and their blends; mercerization of cotton; machines for yarn and fabric mercerization.

Dyeing and printing of natural- and synthetic- fibre fabrics and their blends with different dye classes; dyeing and printing machines; styles of printing; fastness properties of dyed and printed textile materials.

Finishing of textile materials, wash and wear, durable press, soil release, water repellent, flame retardant and antistatic finishes; shrink-resistance finish for wool; heat setting of synthetic-fibre fabrics, finishing machines; energy efficient processes; pollution control.

XE - ENGINERING SCIENCES

The syllabi of the sections of this paper are as follows:

SECTION A. ENGINEERING MATHEMATICS (Compulsory)

Linear Algebra : Determinates, algebra of matrices, rank, inverse, system of linear equations, symmetric, skew-symmetric and orthogonal matrices. Hermitian, skew-hermitian and unitary matrices. eigenvalues and eigenvectors, diagonalisation of matrices, Cayley-Hamiltonian, quadratic forms.

Calculus : Functions of single variables, limit, continuity and differentiability, Mean value theorems, Intermediate forms and L'Hospital rule, Maxima and minima, Taylor's series, Fundamental and mean value-theorems of integral calculus. Evaluation of definite and improper integrals, Beta and Gamma functions, Functions of two variables, limit, continuity, partial derivatives, Euler's theorem for homogeneous functions, total derivatives, maxima and minima, Lagrange method of multipliers, double and triple integrals and their applications, sequence and series, tests for convergence, power series, Fourier Series, Fourier integrals.

Complex variable: Analytic functions, Cauchy's integral theorem and integral formula without proof. Taylor's and Laurent' series, Residue theorem (without proof) with application to the evaluation of real integarls.

Vector Calculus: Gradient, divergence and curl, vector identities, directional derivatives, line, surface and volume integrals, Stokes, Gauss and Green's theorems (without proofs) with applications.

Ordinary Differential Equations: First order equation (linear and nonlinear), higher order linear differential equations with constant coefficients, method of variation of paramaters, Cauchy's and Euler's equations, initial and boundary value problems, power series solutions, Legendre polynomials and Bessel's functions of the first kind.

Partial Differential Equations: Variables separable method, solutions of one dimensional heat, wave and Laplace equations.

Probability and Statistics: Definitions of probability and simple theorems, conditional probability, mean, mode and standard deviation, random variables, discrete and continuous distributions, Poisson, normal and Binomial distribution, correlation and regression

Numerical Methods: L-U decomposition for systems of linear equations,Newton-Raphson method, numerical integration(trapezoidal and Simpson's rule), numerical methods for first order differential equation (Euler method)

SECTION B. COMPUTATIONAL SCIENCE

Numerical Methods: Truncation errors, round off errors and their propagation; Interpolation; Lagrange, Newton's forward, backward and divided difference formulas, least square curve fitting, solution of non-linear equations of one variables using bisection, false position, secant and Newton Raphson methods; Rate of convergence of these methods, general iterative methods. Simple and multiple roots of polynomials. Solutions of system of linear algebraic equations using Gauss elimination methods, Jacobi and Gauss-Seidel iterative methods and their rate of convergence; ill conditioned and well conditioned system. eigen values and eigen vectors using power methods. Numerical integration using trapezoidal, Simpson's rule and other quadrature formulas. Numerical Differentiation. Solution of boundary value problems. Solution of initial value problems of ordinary differential equations using Euler's method, predictor corrector and Runge Kutta method.

Programming : Elementary concepts and terminology of a computer system and system software, Fortran77 and C programming.

Fortran : Program organization, arithmetic statements, transfer of control, Do loops, subscripted variables, functions and subroutines.

C language : Basic data types and declarations, flow of control- iterative statement, conditional statement, unconditional branching, arrays, functions and procedures.

SECTION C. ELECTRICAL SCIENCES

Electric Circuits: Ideal voltage and current sources; RLC circuits, steady state and transient analysis of DC circuits, network theorems; alternating currents and voltages, single-phase AC circuits, resonance; three-phase circuits.

Magnetic circuits: Mmf and flux, and their relationship with voltage and current; transformer, equivalent circuit of a practical transformer, three-phase transformer connections.

Electrical machines: Principle of operation, characteristics, efficiency and regulation of DC and synchronous machines; equivalent circuit and performance of three-phase and single-phase induction motors.

Electronic Circuits: Characteristics of p-n junction diodes, zener diodes, bipolar junction transistors (BJT) and junction field effect transistors (JFET); MOSFET's structure, characteristics, and operations; rectifiers, filters, and regulated power supplies; biasing circuits, different configurations of transistor amplifiers, class A, B and C of power amplifiers; linear applications of operational amplifiers; oscillators; tuned and phase shift types.

Digital circuits: Number systems, Boolean algebra; logic gates, combinational circuits, flip-flops (RS, JK, D and T) counters.

Measuring instruments: Moving coil, moving iron, and dynamometer type instruments; shunts, instrument transformers, cathode ray oscilloscopes; D/A and A/D converters.

SECTION D. FLUID MECHANICS

Fluid Properties: Relation between stress and strain rate for Newtonian fluids

Hydrostatics, buoyancy, manometry

Concept of local and convective accelerations; control volume analysis for mass, momentum and energy conservation.

Differential equations of continuity and momentum (Euler's equation of motion); concept of fluid rotation, stream function, potential function; Bernoulli's equation and its applications.

Qualitative ideas of boundary layers and its separation; streamlined and bluff bodies; drag and lift forces.

Fully-developed pipe flow; laminar and turbulent flows; friction factor; Darcy Weisbach relation; Moody's friction chart; losses in pipe fittings; flow measurements using venturimeter and orifice plates.

Dimensional analysis; similitude and concept of dynamic similarity; importance of dimensionless numbers in model studies.

SECTION E. MATERIALS SCIENCE

Atomic structure and bonding in materials: metals, ceramics and polymers.

Structure of materials: Crystal systems, unit cells and space lattice; determination of structures of simple crystals by X-ray diffraction; Miller indices for planes and directions. Packing geometry in metallic, ionic and covalent solids.

Concept of amorphous, single and polycrystalline structures and their effects on properties of materials.

Imperfections in crystalline solids and their role in influencing various properties.

Fick´s laws of diffusion and applications of diffusion in sintering, doping of semiconductors and surface hardening of metals.

Alloys: solid solution and solubility limit. Binary phase diagram, intermediate phases and intermetallic compounds; iron-iron carbide phase diagram. Phase transformation in steels. Cold and hot working of metals, recovery, recrystallization and grain growth.

Properties and applications of ferrous and nonferrous alloys.

Structure, properties, processing and applications of traditional and advanced ceramics.

Polymers: classification, polymerization, structure and properties, additives for polymer products, processing and application.

Composites: properties and application of various composites.

Corrosion and environmental degradation of materials (metals, ceramics and polymers).

Mechanical properties of materials: Stress-strain diagrams of metallic, ceramic and polymeric materials, modulus of elasticity, yield strength, plastic deformation and toughness, tensile strength and elongation at break; viscoelasticity, hardness, impact strength. ductile and brittle fracture. creep and fatigue properties of materials.

Heat capacity, thermal conductivity, thermal expansion of materials.

Concept of energy band diagram for materials; conductors, semiconductors and insulators in terms of energy bands. Electrical conductivity, effect of temperature on conductivity in materials, intrinsic and extrinsic semiconductors, dielectric properties of materials.

Refraction, reflection, absorption and transmission of electromagnetic radiation in solids.

Origin of magnetism in metallic and ceramic materials, paramagnetism, diamagnetism, antiferromagnetism, ferromagnetism, ferrimagnetism in materials and magnetic hysteresis.

Advanced materials: Smart materials exhibiting ferroelectric, piezoelectric, optoelectronic, semiconducting behaviour; lasers and optical fibers; photoconductivity and superconductivity in materials.

SECTION F. SOLID MECHANICS

Equivalent force systems; free-body diagrams; equilibrium equations; analysis of determinate and indeterminate trusses and frames; friction.

Simple relative motion of particles; force as function of position, time and speed; force acting on a body in motion; laws of motion; law of conservation of energy; law of conservation of momentum

Stresses and strains; principal stresses and strains; Mohr's circle; generalized Hooke's Law; equilibrium equations; compatibility conditions; yield criteria.

Axial, shear and bending moment diagrams; axial, shear and bending stresses; deflection (for symmetric bending); torsion in circular shafts; thin cylinders; energy methods (Castigliano's Theorems); Euler buckling.

SECTION G. THERMODYNAMICS

Basic Concepts: Continuum, macroscopic approach, thermodynamic system (closed and open or control volume); thermodynamic properties and equilibrium; state of a system, state diagram, path and process; different modes of work; Zeroth law of thermodynamics; concept of temperature; heat.

First Law of Thermodynamics: Energy, enthalpy, specific heats, first law applied to systems and control volumes, steady and unsteady flow analysis.

Second Law of Thermodynamics: Kelvin-Planck and Clausius statements, reversible and irreversible processes, Carnot theorems, thermodynamic temperature scale, Clausius inequality and concept of entropy, principle of increase of entropy; availability and irreversibility.

Properties of Pure Substances: Thermodynamic properties of pure substances in solid, liquid and vapour phases, P-V-T behaviour of simple compressible substances, phase rule, thermodynamic property tables and charts, ideal and real gases, equations of state, compressibility chart.

Thermodynamic Relations: T-ds relations, Maxwell equations, Joule-Thomson coefficient, coefficient of volume expansion, adiabatic and isothermal compressibilities, Clapeyron equation.

Ideal Gas Mixtures: Dalton's and Amagat's laws, calculations of properties, air-water vapour mixtures.

XL - LIFE SCIENCES

The syllabi of the Sections of this paper are as follows:

SECTION H. CHEMISTRY (Compulsory)

Atomic structure and periodicity: Quantum chemistry; Planck's quantum theory, wave particle duality, uncertainty principle, quantum mechanical model of hydrogen atom; electronic configuration of atoms; periodic table and periodic properties; ionization energy, election affinity, electronegativity, atomic size.

Structure and bonding: Ionic and covalent bonding M.O. and V.B. approaches for diatomic molecules, VSEPR theory and shape of molecules, hybridisation, resonance, dipole moment, structure parameters such as bond length, bond angle and bond energy, hydrogen bonding, van der Waals interactions. Ionic solids; ionic radii, lattice energy (Born-Haber Cycle).

s.p. and d Block Elements: Oxides, halides and hydrides of alkali and alkaline earth metals, B, Al, S, N, P and S, silicones, general characteristics of 3d elements, coordination complexes: valence bond and crystal field theory, color, geometry and magnetic properties.

Chemical Equilibria: Colligative properties of solutions, ionic equilibria in solution, solubility product, common ion effect, hydrolysis of salts, pH, buffer and their applications in chemical analysis.

Electrochemistry: Conductance, Kohlrausch law, Half Cell potentials, emf, Nernst equation, galvanic cells, thermodynamic aspects and their applications.

Reaction Kinetics: Rate constant, order of reaction, molecularity, activation energy, zero, first and second order kinetics, equilibrium constants (Kc, Kp and Kx) for homogeneous reactions, catalysis and elementary enzyme reactions.

Thermodynamics: First law, reversible and irreversible processes, internal energy, enthalpy, Kirchoff's equation, heat of reaction, Hess law, heat of formation, Second law, entropy, free energy, and work function. Gibbs-Helmholtz equation, Clausius-Clapeyron equation, free energy change and equilibrium constant, Troutons rule, Third law of thermodynamics.

Mechanistic Basis of Organic Reactions: Elementary treatment of SN1, SN2, E1 and E2 reactions, Hoffmann and Saytzeff rules, Addition reactions, Markonikoff rule and Kharash effect, Diels-Alder reaction, aromatic electrophilic substitution, orientation effect as exemplified by various functional groups.

Structure-Reactivity Correlations: Acids and bases, electronic and steric effects, optical and geometrical isomerism, tautomerism, concept of aromaticity

SECTION I. BIOCHEMISTRY

Organization of life. Importance of water. Cell structure and organelles. Structure and function of biomolecules: Carbohydrates, Lipids, Proteins and Nucleic acids. Biochemical separation techniques. Spectroscopic methods; UV-visible and fluorescence. Protein structure, folding and function: Myoglobin, Hemoglobin, Lysozyme, ribonuclease A, Carboxypeptidase and Chymotrypsin. Enzyme kinetics and regulation, Coenzymes.

Metabolism and bioenergitics. Generation and utilization of ATP. Photosynthesis. Major metabolic pathways and their regulation. Biological membranes. Transport across membranes. Signal transduction; hormones and neurotransmitters.

DNA replication, transcription and translation. Biochemical regulation of gene expression. Recombinant DNA technology and applications. Genomics and Proteomics.

The immune system. Active and passive immunity. Complement system. Antobody structure, function and diversity. Cells of the immune system: T, B and macrophages. T and B cell activation. Major histocompatibilty complex. T cell receptor. Immunological techniques: Immunodiffusion, immunoelectrophoresis, RIA and ELISA.

SECTION J. BIOTECHNOLOGY

Recombinant DNA technology for the production of therapeutic proteins. Micro array technology. Heterologous protein expression systems in bacteria, yeast etc.

Architecture of plant genome; plant tissue culture techniques; methods of gene transfer into plant cells; manipulation of phenotypic traits in plants; plant cell fermentations and production of secondary metabolites using suspension/ immobilized cell culture; methods for plant micro propagation; crop improvement and development of transgenic plants. Expression of animal proteins in plants.

Animal cell metabolism and regulation; cell cycle; primary cell culture; nutritional requirements for animal cell culture; techniques for the mass culture of animal cell lines; production of vaccines; growth hormones and interferons using animal cell culture; cytokines-production and therapeutic uses; hybridoma technology; vectors for gene transfer and expression in animal cells. Transgenic animals and molecular pharming.

Microbial production of industrial enzymes; methods for immobilization of enzymes; kinetics of soluble and immobilized enzymes; application of soluble and immobilized enzymes; enzyme-based sensors.

Microbial growth kinetics; batch, fed batch and continuous culture of microbial cells; media for industrial fermentations; sterilization of air and media; design features and operation of stirred tank, air-lift and fluidized bed reactors; aeration and agitation in aerobic fermentations; recovery and purification of fermentation products- filtration, centrifugation, cell disintegration, solvent extraction and chromatographic separations; industrial fermentations for the production of ethanol, citric acid, lysine, penicillin and other biomolecules; simple calculations based on material and energy balance of fermentation processes; application of microbes in the management of domestic and industrial wastes.

SECTION K. BOTANY

Anatomy: Roots, stem and leaves of land plants, meristems, vascular system, their ontogeny, structure and functions. Plant cell structure, organisation, organelles, cytoskeleton, cell wall and membranes.

Development: Cell cycle, cell division, senescence, hormonal regulation of growth; life cycle of an angiosperm, pollination, fertilization, embryogenesis, seed formation, seed storage proteins, seed dormancy and germination. Concept of cellular totipotency, organogenesis and somatic embryogenesis, somaclonal variation, embryo culture, in vitro fertilization.

Physiology and Biochemistry: Plant water relations, transport of minerals and solutes, N2 metabolism, proteins and nucleic acid, respiration, photophysiology, photosynthesis, photorespiration; biosynthesis, mechanism of action and physiological effects of plant growth regulators.

Genetics: Principles of Mendelian inheritance, linkage, recombination and genetic mapping; extrachromosomal inheritance; eukaryotic genome organization (chromatin structure) and regulation of gene expression, gene mutation, chromosome aberrations (numerical and structural), transposons.

Plant Breeding: Principles, methods - selection, hybridization, heterosis; male sterility, self and inter-specific incompatibility; haploidy; somatic cell hybridization; molecular marker-assisted selection; gene transfer methods viz. direct and vector-mediated, transgenic plants and their applications in agriculture.

Economic Botany: Economically important plants - cereals, pulses, plants yielding fiber, timber, sugar, beverages, oils, rubber, dyes, gums, drugs and narcotics - a general account.

Systematics: Systems of classification (non-phylogenetic vs. phylogenetic - outline), plant groups, molecular systematics.

Plant Pathology: Nature and classification of plant diseases, diseases of important crops caused by fungi, bacteria and viruses, and their control measures, mechanism(s) of pathogenesis and resistance, molecular detection of pathogens; plant-microbe beneficial interactions.

Ecology and Plant Geography: Ecosystems - types, dynamics, degradation, ecological succession; food chains; vegetation types of the world; pollution and global warming; speciation and extinction, conservation strategies, cryopreservation.

SECTION L. MICROBIOLOGY

Historical perspective - Discovery of the microbial world; Controversy over spontaneous generation; Role of microorganisms in transformation of organic matter and in the causation of diseases.

Methods in microbiology - Pure culture techniques; Theory and practice of sterilization; Principles of microbial nutrition; Construction of culture media; Enrichment culture techniques for isolation of chemoautotrophs, chemoheterotrophs and photosynthetic microorganisms.

Microbial evolution, systematics and taxonomy - Evolution of earth and earliest life forms; Primitive organisms and their metabolic strategies; New approaches to bacterial taxonomic classification including ribotyping; Nomenclature.

Microbial diversity - Bacteria, archea and their broad classification; Eukaryotic microbes, yeast, fungi, slime mold and protozoa; Viruses and their classification.

Microbial growth -The definition of growth, mathematical expression of growth, growth curve, measurement of growth and growth yields; Synchronous growth; Continuous culture.

Nutrition and metabolism - Overview of metabolism; Microbial nutrition; Energy classes of microorganisms; Culture media; Energetics, modes of ATP generation; ATP generation by heterotrophs; Fermentation; Glycolysis; Respiration; The citric acid cycle; Electron transport systems; Alternate modes of energy generation; Pathways (anabolism) in the biosynthesis of amino acids, purines, pyrimidines and fatty acids.

Metabolic diversity among microorganisms - Photosynthesis in microorganisms; Role of chlorophylls, carotenoids and phycobilins; Calvin cycle; Chemolithotrophy; Hydrogen- iron-nitrite-oxidizing bacteria; Nitrate and sulfate reduction; Methanogenesis and acetogenesis.

Prokaryotic cells: structure-function - Cells walls of eubacteria (peptidoglycan) and related molecules; Outer-membrane of gram-negative bacteria; Cell wall and cell membrane synthesis; Flagella and motility; Cell inclusions like endospores, gas vesicles.

Microbial diseases and host parasite relationships - Normal microflora of skin; Oral cavity; Gastrointestinal tract; Entry of pathogens into the host; Infectious disease transmission; Respiratory infections caused by bacteria and viruses; Tuberculosis; Sexually transmitted diseases including AIDS; Diseases transmitted by animals (Rabies, plague), insects and ticks (rikettsias, Lyme disease, malaria); Food and water borne diseases; Public health and water quality; Pahtogenic fungi; Emerging and resurgent infectious diseases.

Chemotherapy/Antibiotics - Antimicrobial agents; Sulfa drugs; Antibiotics; Pencillins and cephalosporins; Broad-spectrum antibiotics; Antibiotics from prokaryotes; Antifungal antibiotics; Mode of action; Resistance to antibiotics.

Microbial genetics - Genes, mutation and mutagenesis - UV and chemical mutagnes; Types of mutations; Ames test for mutagenesis; Methods of genetic analysis. Bacterial genetic system - Transformation; Conjugation; Transduction; Recombination; Plasmids and Transposons; Bacterial genetic map with reference to E. coli. Viruses and their genetic system - Phage ? and its life cycle; RNA phages; RNA viruses; Retroviruses; Genetic systems of yeast and Neurospora; Extrachromosomal inheritance and mitochondrial genetics; Basic concept of genomics.

SECTION M. ZOOLOGY

Animal world: Animal diversity, distribution, systematic and classification of animals, the phylogenetic relationship.

Evolution: Origin of life, history of life on earth, evolutionary theories, natural selection, adaptation, speciation.

Genetics: Principles of inheritance, molecular basis of heredity, the genetic material, transmission of genetic material, mutations, cytoplasmic inheritance.

Biochemistry and Molecular Biology: Nucleic acids, proteins and other biological macromolecules. Replication, transcription and translation, regulation of gene expression, organization of genome, Kreb's cycle, glycolysis, enzyme catalysis, hormones and their action.

Cell Biology: Structure of cell, cellular organelles and their structure and function, cell cycle, cell division, cellular differentiation, chromosome and chromatin structure. Eukaryotic gene organisation and expression.

Animal Anatomy and Physiology: Comparative physiology, the respiratory system, circulatory system, digestive system, the nervous system, the excretory system, the endocrine system, the reproductive system, the skeletal system, osmoregulation.

Parasitology and Immunology: Nature of parasite, host-parasite relation, protozoan and helminthic parasites, the immune response, cellular and humoral immune response, evolution of the immune system.

Development Biology: Embryonic development, cellular differentiation, organogenesis, metamorphosis, genetic basis of development.

Ecology: The ecosystem, habitats the food chain, population dynamics, species diversity, zoogeography, biogeochemical cycles, conservation biology.

Animal Behaviour: Types of behaviours, courtship, mating and territoriality, instinct, learning and memory, social behaviour across the animal taxa, communication, pheromones, evolution of animal behaviour.

IT - INFORMATION TECHNOLOGY

ENGINEERING MATHEMATICS

Mathematical Logic: Propositional Logic; First Order Logic.

Probability: Conditional Probability; Mean, Median, Mode and Standard Deviation; Random Variables; Distributions; uniform, normal, exponential, Poisson, Binomial.

Set Theory & Algebra: Sets; Relations; Functions; Groups; Partial Orders; Lattice; Boolean Algebra.

Combinatorics: Permutations; Combinations; Counting; Summation; generating functions; recurrence relations; asymptotics.

Graph Theory: Connectivity; spanning trees; Cut vertices & edges; covering; matching; independent sets; Colouring; Planarity; Isomorphism.

Linear Algebra: Algebra of matrices, determinants, systems of linear equations, Eigen values and Eigen vectors.

Numerical Methods: LU decomposition for systems of linear equations; numerical solutions of non linear algebraic equations by Secant, Bisection and Newton-Raphson Methods; Numerical integration by trapezoidal and Simpson's rules.

Calculus: Limit, Continuity & differentiability, Mean value Theorems, Theorems of integral calculus, evaluation of definite & improper integrals, Partial derivatives, Total derivatives, maxima & minima.

FORMAL LANGUAGES AND AUTOMATA

Regular Languages: finite automata, regular expressions, regular grammar.

Context free languages: push down automata, context free grammars

COMPUTER HARDWARE

Digital Logic: Logic functions, minimization, design and synthesis of combinatorial and sequential circuits, number representation and computer arithmetic (fixed and floating point)

Computer organization: Machine instructions and addressing modes, ALU and data path, hardwired and microprogrammed control, memory interface, I/O interface (interrupt and DMA mode), serial communication interface, instruction pipelining, cache, main and secondary storage

SOFTWARE SYSTEMS

Data structures and Algorithms: the notion of abstract data types, stack, queue, list, set, string, tree, binary search tree, heap, graph, tree and graph traversals, connected components, spanning trees, shortest paths, hashing, sorting, searching, design techniques (greedy, dynamic, divide and conquer), asymptotic analysis (best, worst, average cases) of time and space, upper and lower bounds, intractability

Programming Methodology: C programming, program control (iteration, recursion, functions), scope, binding, parameter passing, elementary concepts of object oriented programming

Operating Systems (in the context of Unix): classical concepts (concurrency, synchronization, deadlock), processes, threads and interprocess communication, CPU scheduling, memory management, file systems, I/O systems, protection and security

Information Systems and Software Engineering: information gathering, requirement and feasibility analysis, data flow diagrams, process specifications, input/output design, process life cycle, planning and managing the project, design, coding, testing, implementation, maintenance.

Databases: relational model, database design, integrity constraints, normal forms, query languages (SQL), file structures (sequential, indexed), b-trees, transaction and concurrency control

Data Communication: data encoding and transmission, data link control, multiplexing, packet switching, LAN architecture, LAN systems (Ethernet, token ring), Network devices: switches, gateways, routers

Networks: ISO/OSI stack, sliding window protocols, routing protocols, TCP/UDP, application layer protocols & systems (http, smtp, dns, ftp), network security

Web technologies: three tier web based architecture; JSP, ASP, J2EE, .NET systems; html, XML

AG - AGRICULTURAL ENGINEERING

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

FARM MACHINERY AND POWER:

Sources of power on the farm-human, animal, mechanical, electrical, wind, solar and biomass; design and selection of machine elements - gears, pulleys, chains and sprockets and belts; overload safety devices used in farm machinery; measurement of force, torque, speed, displacement and acceleration on machine elements.

Soil tillage; forces acting on a tillage tool; hitch systems and hitching of tillage implements; functional requirements, principles of working, construction and operation of manual, animal and power operated equipment for tillage. sowing, planting, fertilizer application, inter-cultivation, spraying, mowing, chaff cutting, harvesting, threshing and transport; testing of agricultural machinery and equipment; calculation of performance parameters -field capacity, efficiency, application rate and losses; cost analysis of implements and tractors.

Thermodynamic principles of I.C. engines; I.C. engine cycles; engine components; fuels and combustion; lubricants and their properties; I.C. engine systems - fuel, cooling, lubrication, ignition, electrical, intake and exhaust; selection, operation, maintenance and repair of I.C. engines; power efficiencies and measurement; calculation of power, torque, fuel consumption, heat load and power losses.

Tractors and power tillers - type, selection, maintenance and repair; tractor clutches and brakes; power transmission systems - gear trains, differential, final drives and power take-off; mechanics of tractor chassis; traction theory; three point hitches- free link and restrained link operations; mechanical steering and hydraulic control systems used in tractors; human engineering and safety in tractor design; tractor tests and performance.

SOIL AND WATER CONSERVATION ENGINEERING:

Ideal and real fluids, properties of fluids; hydrostatic pressure and its measurement; hydrostatic forces on plane and curved surface; continuity equation; Bernoulli's theorem; laminar and turbulent flow in pipes, Darcy-Weisbach and Hazen-Williams equations, Moody's diagram; flow through orifices and notches; flow in open channels.

Engineering properties of soils, fundamental definitions and relationships; index properties of soils; permeability and seepage analysis; shear strength, Mohr's circle of stresses; active and passive earth pressures; stability of slopes.

Hydrological cycle; precipitation measurement, analysis of precipitation data; abstraction from precipitation; runoff; hydrograph analysis, unit hydrograph theory and application; stream flow measurement; flood routing, hydrological reservoir and channel routing.

Mechanics of soil erosion, factors affecting erosion; soil loss estimation; biological and engineering measures to control erosion, terraces and bunds; vegetative waterways; gully control structures, drop, drop inlet and chute spillways; farm ponds; earthen dams; principles of watershed management.

Water requirement of crops; consumptive use and evapo-transpiration; irrigation scheduling; irrigation efficiencies; design of prismatic and silt loaded channels; methods of irrigation water application; design and evaluation of irrigation methods; drainage coefficient; surface and subsurface drainage systems; leaching requirement and salinity control; irrigation and drainage water quality; classification of pumps; pump characteristics; pump selection; types of aquifer; evaluation of aquifer properties; well hydraulics; ground water recharge.

AGRICULTURAL PROCESSING AND FOOD ENGINEERING:

Steady state heat transfer in conduction, convection and radiation; transient heat transfer in simple geometry; condensation and boiling heat transfer; working principles of heat exchangers; diffusive and convective mass transfer; simultaneous heat and mass transfer in agricultural processing operations.

Material and energy balances in food processing systems; water activity, sorption and desorption isotherms; centrifugal separation of solids, liquids and gases; kinetics of microbial death - pasteurisation and sterilization of liquid foods; preservation of food by cooling and freezing; psychrometry - properties of air-vapour mixture; concentration and dehydration of liquid foods - evaporators, tray, drum and spray dryers.

Mechanics and energy requirement in size reduction of granular solids; particle size analysis for comminuted solids; size separation by screening; fluidisation of granular solids; cleaning and grading efficiency and effectiveness of grain cleaners; conditioning and hydrothermal treatments for grains; dehydration of food grains; processes and machines for processing of cereals, pulses and oilseeds; design considerations for grain silos.

AR - ARCHITECTURE AND PLANNING

City planning: Historical development of cities; principles of city planning; new towns; survey methods, site planning, planning regulations and building bye-laws.

Housing: Concept of shelter; housing policies and design; community planning; role of government agencies; finance and management.

Landscape Design: Principles of landscape design and site planning; history and landscape styles; landscape elements and materials; planting design.

Computer Aided Design: Application of computers in architecture and planning; understanding elements of hardware and software; computer graphics; programming languages - C and Visual Basic and usage of packages such as AutoCAD.

Environmental and Building Science: Elements of environmental science; ecological principles concerning environment; role of micro-climate in design; climatic control through design elements; thermal comfort; elements of solar architecture; principles of lighting and illumination; basic principles of architectural acoustics; air pollution, noise pollution and their control.

Visual and Urban Design: Principles of visual composition; proportion, scale, rhythm, symmetry, harmony, balance, form and colour; sense of place and space, division of space; focal point, vista, imageability, visual survey.

History of Architecture: Indian - Indus valley, Vedic, Buddhist, Indo-Aryan, Dravidian and Mughal periods; European - Egyptian, Greek, Roman, medieval and renaissance periods.

Development of Contemporary Architecture: Architectural developments and impacts on society since industrial revolution; influence of modern art on architecture; works of national and international architects; post modernism in architecture.

Building Services: Water supply, Sewerage and Drainage systems; Sanitary fittings and fixtures; principles of electrification of buildings; elevators, their standards and uses; air-conditioning systems; fire fighting systems.

Building Construction and Management: Building construction techniques, methods and details; building systems and prefabrication of building elements; principles of modular coordination; estimation, specification, valuation, professional practice; project management, PERT, CPM.

Materials and Structural Systems: Behavioural characteristics of all types of building materials e.g. mud, timber, bamboo, brick, concrete, steel, glass, FRP; principles of strength of materials; design of structural elements in wood, steel and RCC; elastic and limit state design; complex structural systems; principles of pre-stressing.

Planning Theory: Planning process; multilevel planning; comprehensive planning; central place theory; settlement pattern; land use and land utilization.

Techniques of Planning: Planning surveys; Preparation of urban and regional structure plans, development plans, action plans; site planning principles and design; statistical methods; application of remote sensing techniques in urban and regional planning.

Traffic and Transportation Planning: Principles of traffic engineering and transportation planning; methods of conducting surveys; design of roads, intersections and parking areas; hierarchy of roads and levels of services; traffic and transport management in urban areas; traffic safety and traffic laws; public transportation planning; modes of transportation.

Services and Amenities: Principles and design of water supply systems, sewerage systems, solid waste disposal systems, power supply and communication systems; Health, education, recreation and demography related standards at various levels of the settlements.

Development Administration and Management: Planning laws; development control and zoning regulations; laws relating to land acquisition; development enforcements, land ceiling; regional and urban plan preparations; planning and municipal administration; taxation, revenue resources and fiscal management; public participation and role of NGO.

CE - CIVIL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

STRUCTURAL ENGINEERING

Mechanics: Bending moments and shear forces in statically determinate beams; simple stress and strain: relationship; stress and strain in two dimensions, principal stresses, stress transformation, Mohr's circle; simple bending theory; flexural shear stress; thin-walled pressure vessels; uniform torsion.

Structural Analysis: Analysis of statically determinate trusses, arches and frames; displacements in statically determinate structures and analysis of statically indeterminate structures by force/energy methods; analysis by displacement methods (slope-deflection and moment-distribution methods); influence lines for determinate and indeterminate structures; basic concepts of matrix methods of structural analysis.

Concrete Structures: Basic working stress and limit states design concepts; analysis of ultimate load capacity and design of members subject to flexure, shear, compression and torsion (beams, columns and isolated footings); basic elements of prestressed concrete: analysis of beam sections at transfer and service loads.

Steel Structures: Analysis and design of tension and compression members, beams and beam-columns, column bases; connections - simple and eccentric, beam-column connections, plate girders and trusses; plastic analysis of beams and frames.

GEOTECHNICAL ENGINEERING

Soil Mechanics: Origin of soils; soil classification; three-phase system, fundamental definitions, relationship and inter-relationships; permeability and seepage; effective stress principle: consolidation, compaction; shear strength.

Foundation Engineering: Sub-surface investigation - scope, drilling bore holes, sampling, penetrometer tests, plate load test; earth pressure theories, effect of water table, layered soils; stability of slopes - infinite slopes, finite slopes; foundation types - foundation design requirements; shallow foundations; bearing capacity, effect of shape, water table and other factors, stress distribution, settlement analysis in sands and clays; deep foundations - pile types, dynamic and static formulae, load capacity of piles in sands and clays.

WATER RESOURCES ENGINEERING

Fluid Mechanics and Hydraulics: Hydrostatics, applications of Bernoulli equation, laminar and turbulent flow in pipes, pipe networks; concept of boundary layer and its growth; uniform flow, critical flow and gradually varied flow in channels, specific energy concept, hydraulic jump; forces on immersed bodies; flow measurement in channels; tanks and pipes; dimensional analysis and hydraulic modeling. Applications of momentum equation, potential flow, kinematics of flow; velocity triangles and specific speed of pumps and turbines.

Hydrology: Hydrologic cycle; rainfall; evaporation infiltration, unit hydrographs, flood estimation, reservoir design, reservoir and channel routing, well hydraulics.

Irrigation: Duty, delta, estimation of evapo-transpiration; crop water requirements; design of lined and unlined canals; waterways; head works, gravity dams and Ogee spillways. Designs of weirs on permeable foundation, irrigation methods.

ENVIRONMENTAL ENGINEERING

Water requirements; quality and standards, basic unit processes and operations for water treatment, distribution of water. Sewage and sewerage treatment: quantity and characteristic of waste water sewerage; primary and secondary treatment of waste water; sludge disposal; effluent discharge standards.

TRANSPORTATION ENGINEERING

Highway planning; geometric design of highways; testing and specifications of paving materials; design of flexible and rigid pavements.

CH - CHEMICAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

CHEMICAL ENGINEERING

Process Calculations and Thermodynamics: Laws of conservation of mass and energy; use of tie components; recycle, bypass and purge calculations; degree of freedom analysis.

First and Second laws of thermodynamics and their applications; equations of state and thermodynamic properties of real systems; phase equilibria; fugacity, excess properties and correlations of activity coefficients; chemical reaction equilibria.

Fluid Mechanics and Mechanical Operations: Fluid statics, Newtonian and non-Newtonian fluids, Bernoulli equation, Macroscopic friction factors, energy balance, dimensional analysis, shell balances, flow through pipeline systems, flow meters, pumps and compressors, packed and fluidized beds, elementary boundary layer theory, size reduction and size separation; free and hindered settling; centrifuge and cyclones; thickening and classification, filtration, mixing and agitation; conveying of solids.

Heat Transfer: Conduction, convection and radiation, heat transfer coefficients, steady and unsteady heat conduction, boiling, condensation and evaporation; types of heat exchangers and evaporators and their design.

Mass Transfer: Fick's law, molecular diffusion in fluids, mass transfer coefficients, film, penetration and surface renewal theories; momentum, heat and mass transfer analogies; stagewise and continuous contacting and stage efficiencies; HTU & NTU concepts design and operation of equipment for distillation, absorption, leaching, liquid-liquid extraction, crystallization, drying, humidification, dehumidification and adsorption.

Chemical Reaction Engineering: Theories of reaction rates; kinetics of homogeneous reactions, interpretation of kinetic data, single and multiple reactions in ideal reactors, non-ideal reactors; residence time; non-isothermal reactors; kinetics of heterogeneous catalytic reactions; diffusion effects in catalysis.

Instrumentation and Process Control: Measurement of process variables; sensors, transducers and their dynamics, dynamics of simple systems, dynamics such as CSTRs, transfer functions and responses of simple systems, process reaction curve, controller modes (P, PI, and PID); control valves; analysis of closed loop systems including stability, frequency response (including Bode plots) and controller tuning, cascade, feed forward control.

Plant Design and Economics: Design and sizing of chemical engineering equipment such as compressors, heat exchangers, multistage contactors; principles of process economics and cost estimation including total annualized cost, cost indexes, rate of return, payback period, discounted cash flow, optimization in Design.

Chemical Technology: Inorganic chemical industries; sulfuric acid, NaOH, fertilizers (Ammonia, Urea, SSP and TSP); natural products industries (Pulp and Paper, Sugar, Oil, and Fats); petroleum refining and petrochemicals; polymerization industries; polyethylene, polypropylene, PVC and polyester synthetic fibers.

CS - COMPUTER SCIENCE AND ENGINEERING

ENGINEERING MATHEMATICS

Mathematical Logic: Propositional Logic; First Order Logic.

Probability: Conditional Probability; Mean, Median, Mode and Standard Deviation; Random Variables; Distributions; uniform, normal, exponential, Poisson, Binomial.

Set Theory & Algebra: Sets; Relations; Functions; Groups; Partial Orders; Lattice; Boolean Algebra.

Combinatorics: Permutations; Combinations; Counting; Summation; generating functions; recurrence relations; asymptotics.

Graph Theory: Connectivity; spanning trees; Cut vertices & edges; covering; matching; independent sets; Colouring; Planarity; Isomorphism.

Linear Algebra: Algebra of matrices, determinants, systems of linear equations, Eigen values and Eigen vectors.

Numerical Methods: LU decomposition for systems of linear equations; numerical solutions of non linear algebraic equations by Secant, Bisection and Newton-Raphson Methods; Numerical integration by trapezoidal and Simpson's rules.

Calculus: Limit, Continuity & differentiability, Mean value Theorems, Theorems of integral calculus, evaluation of definite & improper integrals, Partial derivatives, Total derivatives, maxima & minima.

THEORY OF COMPUTATION

Formal Languages and Automata Theory: Regular languages and finite automata, Context free languages and Push-down automata, Recursively enumerable sets and Turing machines, Un-decidability;

Analysis of Algorithms and Computational Complexity: Asymptotic analysis (best, worst, average case) of time and space, Upper and lower bounds on the complexity of specific problems, NP-completeness.

COMPUTER HARDWARE

Digital Logic: Logic functions, Minimization, Design and synthesis of Combinational and Sequential circuits; Number representation and Computer Arithmetic (fixed and floating point);

Computer Organization: Machine instructions and addressing modes, ALU and Data-path, hardwired and micro-programmed control, Memory interface, I/O interface (Interrupt and DMA mode), Serial communication interface, Instruction pipelining, Cache, main and secondary storage.

SOFTWARE SYSTEMS

Data structures: Notion of abstract data types, Stack, Queue, List, Set, String, Tree, Binary search tree, Heap, Graph;

Programming Methodology: C programming, Program control (iteration, recursion, Functions), Scope, Binding, Parameter passing, Elementary concepts of Object oriented, Functional and Logic Programming;

Algorithms for problem solving: Tree and graph traversals, Connected components, Spanning trees, Shortest paths; Hashing, Sorting, Searching; Design techniques (Greedy, Dynamic Programming, Divide-and-conquer);

Compiler Design: Lexical analysis, Parsing, Syntax directed translation, Runtime environment, Code generation, Linking (static and dynamic); Operating Systems: Classical concepts (concurrency, synchronization, deadlock), Processes, threads and Inter-process communication, CPU scheduling, Memory management, File systems, I/O systems, Protection and security.

Databases: Relational model (ER-model, relational algebra, tuple calculus), Database design (integrity constraints, normal forms), Query languages (SQL), File structures (sequential files, indexing, B+ trees), Transactions and concurrency control;

Computer Networks: ISO/OSI stack, sliding window protocol, LAN Technologies (Ethernet, Token ring), TCP/UDP, IP, Basic concepts of switches, gateways, and routers.

CH - CHEMISTRY

PHYSICAL CHEMISTRY

Structure: Quantum theory - principles and techniques; applications to particle in a box, harmonic oscillator, rigid rotor and hydrogen atom; valence bond and molecular orbital theories and Huckel approximation, approximate techniques: variation and perturbation; symmetry, point groups; rotational, vibrational, electronic, NMR and ESR spectroscopy.

Equilibrium: First law of thermodynamics, heat, energy and work; second law of thermodynamics and entropy; third law and absolute entropy; free energy; partial molar quantities; ideal and non-ideal solutions; phase transformation: phase rule and phase diagrams- one, two, and three component systems; activity, activity coefficient, fugacity and fugacity coefficient ; chemical equilibrium, response of chemical equilibrium to temperature and pressure; colligative properties; kinetic theory of gases; thermodynamics of electrochemical cells; standard electrode potentials: applications - corrosion and energy conversion; molecular partition function (translational, rotational, vibrational and electronic).

Kinetics: Rates of chemical reactions, theories of reaction rates, collision and transition state theory; temperature dependence of chemical reactions; elementary reactions, consecutive elementary reactions; steady state approximation, kinetics of photochemical reactions and free radical polymerization, homogenous and heterogeneous catalysis.

INORGANIC CHEMISTRY

Non-Transition Elements: General characteristics, structure and reactions of simple and industrially important compounds, boranes, carboranes, silicates, silicones, diamond and graphite; hydrides, oxides and oxoacids of N, P, S and halogens; boron nitride, borazines and phosphazenes; xenon compounds. Shapes of molecules, hard-soft acid base concept.

Transition Elements: General characteristics of d and f block elements; coordination chemistry: structure and isomerism, stability, theories of metal-ligand bonding (CFT and LFT), electronic spectra and magnetic properties of transition metal complexes and lanthanides; metal carbonyls, metal-metal bonds and metal atom clusters, metallocenes; transition metal complexes with bonds to hydrogen, alkyls, alkenes, and arenes; metal carbenes; use of organometallic compounds as catalysts in organic synthesis; mechanisms of substitution and electron transfer reactions of coordination complexes. Role of metals with special reference to Na, K, Mg, Ca, Fe, Co, Zn, and Mo in biological systems.

Solids: Crystal systems and lattices, Miller planes, crystal packing, crystal defects; Bragg's Law; ionic crystals, band theory, metals and semiconductors. Spinels.

Instrumental methods of analysis: atomic absorption, UV-visible spectrometry, chromatographic and electro-analytical methods.

ORGANIC CHEMISTRY

Synthesis, reactions and mechanisms involving the following: Alkenes, alkynes, arenes, alcohols, phenols, aldehydes, ketones, carboxylic acids and their derivatives; halides, nitro compounds and amines; stereochemical and conformational effects on reactivity and specificity; reactions with diborane and peracids. Michael reaction, Robinson annulation, reactivity umpolung, acyl anion equivalents; molecular rearrangements involving electron deficient atoms.

Photochemistry: Basic principles, photochemistry of olefins, carbonyl compounds, arenes, photo oxidation and reduction.

Pericyclic reactions: Cycloadditions, electrocyclic reactions, sigmatropic reactions; Woodward-Hoffmann rules.

Heterocycles: Structural properties and reactions of furan, pyrrole, thiophene, pyridine, indole.

Biomolecules: Structure, properties and reactions of mono- and di-saccharides, physico-chemical properties of amino acids, structural features of proteins and nucleic acids.

Spectroscopy: Principles and applications of IR, UV-visible, NMR and mass spectrometry in the determination of structures of organic compounds.

EC - ELECTRONICS AND COMMUNICATION ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix Algebra, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Mean value theorems, Theorems of integral calculus, Evaluation of definite and improper integrals, Partial Derivatives, Maxima and minima, Multiple integrals, Fourier series. Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equation (linear and nonlinear), Higher order linear differential equations with constant coefficients, Method of variation of parameters, Cauchy's and Euler's equations, Initial and boundary value problems, Partial Differential Equations and variable separable method.

Complex variables: Analytic functions, Cauchy's integral theorem and integral formula, Taylor's and Laurent' series, Residue theorem, solution integrals.

Probability and Statistics: Sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Discrete and continuous distributions, Poisson, Normal and Binomial distribution, Correlation and regression analysis.

Numerical Methods: Solutions of non-linear algebraic equations, single and multi-step methods for differential equations.

Transform Theory: Fourier transform, Laplace transform, Z-transform.

ELECTRONICS & COMMUNICATION ENGINEERING

Networks: Network graphs: matrices associated with graphs; incidence, fundamental cut set and fundamental circuit matrices. Solution methods: nodal and mesh analysis. Network theorems: superposition, Thevenin and Norton's maximum power transfer, Wye-Delta transformation. Steady state sinusoidal analysis using phasors. Linear constant coefficient differential equations; time domain analysis of simple RLC circuits, Solution of network equations using Laplace transform: frequency domain analysis of RLC circuits. 2-port network parameters: driving point and transfer functions. State equations for networks.

Electronic Devices: Energy bands in silicon, intrinsic and extrinsic silicon. Carrier transport in silicon: diffusion current, drift current, mobility, resistivity. Generation and recombination of carriers. p-n junction diode, Zener diode, tunnel diode, BJT, JFET, MOS capacitor, MOSFET, LED, p-I-n and avalanche photo diode, LASERs. Device technology: integrated circuits fabrication process, oxidation, diffusion, ion implantation, photolithography, n-tub, p-tub and twin-tub CMOS process.

Analog Circuits: Equivalent circuits (large and small-signal) of diodes, BJTs, JFETs, and MOSFETs. Simple diode circuits, clipping, clamping, rectifier. Biasing and bias stability of transistor and FET amplifiers. Amplifiers: single-and multi-stage, differential, operational, feedback and power. Analysis of amplifiers; frequency response of amplifiers. Simple op-amp circuits. Filters. Sinusoidal oscillators; criterion for oscillation; single-transistor and op-amp configurations. Function generators and wave-shaping circuits. Power supplies.

Digital circuits: Boolean algebra, minimization of Boolean functions; logic gates digital IC families (DTL, TTL, ECL, MOS, CMOS). Combinational circuits: arithmetic circuits, code converters, multiplexers and decoders. Sequential circuits: latches and flip-flops, counters and shift-registers. Sample and hold circuits, ADCs, DACs. Semiconductor memories. Microprocessor(8085): architecture, programming, memory and I/O interfacing.

Signals and Systems: Definitions and properties of Laplace transform, continuous-time and discrete-time Fourier series, continuous-time and discrete-time Fourier Transform, z-transform. Sampling theorems. Linear Time-Invariant (LTI) Systems: definitions and properties; casuality, stability, impulse response, convolution, poles and zeros frequency response, group delay, phase delay. Signal transmission through LTI systems. Random signals and noise: probability, random variables, probability density function, autocorrelation, power spectral density.

Controls Systems: Basic control system components; block diagrammatic description, reduction of block diagrams. Open loop and closed loop (feedback) systems and stability analysis of these systems. Signal flow graphs and their use in determining transfer functions of systems; transient and steady state analysis of LTI control systems and frequency response. Tools and techniques for LTI control system analysis: root loci, Routh-Hurwitz criterion, Bode and Nyquist plots. Control system compensators: elements of lead and lag compensation, elements of Proportional-Integral-Derivative(PID) control. State variable representation and solution of state equation of LTI control systems.

Communications: Analog communication systems: amplitude and angle modulation and demodulation systems, spectral analysis of these operations, superheterodyne receivers; elements of hardware, realizations of analog communication systems; signal-to-noise ratio (SNR) calculations for amplitude modulation (AM) and frequency modulation (FM) for low noise conditions. Digital communication systems: pulse code modulation (PCM), differential pulse code modulation (DPCM), delta modulation (DM); digital modulation schemes-amplitude, phase and frequency shift keying schemes (ASK, PSK, FSK), matched filter receivers, bandwith consideration and probability of error calculations for these schemes.

Electromagnetics: Elements of vector calculus: divergence and curl; Gauss' and Stokes' theorems, Maxwell's equations: differential and integral forms. Wave equation, Poynting vector. Plane waves: propagation through various media; reflection and refraction; phase and group velocity; skin depth. Transmission lines: characteristic impedance; impedance transformation; Smith chart; impedance matching; pulse excitation. Waveguides: modes in rectangular waveguides; boundary conditions; cut-off frequencies; dispersion relations. Antennas: Dipole antennas; antenna arrays; radiation pattern; reciprocity theorem, antenna gain.

EE - ELECTRICAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix Algebra, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Mean value theorems, Theorems of integral calculus, Evaluation of definite and improper integrals, Partial Derivatives, Maxima and minima, Multiple integrals, Fourier series. Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equation (linear and nonlinear), Higher order linear differential equations with constant coefficients, Method of variation of parameters, Cauchy's and Euler's equations, Initial and boundary value problems, Partial Differential Equations and variable separable method.

Complex variables: Analytic functions, Cauchy's integral theorem and integral formula, Taylor's and Laurent' series, Residue theorem, solution integrals.

Probability and Statistics: Sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Discrete and continuous distributions, Poisson, Normal and Binomial distribution, Correlation and regression analysis.

Numerical Methods: Solutions of non-linear algebraic equations, single and multi-step methods for differential equations.

Transform Theory: Fourier transform, Laplace transform, Z-transform.

ELECTRICAL ENGINEERING

Electrical Circuits and Fields: Network graph, KCL, KVL, node/ cut set, mesh/ tie set analysis, transient response of d.c. and a.c. networks; sinusoidal steady-state analysis; resonance in electrical circuits; concepts of ideal voltage and current sources, network theorems, driving point, immittance and transfer functions of two port networks, elementary concepts of filters; three phase circuits; Fourier series and its application; Gauss theorem, electric field intensity and potential due to point, line, plane and spherical charge distribution, dielectrics, capacitance calculations for simple configurations; Ampere's and Biot-Savart's law, inductance calculations for simple configurations.

Electrical Machines: Single phase transformer - equivalent circuit, phasor diagram, tests, regulation and efficiency; three phase transformers - connections, parallel operation; auto transformer and three-winding transformer; principles of energy conversion, windings of rotating machines: D. C. generators and motors - characteristics, starting and speed control, armature reaction and commutation; three phase induction motors-performance characteristics, starting and speed control; single-phase induction motors; synchronous generators-performance, regulation, parallel operation; synchronous motors - starting, characteristics, applications, synchronous condensers; fractional horse power motors; permanent magnet and stepper motors.

Power Systems: Electric power generation - thermal, hydro, nuclear; transmission line parameters; steady-state performance of overhead transmission lines and cables and surge propagation; distribution systems, insulators, bundle conductors, corona and radio interference effects; per-unit quantities; bus admittance and impedance matrices; load flow; voltage control and power factor correction; economic operation; symmetrical components, analysis of symmetrical and unsymmetrical faults; principles of over current, differential and distance protections; concept of solid state relays and digital protection; circuit breakers; concept of system stability-swing curves and equal area criterion; basic concepts of HVDC transmission.

Control Systems: Principles of feedback; transfer function; block diagrams: steady-state errors; stability-Routh and Nyquist criteria; Bode plots; compensation; root loci; elementary state variable formulation; state transition matrix and response for Linear Time Invariant systems.

Electrical and Electronic Measurements: Bridges and potentiometers, PMMC, moving iron, dynamometer and induction type instruments; measurement of voltage, current, power, energy and power factor; instrument transformers; digital voltmeters and multimeters; phase, time and frequency measurement; Q-meter, oscilloscopes, potentiometric recorders, error analysis.

Analog and Digital Electronics: Characteristics of diodes, BJT, FET, SCR; amplifiers-biasing, equivalent circuit and frequency response; oscillators and feedback amplifiers, operational amplifiers- characteristics and applications; simple active filters; VCOs and timers; combinational and sequential logic circuits, multiplexer, Schmitt trigger, multivibrators, sample and hold circuits, A/D and D/A converters; microprocessors and their applications.

Power Electronics and Electric Drives: Semiconductor power devices-diodes, transistors, thyristors, triacs, GTOs, MOSFETs and IGBTs - static characteristics and principles of operation; triggering circuits; phase control rectifiers; bridge converters-fully controlled and half controlled; principles of choppers and inverters, basic concepts of adjustable speed dc and ac drives.

GG - GEOLOGY AND GEOPHYSICS

PART - I

Earth and planetary system; size, shape, internal structure and composition of the earth; atmosphere and greenhouse effect; isostasy; elements of seismology; continents and continental processes; physical oceanography; palaeomagnetism, continental drift plate tectonics, geothermal energy.

Weathering; soil formation; action of river, wind and glacier; oceans and oceanic features; earthquakes, volcanoes, orogeny and mountain building; elements of structural geology; crystallography; classification, composition and properties of minerals and rocks; engineering properties of rocks and soils, role of geology in the construction of engineering structures.

Processes of ore formation, occurrence and distribution of ores on land and on ocean floor;

coal and petroleum resources in India; ground water geology including well hydraulics, geological time scale and geochronology; stratigraphic principles and stratigraphy of India; basics concepts of gravity, magnetic and electrical prospecting for ores and ground water.

PART - IIA: GEOLOGY

Crystal symmetry, forms, twinning; crystal chemistry; optical mineralogy, classification of minerals, diagnostic properties of rock minerals.

Mineralogy, structure, texture and classification of igneous, sedimentary and metamorphic rock, their origin and evolution; application of thermodynamics; structure and petrology of sedimentary rocks; sedimentary processes and environments, sedimentary facies, basin studies; basement cover relationship;

Primary and secondary structures; geometry and genesis of folds, faults, joints, unconformities, cleavage, schistosity and lineation; methods of projection. Tectonites and their significance; shear zone; superposed folding.

Morphology, classification and geological significance of important invertebrates, vertebrates, microfossils and palaeoflora; stratigraphic principles and Indian stratigraphy; geomorphic processes and agents; development and evolution of landforms; slope and drainage; processes on deep oceanic and near-shore regions; quantitative and applied geomorphology; air photo interpretation and remote sensing; chemical and optical properties of ore minerals; formation and localization of ore deposits; prospecting and exploration of economic minerals; coal and petroleum geology; origin and distribution of mineral and fuel deposits in India; ore dressing and mineral economics.

Cosmic abundance; meteorites; geochemical evolution of the earth; geochemical cycles; distribution of major, minor and trace elements; isotope geochemistry; geochemistry of waters including solution equilibria and water rock interaction.

Engineering properties of rocks and soils; rocks as construction material; geology of dams, tunnels and excavation sites; natural hazards; the fly ash problem; ground water geology and exploration; water quality; impact of human activity; Remote sensing techniques for the interpretation of landforms and resource management.

PART - II B: GEOPHYSICS

The earth as a planet; different motions of the earth; gravity filed of the earth and its shape; geochronology; isostasy, seismology and interior of the earth; variation of density, velocity, pressure, temperature, electrical and magnetic properties inside the earth; earthquakes-causes and measurements; zonation and seismic hazards; geomagnetic field, palaeomagnetism; oceanic and continental lithosphere; plate tectonics; heat flow; upper and lower atmospheric phenomena.

Theories of scalar and vector potential fields; Laplace, Maxwell and Helmholtz equations for solution of different types of boundary value problems for Cartesian, cylindrical and spherical polar coordinates; Green's theorem; Image theory; integral equations and conformal transformations in potential theory; Eikonal equation and ray theory.

'G' and 'g' units of measurement, density of rocks, gravimeters, preparation, analysis and interpretation of gravity maps; derivative maps, analytical continuation; gravity anomaly type curves; calculation of mass.

Earth's magnetic field, units of measurement, magnetic susceptibility of rocks, magnetometers, corrections, preparation of magnetic maps, magnetic anomaly type curve, analytical continuation, interpretation and application; magnetic well logging.

Conduction of electricity through rocks, electrical conductivities of metals, metallic, non-metallic and rock forming minerals, D.C. resistivity units and methods of measurement, electrode configuration for sounding and profiling, application of filter theory, interpretation of resistivity field data, application; self potential origin, classification, field measurement, interpretation of induced polarization time frequency, phase domain; IP units and methods of measurement, interpretation and application; ground-water exploration.

Origin of electromagnetic field elliptic polarization, methods of measurement for different source-receiver configuration components in EM measurements, interpretation and applications; earth's natural electromagnetic field, tellurics, magneto-tellurics; geomagnetic depth sounding principles, methods of measurement, processing of data and interpretation.

Seismic methods of prospecting: Reflection, refraction and CDP surveys; land and marine seismic sources, generation and propagation of elastic waves, velocity increasing with depth, geophones, hydrophones, recording instruments (DFS), digital formats, field layouts, seismic noises and noise profile analysis, optimum geophone grouping, noise cancellation by shot and geophone arrays, 2D and 3D seismic data acquisition and processing, CDP stacking charts, binning, filtering, dip-moveout, static and dynamic corrections, deconvolution, migration, signal processing, Fourier and Hilbert transforms, attribute analysis, bright and dim spots, seismic stratigraphy, high resolution seismics, VSP.

Principles and techniques of geophysical well-logging, SP, resistivity, induction, micro gamma ray, neutron, density, sonic, temperature, dip meter, caliper, nuclear magnetic, cement bond logging. Quantitative evaluation of formations from well logs; well hydraulics and application of geophysical methods for groundwater study; application of bore hole geophysics in ground water, mineral and oil exploration. Remote sensing techniques and application of remote sensing methods in geophysics.

IN - INSTRUMENTATION ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix Algebra, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Mean value theorems, Theorems of integral calculus, Evaluation of definite and improper integrals, Partial Derivatives, Maxima and minima, Multiple integrals, Fourier series. Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equation (linear and nonlinear), Higher order linear differential equations with constant coefficients, Method of variation of parameters, Cauchy's and Euler's equations, Initial and boundary value problems, Partial Differential Equations and variable separable method.

Complex variables: Analytic functions, Cauchy's integral theorem and integral formula, Taylor's and Laurent' series, Residue theorem, solution integrals.

Probability and Statistics: Sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Discrete and continuous distributions, Poisson, Normal and Binomial distribution, Correlation and regression analysis.

Numerical Methods: Solutions of non-linear algebraic equations, single and multi-step methods for differential equations.

Transform Theory: Fourier transform, Laplace transform, Z-transform.

INSTRUMENTATION ENGINEERING

Measurement Basics and Metrology: Static and dynamic characteristics of measurement systems. Standards and calibration. Error and uncertainty analysis, statistical analysis of data, and curve fitting. Linear and angular measurements; Measurement of straightness, flatness, roundness and roughness.

Transducers, Mechanical Measurements and Industrial Instrumentation: Transducers - elastic, resistive, inductive, capacitive, thermo-electric, piezoelectric, photoelectric, electro-mechanical, electro-chemical, and ultrasonic. Measurement of displacement, velocity (linear and rotational), acceleration, shock, vibration, force, torque, power, strain, stress, pressure, flow, temperature, humidity, viscosity, and density. energy storing elements, suspension systems and dampers.

Analog Electronics: Characteristics of diodes, BJTs, JFETs and MOSFETs; Diode circuits; Amplifiers: single and multi-stage, feedback; Frequency response; Operational amplifiers - design, characteristic, linear and non-linear applications: difference amplifiers; instrumentation amplifiers; precision rectifiers, I-to-V converters, active filters, oscillators, comparators, signal generators, wave shaping circuits.

Digital Electronics: Combinational logic circuits, minimization of Boolean functions; IC families (TTL, MOS, CMOS), arithmetic circuits, multiplexer and decoders. Sequential circuits: flip-flops, counters, shift registers. Schmitt trigger, timers, and multivibrators. Analog switches, multiplexers, S/H circuits. Analog-to-digital and digital-to-analog converters. Basics of computer organization and architecture. 8-bit microprocessor (8085), applications, memory, I/O interfacing, and microcontrollers.

Signals and Systems: Vectors and matrices; Fourier series; Fourier transforms; Ordinary differential equations. Impulse and frequency responses of first and second order systems. Laplace transform and transfer function, convolution and correlation. Amplitude and frequency modulations and demodulations. Discrete time systems, difference equations, impulse and frequency responses; Z-transforms and transfer functions; IIR and FIR filters.

Electrical and Electronic Measurements: Measurement of R, L and C; bridges and potentiometers. Measurement of voltage, current, power, power factor, and energy; Instrument transformers; Q meter, waveform analyzers. Digital volt-meters and multi-meters. Time, phase and frequency measurements; Oscilloscope. Noise and interference in instrumentation.

Control Systems & Process Control: Principles of feedback; transfer function, signal flow graphs. Stability criteria, Bode plots, root-loci, Routh and Nyquist criteria. Compensation techniques; State space analysis. System components: mechanical, hydraulic, pneumatic, electrical and electronic; Servos and synchros; Stepper motors. On-off, cascade, P, PI, PID and feed-forward controls. Controller tuning and general frequency response.

Analytical, Optical and Biomedical Instrumentation: Principles of spectrometry, UV, visible, IR mass spectrometry, X-ray methods; nuclear radiation measurements, gas, solid and semi conductor lasers and their characteristics, interferometers, basics of fibre optics, transducers in biomedical applications, cardiovascular system measurements, instrumentation for clinical laboratory.

MA - MATHEMATICS

Linear Algebra: Finite dimensional vector spaces. Linear transformations and their matrix representations, rank; systems of linear equations, eigenvalues and eigenvectors, minimal polynomial, Cayley-Hamilton theorem, diagonalisation, Hermitian, Skew-Hermitian and unitary matrices. Finite dimensional inner product spaces, self-adjoint and Normal linear operators, spectral theorem, Quadratic forms.

Complex Analysis: Analytic functions, conformal mappings, bilinear transformations, complex integration: Cauchy's integral theorem and formula, Liouville's theorem, maximum modulus principle, Taylor and Laurent's series, residue theorem and applications for evaluating real integrals.

Real Analysis: Sequences and series of functions, uniform convergence, power series, Fourier series, functions of several variables, maxima, minima, multiple integrals, line, surface and volume integrals, theorems of Green, Stokes and Gauss; metric spaces, completeness, Weierstrass approximation theorem, compactness. Lebesgue measure, measurable functions; Lebesgue integral, Fatou's lemma, dominated convergence theorem.

Ordinary Differential Equations: First order ordinary differential equations, existence and uniqueness theorems, systems of linear first order ordinary differential equations, linear ordinary differential equations of higher order with constant coefficients; linear second order ordinary differential equations with variable coefficients, method of Laplace transforms for solving ordinary differential equations, series solutions; Legendre and Bessel functions and their orthogonality, Sturm Liouville system, Greeen's functions.

Algebra: Normal subgroups and homomorphisms theorems, automorphisms. Group actions, sylow's theorems and their applications groups of order less than or equal to 20, Finite p-groups. Euclidean domains, Principal ideal domains and unique factorizations domains. Prime ideals and maximal ideals in commutative rings.

Functional Analysis: Banach spaces, Hahn-Banach theorems, open mapping and closed graph theorems, principle of uniform boundedness; Hilbert spaces, orthonormal sets, Riesz representation theorem, self-adjoint, unitary and normal linear operators on Hilbert Spaces.

Numerical Analysis: Numerical solution of algebraic and transcendental equations; bisection, secant method, Newton-Raphson method, fixed point iteration, interpolation: existence and error of polynomial interpolation, Lagrange, Newton, Hermite(osculatory)interpolations; numerical differentiation and integration, Trapezoidal and Simpson rules; Gaussian quadrature; (Gauss-Legendre and Gauss-Chebyshev), method of undetermined parameters, least square and orthonormal polynomial approximation; numerical solution of systems of linear equations: direct and iterative methods, (Jacobi Gauss-Seidel and SOR) with convergence; matrix eigenvalue problems: Jacobi and Given's methods, numerical solution of ordinary differential equations: initial value problems, Taylor series method, Runge-Kutta methods, predictor-corrector methods; convergence and stability.

Partial Differential Equations: Linear and quasilinear first order partial differential equations, method of characteristics; second order linear equations in two variables and their classification; Cauchy, Dirichlet and Neumann problems, Green's functions; solutions of Laplace, wave and diffusion equations in two variables Fourier series and transform methods of solutions of the above equations and applications to physical problems.

Mechanics: Forces in three dimensions, Poinsot central axis, virtual work, Lagrange's equations for holonomic systems, theory of small oscillations, Hamiltonian equations;

Topology: Basic concepts of topology, product topology, connectedness, compactness, countability and separation axioms, Urysohn's Lemma, Tietze extension theorem, metrization theorems, Tychonoff theorem on compactness of product spaces.

Probability and Statistics: Probability space, conditional probability, Bayes' theorem, independence, Random variables, joint and conditional distributions, standard probability distributions and their properties, expectation, conditional expectation, moments. Weak and strong law of large numbers, central limit theorem. Sampling distributions, UMVU estimators, sufficiency and consistency, maximum likelihood estimators. Testing of hypotheses, Neyman-Pearson tests, monotone likelihood ratio, likelihood ratio tests, standard parametric tests based on normal, X2 ,t, F-distributions. Linear regression and test for linearity of regression. Interval estimation.

Linear Programming: Linear programming problem and its formulation, convex sets their properties, graphical method, basic feasible solution, simplex method, big-M and two phase methods, infeasible and unbounded LPP's, alternate optima. Dual problem and duality theorems, dual simplex method and its application in post optimality analysis, interpretation of dual variables. Balanced and unbalanced transportation problems, unimodular property and u-v method for solving transportation problems. Hungarian method for solving assignment problems.

Calculus of Variations and Integral Equations: Variational problems with fixed boundaries; sufficient conditions for extremum, Linear integral equations of Fredholm and Volterra type, their iterative solutions. Fredholm alternative.

ME - MECHANICAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

APPLIED MECHANICS AND DESIGN

Engineering Mechanics: Equivalent force systems, free-body concepts, equations of equilibrium, trusses and frames, virtual work and minimum potential energy. Kinematics and dynamics of particles and rigid bodies, impulse and momentum (linear and angular), energy methods, central force motion.

Strength of Materials: Stress and strain, stress-strain relationship and elastic constants, Mohr's circle for plane stress and plane strain, shear force and bending moment diagrams, bending and shear stresses, deflection of beams, torsion of circular shafts, thin and thick cylinders, Euler's theory of columns, strain energy methods, thermal stresses.

Theory of Machines: Displacement, velocity and acceleration, analysis of plane mechanisms, dynamic analysis of slider-crank mechanism, planar cams and followers, gear tooth profiles, kinematics of gears, governors and flywheels, balancing of reciprocating and rotating masses.

Vibrations: Free and forced vibration of single degree freedom systems, effect of damping, vibration isolation, resonance, critical speed of rotors.

Design of Machine Elements: Design for static and dynamic loading, failure theories, fatigue strength; design of bolted, riveted and welded joints; design of shafts and keys; design of spur gears, rolling and sliding contact bearings; brakes and clutches; belt, rope and chain drives.

FLUID MECHANICS AND THERMAL SCIENCES

Fluid Mechanics: Fluid properties, fluid statics, manometry, buoyancy; control-volume analysis of mass, momentum and energy; fluid acceleration; differential equations of continuity and momentum; Bernoulli's equation; viscous flow of incompressible fluids; boundary layer; elementary turbulent flow; flow through pipes, head losses in pipes, bends etc.

Heat-Transfer: Modes of heat transfer; one dimensional heat conduction, resistance concept, electrical analogy, unsteady heat conduction, fins; dimensionless parameters in free and forced convective heat transfer, various correlations for heat transfer in flow over flat plates and through pipes; thermal boundary layer; effect of turbulence; radiative heat transfer, black and grey surfaces, shape factors, network analysis; heat exchanger performance, LMTD and NTU methods.

Thermodynamics: Zeroth, First and Second laws of thermodynamics; thermodynamic system and processes; irreversibility and availability; behaviour of ideal and real gases, properties of pure substances, calculation of work and heat in ideal processes; analysis of thermodynamic cycles related to energy conversion; Carnot, Rankine, Otto, Diesel, Brayton and vapour compression cycles.

Power Plant Engineering: Steam generators; steam power cycles; steam turbines; impulse and reaction principles, velocity diagrams, pressure and velocity compounding; reheating and reheat factor; condensers and feed heaters.

I.C. Engines: Requirements and suitability of fuels in IC engines, fuel ratings, fuel-air mixture requirements; normal combustion in SI and CI engines; engine performance calculations.

Refrigeration and air-conditioning: Refrigerant compressors, expansion devices, condensers and evaporators; properties of moist air, psychrometric chart, basic psychometric processes.

Turbomachinery: Components of gas turbines; compression processes, centrifugal and axial flow compressors; axial flow turbines, elementary theory; hydraulic turbines; Euler-turbine equation; specific speed, Pelton-wheel, Francis and Kaplan turbines; centrifugal pumps.

MANUFACTURING AND INDUSTRIAL ENGINEERING

Engineering Materials: Structure and properties of engineering materials and their applications, heat treatment.

Metal Casting: Casting processes (expendable and non-expendable) -pattern, moulds and cores, heating and pouring, solidification and cooling, gating design, design considerations, defects.

Forming Processes: Stress-strain diagrams for ductile and brittle material, Plastic deformation and yield criteria, fundamentals of hot and cold working processes, Bulk metal forming processes (forging, rolling, extrusion, drawing), sheet metal working processes (punching, blanking, bending, deep drawing, coining, spinning, load estimation using homogeneous deformation methods, defects). processing of powder metals- atomization, compaction, sintering, secondary and finishing operations. forming and shaping of plastics- extrusion, injection moulding.

Joining Processes: Physics of welding, fusion and non-fusion welding processes, brazing and soldering, adhesive bonding, design considerations in welding, weld quality defects.

Machining and Machine Tool Operations: Mechanics of machining, single and multi-point cutting tools, tool geometry and materials, tool life and wear, cutting fluids, machinability, economics of machining, non-traditional machining processes.

Metrology and Inspection: Limits, fits and tolerances, linear and angular measurements, comparators, gauge design, interferometry, form and finish measurement, measurement of screw threads, alignment and testing methods.

Tool Engineering: Principles of work holding, design of jigs and fixtures.

Computer Integrated Manufacturing: Basic concepts of CAD, CAM and their integration tools.

Manufacturing Analysis: Part-print analysis, tolerance analysis in manufacturing and assembly, time and cost analysis.

Work-Study: Method study, work measurement, time study, work sampling, job evaluation, merit rating.

Production Planning and Control: Forecasting models, aggregate production planning, master scheduling, materials requirements planning.

Inventory Control: Deterministic and probabilistic models, safety stock inventory control systems.

Operations Research: Linear programming, simplex and duplex method, transportation, assignment, network flow models, simple queuing models, PERT and CPM

MN - MINING ENGINEERING

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

MINING ENGINEERING

Mechanics: Equivalent force systems, equations of equilibrium, two dimensional frames and trusses, free body diagrams, friction forces, particle kinematics and dynamics.

Mine Development, Geomechanics and Strata Control: Drivages for underground mine development, drilling methods and machines, explosives, blasting devices and practices, shaft sinking. Physico-mechanical properties of rocks, rock mass classification, ground control instrumentation and stress measurement techniques, theories of rock failure, ground vibrations, stress distribution around mine openings, subsidence, design of supports in roadways and workings, stability of open pits, slopes.

Mining Methods and Machinery: Surface mining - layout, development, loading, transportation and mechanization, continuous surface mining systems. Underground coal mining - bord and pillar system, longwall mining, thick seam mining methods. Underground metal mining: different stoping methods, stope mechanization, ore handling systems, mine filling. Generation and transmission of mechanical, hydraulic, and pneumatic power. Materials handling - haulages, conveyors, ropeways, face and development machinery, hoisting systems, and pumps.

Ventilation, Underground Hazards and Surface Environment: Underground atmosphere, heat load sources and thermal environment, air cooling, mechanics of air flow distribution, natural and mechanical ventilation, mine fans and their usage, auxiliary ventilation. Subsurface hazards from fires, explosions, gases, dust, and inundation, rescue apparatus and practices, safety in mines, accident analysis, noise, mine lighting. Air and water pollution: causes, dispersion, quality standards, and control.

Surveying, Mine Planning and Systems Engineering: Fundamentals of engineering surveying, Levels and levelling, Theodolite, tacheometry, triangulation, contouring, errors and adjustments, correlation, underground surveying, curves, photogrammetry, field astronomy, GPS fundamentals. Principles of planning - Sampling methods and practices, reserve estimation techniques, basics of geostatistics, optimization of facility location, cash flow concepts and mine valuation, open pit design. Work study, concepts of reliability, reliability of series and parallel systems. Linear programming, transportation and assignment problems, queueing, network analysis, inventory control.

MT - METALLURGICAL ENGINEERING

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

METALLURGICAL ENGINEERING

Thermodynamics and Rate Processes: Laws of thermodynamics, activity, equilibrium constant, applications to metallurgical systems, solutions, phase equilibria, basic kinetic laws, order of reactions, rate constants and rate limiting steps principles of electro chemistry, aqueous, corrosion and protection of metals, oxidation and high temperature corrosion - characterization and control; momentum transfer - concepts of viscosity, shell balances, Bernoulli's equation; heat transfer - conduction, convection and heat transfer coefficient relations, radiation, mass transfer - diffusion and Fick's laws.

Extractive Metallurgy: Flotation, gravity and other methods of mineral processing; agglomeration, pyro-hydro-and electro-metallurgical processes; material and energy balances; principles and processes for the extraction of non-ferrous metals - aluminium, copper, zinc, lead, magnesium, nickel, titanium and other rare metals; iron and steel making - principles, blast furnace, direct reduction processes, primary and secondary steel making, deoxidation and inclusion in steel; ingot and continuous casting; stainless steel making, design of furnaces; fuels and refractories.

Physical Metallurgy: Crystal structure and bonding characteristics of metals, alloys, ceramics and polymers; solid solutions; solidification; phase transformation and binary phase diagrams; principles of heat treatment of steels, aluminum alloys and cast irons; recovery, recrystallization and grain growth; industrially important ferrous and non-ferrous alloys; elements of X-ray and electron diffraction; principles of scanning and transmission electron microscopy; elements of ceramics, composites and electronic materials; electronic basis of thermal, optical, electrical and magnetic properties of materials.

Mechanical Metallurgy: Elements of elasticity and plasticity; defects in crystals; elements of dislocation theory - types of dislocations, slip and twinning, stress fields of dislocations, dislocation interactions and reactions, methods of seeing dislocations; strengthening mechanisms; tensile, fatigue and creep behaviour; superplasticity; fracture - Griffith theory, ductile to brittle transition, fracture toughness; failure analysis; mechanical testing - tension, compression, torsion, hardness, impact, creep, fatigue, fracture toughness and formability tests.

Manufacturing Processes: Metal casting - patterns, moulds, melting, gating, feeding and casting processes, defects and castings, hot and cold working of metals; Metal forming - fundamentals of metal forming, rolling wire drawing, extrusion, forming, sheet metal forming processes, defects in forming; Metal joining - soldering, brazing and welding, common welding processes, welding metallurgy, problems associated with welding of steels and aluminium alloys, defects in welding, powder metallurgy; NDT methods - ultrasonic, radiography, eddy current, acoustic emission and magnetic.

PH - PHYSICS

Mathematical Physics: Linear vector space, matrices; vector calculus; linear differential equations; elements of complex analysis; Laplace transforms, Fourier analysis, elementary ideas about tensors.

Classical Mechanics: Conservation laws; central forces; collisions and scattering in laboratory and centre of mass reference frames; mechanics of system of particles; rigid body dynamics; moment of inertia tensor; noninertial frames and pseudo forces; variational principle; Lagrange's and Hamilton's formalisms; equation of motion, cyclic coordinates, Poisson bracket; periodic motion, small oscillations, normal modes; wave equation and wave propagation; special theory of relativity - Lorentz transformations, relativistic kinematics, mass-energy equivalence.

Electromagnetic Theory: Laplace and Poisson equations; conductors and dielectrics; boundary value problems; Ampere's and Biot-Savart's laws; Faraday's law; Maxwell's equations; scalar and vector potentials; Coulomb and Lorentz gauges; boundary conditions at interfaces; electromagnetic waves; interference, diffraction and polarization; radiation from moving charges.

Quantum Mechanics: Physical basis of quantum mechanics; uncertainty principle; Schrodinger equation; one and three dimensional potential problems; Particle in a box, harmonic oscillator, hydrogen atom; linear vectors and operators in Hilbert space; angular momentum and spin; addition of angular momentum; time independent perturbation theory; elementary scattering theory.

Atomic and Molecular Physics: Spectra of one-and many-electron atoms; LS and jj coupling; hyperfine structure; Zeeman and Stark effects; electric dipole transitions and selection rules; X-ray spectra; rotational and vibrational spectra of diatomic molecules; electronic transition in diatomic molecules, Franck-Condon principle; Raman effect; NMR and ESR; lasers.

Thermodynamics and Statistical Physics: Laws of thermodynamics; macrostates, phase space; probability ensembles; partition function, free energy, calculation of thermodynamic quantities; classical and quantum statistics; degenerate Fermi gas; black body radiation and Planck's distribution law; Bose-Einstein condensation; first and second order phase transitions, critical point.

Solid State Physics: Elements of crystallography; diffraction methods for structure determination; bonding in solids; elastic properties of solids; defects in crystals; lattice vibrations and thermal properties of solids; free electron theory; band theory of solids; metals, semiconductors and insulators; transport properties; optical, dielectric and magnetic properties of solids; elements of superconductivity.

Nuclear and Particle Physics: Rutheford scattering; basic properties of nuclei; radioactive decay; nuclear forces; two nucleon problem; nuclear reactions; conservation laws; fission and fusion; nuclear models; particle accelerators, detectors; elementary particles; photons, baryons, mesons and leptons; Quark model.

Electronics: Network analysis; semiconductor devices; bipolar transistors; FETs; power supplies, amplifier, oscillators; operational amplifiers; elements of digital electronics; logic circuits.

PI - PRODUCTION AND INDUSTRIAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

GENERAL ENGINEERING:

Engineering Materials: Structure and properties of engineering materials and their applications; effect of strain, strain rate and temperature on mechanical properties of metals and alloys; heat treatment of metals and alloys.

Applied Mechanics: Engineering mechanics - equivalent force systems, free body concepts, equations of equilibrium, virtual work and minimum potential energy; strength of materials-stress, strain and their relationship, Mohr's circle, deflection of beams, bending and shear stress, Euler's theory of columns.

Theory of Machines and Design: Analysis of planar mechanisms, plane cams and followers; governers and fly wheels; design of elements-failure theories; design of bolted, riveted and welded joints; design of shafts, keys, belt drives, brakes and clutches.

Thermal Engineering: Fluid machines - fluid statics, Bernoulli's equation, flow through pipes, equations of continuity and momentum; Thermodynamics - zeroth, First and Second laws of thermodynamics, thermodynamic system and processes, calculation of work and heat for systems and control volumes; Heat transfer - fundamentals of conduction, convection and radiation.

PRODUCTION ENGINEERING

Metal Casting: Casting processes; patterns-materials; allowances; moulds and cores - materials, making and testing; melting and founding of cast iron, steels and nonferrous metals and alloys; solidification; design of casting, gating and risering; casting defects and inspection.

Metal working: Stress-strain in elastic and plastic deformation; deformation mechanisms; hot and cold working-forging, rolling, extrusion, wire and tube drawing; sheet metal working; analysis of rolling, forging, extrusion and wire /rod drawing; metal working defects, high energy rate forming processes-explosive, magnetic, electro and electrohydraulic.

Metal Joining Processes: Welding processes - gas shielded metal arc, TIG, MIG, submerged arc, electroslag, thermit, resistance, pressure and forge welding; thermal cutting; other joining processes - soldering, brazing, braze welding; welding codes, welding symbols, design of welded joints, defects and inspection; introduction to modern welding processes - friction, ultrasonic, explosive, electron beam, laser and plasma.

Machining and Machine Tool Operations: Machining processes-turning, drilling, boring, milling, shaping, planing, sawing, gear cutting, thread production, broaching, grinding, lapping, honing super finishing; mechanics of cutting- Merchant's analysis, geometry of cutting tools, cutting forces, power requirements; selection of process parameters; tool materials, tool wear and tool life, cutting fluids, machinability; nontraditional machining processes and hybrid processes- EDM, CHM, ECM, USM, LBM, EBM, AJM, PAM AND WJM; economics of machining.

Metrology and Inspection: Limits and fits, linear and angular measurements by mechanical and optical methods, comparators; design of limit gauges; interferometry; measurement of straightness, flatness, roundness, squareness and symmetry; surface finish measurement; inspection of screw threads and gears; alignment testing.

Powder Metallurgy and Processing of Plastics: Production of powders, compaction, sintering; Polymers and composites; injection, compression and blow molding, extrusion, calendaring and thermoforming; molding of composites.

Tool Engineering: Work-holding-location and clamping; principles and methods; design of jigs and fixtures; design of press working tools, forging dies.

Manufacturing Analysis: Sources of errors in manufacturing; process capability; part-print analysis; tolerance analysis in manufacturing and assembly; process planning; parameter selection and comparison of production alternatives; time and cost analysis; Issues in choosing manufacturing technologies and strategies.

Computer Integrated Manufacturing: Basic concepts of CAD, CAM, CAPP, group technology, NC, CNC, DNC, FMS, Robotics and CIM.

INDUSTRIAL ENGINEERING

Product Design and Development: Principles of good product design, component and tolerance design; efficiency, quality and cost considerations; product life cycle; standardization, simplification, diversification, value analysis, concurrent engineering.

Engineering Economy and Costing: Financial statements; elementary cost accounting, methods of depreciation; break-even analysis, techniques for evaluation of capital investments.

Work System Design: Taylor's scientific management, Gilbreths's contributions; productivity concepts and measurements; method study, micro-motion study, principles of motion economy; human factors engineering, ergonomics; work measurement - time study, PMTS, work sampling; job evaluation, merit rating, wage administration, incentive systems; business process reengineering.

Logistics and Facility Design: Facility location factors, evaluation of alternatives, types of plant layout, evaluation; computer aided layout; assembly line balancing; material handling systems; supply chain management.

Production Planning and Inventory Control: Inventory Function costs, classifications - deterministic and probabilistic models; quantity discount; safety stock; inventory control system; Forecasting techniques - causal and time series models, moving average, exponential smoothing; trend and seasonality; aggregate production planning; master scheduling; bill of materials and material requirement planning; order control and flow control, routing, scheduling and priority dispatching; JIT; Kanban PULL systems; bottleneck scheduling and theory of constraints.

Operation Research: Linear programming - problem formulation, simplex method, duality and sensitivity analysis; transportation; assignment; network flow models, constrained optimization and Lagrange multipliers; simple queuing models; dynamic programming; simulation; PERT and CPM, time-cost trade-off, resource leveling.

Quality Control: Taguchi method; design of experiments; quality costs, statistical quality assurance, process control charts, acceptance sampling, zero defects; quality circles, total quality management.

Reliability and Maintenance: Reliability, availability and maintainability; probabilistic failure and repair times; system reliability; preventive maintenance and replacement, TPM.

Management Information System: Value of information; information storage and retrieval system - database and data structures; interactive systems; knowledge based systems.

Intellectual Property System: Definition of intellectual property, importance of IPR; TRIPS, and its implications, WIPO and Global IP structure, and IPS in India; patent, copyright, industrial design and trademark; meanings, rules and procedures, terms, infringements and remedies.

PY - PHARMACEUTICAL SCIENCES

Natural Products: Pharmacognosy & Phytochemistry - Chemistry, tests, isolation, characterization and estimation of phytopharmaceuticals belonging to the group of Alkaloids, Glycosides, Terpenoids, Steroids, Bioflavanoids, Purines, Guggul lipids. Pharmacognosy of crude drugs which contain the above constituents. Standardisation of raw materials and herbal products. WHO guide lines. Quantitative microscopy including modern techniques used for evaluation. Biotechnological principles and techniques for plant development Tissue culture.

Pharmacology: General pharmacological principles including Toxicology. Drug interaction. Pharmacology of drugs acting on Central nervous system, Cardiovascular system, Autonomic nervous system, Gastro intestinal system and Respiratory system. Pharmacology of Autocoids, Hormones, Chemotherapeutic agents including anticancer drugs. Bioassays. Immuno Pharmacology.

Medicinal Chemistry: Structure, nomenclature, classification, synthesis, SAR and metabolism of the following category of drugs which are official in Indian Pharmacopoeia and British Pharmacopoeia Hypnotics and Sedatives, Analgesics, NSAIDS, Neuroleptics, Antidepressants, Anxiolytics, Anticonvulsants, Antihistaminics, Local anaesthetics, Cardio Vascular drugs - Antianginal agents Vasodilators, Adrenergic & cholinergic drugs, Cardiotonic agents, Diuretics, Antihypertensive drugs, Hypoglycemic agents, Antilipedmic agents, Coagulants, Anticoagulants, Antiplatelet agents. Chemotherapeutic agents - Antibiotics, Antibacterials, Sulphadrugs. Antiproliozoal drugs, Antiviral, Antitubercular, Antimalarial, Anticancer, Antiamoebic drugs. Diagnostic agents. Preparation and storage and uses of official Radiopharmaceuticals. Vitamins and Hormones.

Pharmaceutics: Development, manufacturing standards, labeling, packing as per the pharmacopoeal requirements, Storage of different dosage forms and new drug delivery systems. Biopharmaceutics and Pharmacokinetics and their importance in formulation. Formulation and preparation of cosmetics - lipstick, shampoo, creams, nail preparations and dentifrices. Pharmaceutical calculations.

Pharmaceutical Jurisprudence: Legal aspects of manufacture, storage, sale of drugs. D and C act and rules. Pharmacy act.

Pharmaceutical Analysis: Principles, instrumentation and applications of the following. Absorption spectroscopy (UV, visible & IR), Fluorimetry, Flame photometry, Potentiometry, Conductometry and Plarography. Pharmacopoeial assays. Principles of NMR, ESR, Mass spectroscopy, X-ray diffraction analysis and different chromatographic methods.

Biochemistry and Clinical Pharmacy: Biochemical role of hormones, Vitamins, Enzymes, Nucleic acids. Bioenergetics. General principles of immunology. Immunological techniques. Adverse drug interaction.

Microbiology: Principles and methods of microbiological assays of the Pharmacopoeia. Methods of preparation of official sera and vaccines. Serological and diagnostic tests. Applications of microorganisms in Bio Conversions and in Pharmaceutical industry.

TF - TEXTILE ENGINEERING AND FIBRE SCIENCE

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

TEXTILE ENGINEERING & FIBRE SCIENCE

Textile Fibres: Classification of textile fibres according to their nature and origin; general characteristics of textile fibres-their chemical and physical structures and their properties;

essential characteristics of fibre forming polymers; uses of natural and man-made fibres; physical and chemical methods of fibre and blend identification and blend analysis.

Melt Spinning processes with special reference to polyamide and polyester fibres; wet and dry spinning of viscose and acrylic fibres; post spinning operations-drawing, heat setting, texturing- false twist and air-jet, tow-to-top conversion. Methods of investigating fibre structure e.g. X-ray diffraction, birefringence, optical and electron microscopy, I.R. absorption, thermal methods; structure and morphology and principal natural and man-made fibres, mechanical properties of fibres, moisture sorption in fibres; fibre structure and property correlation.

Textile Testing: Sampling techniques, sample size and sampling errors; measurement of fibre length, fineness, crimp, strength and reflectance; measurement of cotton fibre maturity ad trash content; HVI and AFIS for fibre testing. Measurement of yarn count, twist and hairiness; tensile testing of fibres, yarn and fabrics; evenness testing of slivers, rovings and yarns; testing equipment for measurement test methods of fabric properties like thickness, compressibility, air permeability, drape, crease recovery, tear strength bursting strength and abrasion resistance. Correlation analysis, significance tests and analysis of variance; frequency distributions and control charts.

Yarn Manufacture and Yarn Structure: Modern methods of opening, cleaning and blending of fibrous materials; the technology of carding with particular reference to modern developments; causes of irregularity introduced by drafting, the development of modern drafting systems; principles and techniques of preparing material for combing; recent development in combers; functions and synchronization of various mechanisms concerned with roving production; forces acting on yarn and traveller, ring and traveller designs; causes of end breakages; properties of doubles yarns; new methods of yarn production such as rotor spinning, air jet spinning and friction spinning.

Yarn diameter; specific volume, packing coefficient; twist-strength relationship; fibre orientation in yarn; fibre migration.

Fabric Manufacture and Fabric Structure: Principles of cheese and cone winding processes and machines; random and precision winding; package faults and their remedies; yarn clearers and tensioners; different systems of yarn splicing; features of modern cone winding machines; different types of warping creels; features of modern beam and sectional warping machines; different sizing systems, sizing of spun and filament yarns, modern sizing machines; principles of pirn winding processes and machines; primary and secondary motions of loom, effect of their settings and timings on fabric formation, fabric appearance and weaving performance; dobby and jacquard shedding; mechanics of weft insertion with shuttle; warp and weft stop motions, warp protection, weft replenishment; functional principles of weft insertion systems of shuttleless weaving machines, principles of multiphase and circular looms. Principles of weft and warp knitting; basic weft and warp knitted structures; classification, production and areas of application of nonwoven fabrics.

Basic woven fabric constructions and their derivatives; crepe, cord, terry, gauze, lino and double cloth constructions.

Peirce's equations for fabric geometry; thickness, cover and maximum sett of woven fabrics

Textile Chemical Processing: Preparatory processes for natural-and and their blends; mercerization of cotton; machines for yarn and fabric mercerization.

Dyeing and printing of natural- and synthetic- fibre fabrics and their blends with different dye classes; dyeing and printing machines; styles of printing; fastness properties of dyed and printed textile materials.

Finishing of textile materials, wash and wear, durable press, soil release, water repellent, flame retardant and antistatic finishes; shrink-resistance finish for wool; heat setting of synthetic-fibre fabrics, finishing machines; energy efficient processes; pollution control.

XE - ENGINERING SCIENCES

The syllabi of the sections of this paper are as follows:

SECTION A. ENGINEERING MATHEMATICS (Compulsory)

Linear Algebra : Determinates, algebra of matrices, rank, inverse, system of linear equations, symmetric, skew-symmetric and orthogonal matrices. Hermitian, skew-hermitian and unitary matrices. eigenvalues and eigenvectors, diagonalisation of matrices, Cayley-Hamiltonian, quadratic forms.

Calculus : Functions of single variables, limit, continuity and differentiability, Mean value theorems, Intermediate forms and L'Hospital rule, Maxima and minima, Taylor's series, Fundamental and mean value-theorems of integral calculus. Evaluation of definite and improper integrals, Beta and Gamma functions, Functions of two variables, limit, continuity, partial derivatives, Euler's theorem for homogeneous functions, total derivatives, maxima and minima, Lagrange method of multipliers, double and triple integrals and their applications, sequence and series, tests for convergence, power series, Fourier Series, Fourier integrals.

Complex variable: Analytic functions, Cauchy's integral theorem and integral formula without proof. Taylor's and Laurent' series, Residue theorem (without proof) with application to the evaluation of real integarls.

Vector Calculus: Gradient, divergence and curl, vector identities, directional derivatives, line, surface and volume integrals, Stokes, Gauss and Green's theorems (without proofs) with applications.

Ordinary Differential Equations: First order equation (linear and nonlinear), higher order linear differential equations with constant coefficients, method of variation of paramaters, Cauchy's and Euler's equations, initial and boundary value problems, power series solutions, Legendre polynomials and Bessel's functions of the first kind.

Partial Differential Equations: Variables separable method, solutions of one dimensional heat, wave and Laplace equations.

Probability and Statistics: Definitions of probability and simple theorems, conditional probability, mean, mode and standard deviation, random variables, discrete and continuous distributions, Poisson, normal and Binomial distribution, correlation and regression

Numerical Methods: L-U decomposition for systems of linear equations,Newton-Raphson method, numerical integration(trapezoidal and Simpson's rule), numerical methods for first order differential equation (Euler method)

SECTION B. COMPUTATIONAL SCIENCE

Numerical Methods: Truncation errors, round off errors and their propagation; Interpolation; Lagrange, Newton's forward, backward and divided difference formulas, least square curve fitting, solution of non-linear equations of one variables using bisection, false position, secant and Newton Raphson methods; Rate of convergence of these methods, general iterative methods. Simple and multiple roots of polynomials. Solutions of system of linear algebraic equations using Gauss elimination methods, Jacobi and Gauss-Seidel iterative methods and their rate of convergence; ill conditioned and well conditioned system. eigen values and eigen vectors using power methods. Numerical integration using trapezoidal, Simpson's rule and other quadrature formulas. Numerical Differentiation. Solution of boundary value problems. Solution of initial value problems of ordinary differential equations using Euler's method, predictor corrector and Runge Kutta method.

Programming : Elementary concepts and terminology of a computer system and system software, Fortran77 and C programming.

Fortran : Program organization, arithmetic statements, transfer of control, Do loops, subscripted variables, functions and subroutines.

C language : Basic data types and declarations, flow of control- iterative statement, conditional statement, unconditional branching, arrays, functions and procedures.

SECTION C. ELECTRICAL SCIENCES

Electric Circuits: Ideal voltage and current sources; RLC circuits, steady state and transient analysis of DC circuits, network theorems; alternating currents and voltages, single-phase AC circuits, resonance; three-phase circuits.

Magnetic circuits: Mmf and flux, and their relationship with voltage and current; transformer, equivalent circuit of a practical transformer, three-phase transformer connections.

Electrical machines: Principle of operation, characteristics, efficiency and regulation of DC and synchronous machines; equivalent circuit and performance of three-phase and single-phase induction motors.

Electronic Circuits: Characteristics of p-n junction diodes, zener diodes, bipolar junction transistors (BJT) and junction field effect transistors (JFET); MOSFET's structure, characteristics, and operations; rectifiers, filters, and regulated power supplies; biasing circuits, different configurations of transistor amplifiers, class A, B and C of power amplifiers; linear applications of operational amplifiers; oscillators; tuned and phase shift types.

Digital circuits: Number systems, Boolean algebra; logic gates, combinational circuits, flip-flops (RS, JK, D and T) counters.

Measuring instruments: Moving coil, moving iron, and dynamometer type instruments; shunts, instrument transformers, cathode ray oscilloscopes; D/A and A/D converters.

SECTION D. FLUID MECHANICS

Fluid Properties: Relation between stress and strain rate for Newtonian fluids

Hydrostatics, buoyancy, manometry

Concept of local and convective accelerations; control volume analysis for mass, momentum and energy conservation.

Differential equations of continuity and momentum (Euler's equation of motion); concept of fluid rotation, stream function, potential function; Bernoulli's equation and its applications.

Qualitative ideas of boundary layers and its separation; streamlined and bluff bodies; drag and lift forces.

Fully-developed pipe flow; laminar and turbulent flows; friction factor; Darcy Weisbach relation; Moody's friction chart; losses in pipe fittings; flow measurements using venturimeter and orifice plates.

Dimensional analysis; similitude and concept of dynamic similarity; importance of dimensionless numbers in model studies.

SECTION E. MATERIALS SCIENCE

Atomic structure and bonding in materials: metals, ceramics and polymers.

Structure of materials: Crystal systems, unit cells and space lattice; determination of structures of simple crystals by X-ray diffraction; Miller indices for planes and directions. Packing geometry in metallic, ionic and covalent solids.

Concept of amorphous, single and polycrystalline structures and their effects on properties of materials.

Imperfections in crystalline solids and their role in influencing various properties.

Fick´s laws of diffusion and applications of diffusion in sintering, doping of semiconductors and surface hardening of metals.

Alloys: solid solution and solubility limit. Binary phase diagram, intermediate phases and intermetallic compounds; iron-iron carbide phase diagram. Phase transformation in steels. Cold and hot working of metals, recovery, recrystallization and grain growth.

Properties and applications of ferrous and nonferrous alloys.

Structure, properties, processing and applications of traditional and advanced ceramics.

Polymers: classification, polymerization, structure and properties, additives for polymer products, processing and application.

Composites: properties and application of various composites.

Corrosion and environmental degradation of materials (metals, ceramics and polymers).

Mechanical properties of materials: Stress-strain diagrams of metallic, ceramic and polymeric materials, modulus of elasticity, yield strength, plastic deformation and toughness, tensile strength and elongation at break; viscoelasticity, hardness, impact strength. ductile and brittle fracture. creep and fatigue properties of materials.

Heat capacity, thermal conductivity, thermal expansion of materials.

Concept of energy band diagram for materials; conductors, semiconductors and insulators in terms of energy bands. Electrical conductivity, effect of temperature on conductivity in materials, intrinsic and extrinsic semiconductors, dielectric properties of materials.

Refraction, reflection, absorption and transmission of electromagnetic radiation in solids.

Origin of magnetism in metallic and ceramic materials, paramagnetism, diamagnetism, antiferromagnetism, ferromagnetism, ferrimagnetism in materials and magnetic hysteresis.

Advanced materials: Smart materials exhibiting ferroelectric, piezoelectric, optoelectronic, semiconducting behaviour; lasers and optical fibers; photoconductivity and superconductivity in materials.

SECTION F. SOLID MECHANICS

Equivalent force systems; free-body diagrams; equilibrium equations; analysis of determinate and indeterminate trusses and frames; friction.

Simple relative motion of particles; force as function of position, time and speed; force acting on a body in motion; laws of motion; law of conservation of energy; law of conservation of momentum

Stresses and strains; principal stresses and strains; Mohr's circle; generalized Hooke's Law; equilibrium equations; compatibility conditions; yield criteria.

Axial, shear and bending moment diagrams; axial, shear and bending stresses; deflection (for symmetric bending); torsion in circular shafts; thin cylinders; energy methods (Castigliano's Theorems); Euler buckling.

SECTION G. THERMODYNAMICS

Basic Concepts: Continuum, macroscopic approach, thermodynamic system (closed and open or control volume); thermodynamic properties and equilibrium; state of a system, state diagram, path and process; different modes of work; Zeroth law of thermodynamics; concept of temperature; heat.

First Law of Thermodynamics: Energy, enthalpy, specific heats, first law applied to systems and control volumes, steady and unsteady flow analysis.

Second Law of Thermodynamics: Kelvin-Planck and Clausius statements, reversible and irreversible processes, Carnot theorems, thermodynamic temperature scale, Clausius inequality and concept of entropy, principle of increase of entropy; availability and irreversibility.

Properties of Pure Substances: Thermodynamic properties of pure substances in solid, liquid and vapour phases, P-V-T behaviour of simple compressible substances, phase rule, thermodynamic property tables and charts, ideal and real gases, equations of state, compressibility chart.

Thermodynamic Relations: T-ds relations, Maxwell equations, Joule-Thomson coefficient, coefficient of volume expansion, adiabatic and isothermal compressibilities, Clapeyron equation.

Ideal Gas Mixtures: Dalton's and Amagat's laws, calculations of properties, air-water vapour mixtures.

XL - LIFE SCIENCES

The syllabi of the Sections of this paper are as follows:

SECTION H. CHEMISTRY (Compulsory)

Atomic structure and periodicity: Quantum chemistry; Planck's quantum theory, wave particle duality, uncertainty principle, quantum mechanical model of hydrogen atom; electronic configuration of atoms; periodic table and periodic properties; ionization energy, election affinity, electronegativity, atomic size.

Structure and bonding: Ionic and covalent bonding M.O. and V.B. approaches for diatomic molecules, VSEPR theory and shape of molecules, hybridisation, resonance, dipole moment, structure parameters such as bond length, bond angle and bond energy, hydrogen bonding, van der Waals interactions. Ionic solids; ionic radii, lattice energy (Born-Haber Cycle).

s.p. and d Block Elements: Oxides, halides and hydrides of alkali and alkaline earth metals, B, Al, S, N, P and S, silicones, general characteristics of 3d elements, coordination complexes: valence bond and crystal field theory, color, geometry and magnetic properties.

Chemical Equilibria: Colligative properties of solutions, ionic equilibria in solution, solubility product, common ion effect, hydrolysis of salts, pH, buffer and their applications in chemical analysis.

Electrochemistry: Conductance, Kohlrausch law, Half Cell potentials, emf, Nernst equation, galvanic cells, thermodynamic aspects and their applications.

Reaction Kinetics: Rate constant, order of reaction, molecularity, activation energy, zero, first and second order kinetics, equilibrium constants (Kc, Kp and Kx) for homogeneous reactions, catalysis and elementary enzyme reactions.

Thermodynamics: First law, reversible and irreversible processes, internal energy, enthalpy, Kirchoff's equation, heat of reaction, Hess law, heat of formation, Second law, entropy, free energy, and work function. Gibbs-Helmholtz equation, Clausius-Clapeyron equation, free energy change and equilibrium constant, Troutons rule, Third law of thermodynamics.

Mechanistic Basis of Organic Reactions: Elementary treatment of SN1, SN2, E1 and E2 reactions, Hoffmann and Saytzeff rules, Addition reactions, Markonikoff rule and Kharash effect, Diels-Alder reaction, aromatic electrophilic substitution, orientation effect as exemplified by various functional groups.

Structure-Reactivity Correlations: Acids and bases, electronic and steric effects, optical and geometrical isomerism, tautomerism, concept of aromaticity

SECTION I. BIOCHEMISTRY

Organization of life. Importance of water. Cell structure and organelles. Structure and function of biomolecules: Carbohydrates, Lipids, Proteins and Nucleic acids. Biochemical separation techniques. Spectroscopic methods; UV-visible and fluorescence. Protein structure, folding and function: Myoglobin, Hemoglobin, Lysozyme, ribonuclease A, Carboxypeptidase and Chymotrypsin. Enzyme kinetics and regulation, Coenzymes.

Metabolism and bioenergitics. Generation and utilization of ATP. Photosynthesis. Major metabolic pathways and their regulation. Biological membranes. Transport across membranes. Signal transduction; hormones and neurotransmitters.

DNA replication, transcription and translation. Biochemical regulation of gene expression. Recombinant DNA technology and applications. Genomics and Proteomics.

The immune system. Active and passive immunity. Complement system. Antobody structure, function and diversity. Cells of the immune system: T, B and macrophages. T and B cell activation. Major histocompatibilty complex. T cell receptor. Immunological techniques: Immunodiffusion, immunoelectrophoresis, RIA and ELISA.

SECTION J. BIOTECHNOLOGY

Recombinant DNA technology for the production of therapeutic proteins. Micro array technology. Heterologous protein expression systems in bacteria, yeast etc.

Architecture of plant genome; plant tissue culture techniques; methods of gene transfer into plant cells; manipulation of phenotypic traits in plants; plant cell fermentations and production of secondary metabolites using suspension/ immobilized cell culture; methods for plant micro propagation; crop improvement and development of transgenic plants. Expression of animal proteins in plants.

Animal cell metabolism and regulation; cell cycle; primary cell culture; nutritional requirements for animal cell culture; techniques for the mass culture of animal cell lines; production of vaccines; growth hormones and interferons using animal cell culture; cytokines-production and therapeutic uses; hybridoma technology; vectors for gene transfer and expression in animal cells. Transgenic animals and molecular pharming.

Microbial production of industrial enzymes; methods for immobilization of enzymes; kinetics of soluble and immobilized enzymes; application of soluble and immobilized enzymes; enzyme-based sensors.

Microbial growth kinetics; batch, fed batch and continuous culture of microbial cells; media for industrial fermentations; sterilization of air and media; design features and operation of stirred tank, air-lift and fluidized bed reactors; aeration and agitation in aerobic fermentations; recovery and purification of fermentation products- filtration, centrifugation, cell disintegration, solvent extraction and chromatographic separations; industrial fermentations for the production of ethanol, citric acid, lysine, penicillin and other biomolecules; simple calculations based on material and energy balance of fermentation processes; application of microbes in the management of domestic and industrial wastes.

SECTION K. BOTANY

Anatomy: Roots, stem and leaves of land plants, meristems, vascular system, their ontogeny, structure and functions. Plant cell structure, organisation, organelles, cytoskeleton, cell wall and membranes.

Development: Cell cycle, cell division, senescence, hormonal regulation of growth; life cycle of an angiosperm, pollination, fertilization, embryogenesis, seed formation, seed storage proteins, seed dormancy and germination. Concept of cellular totipotency, organogenesis and somatic embryogenesis, somaclonal variation, embryo culture, in vitro fertilization.

Physiology and Biochemistry: Plant water relations, transport of minerals and solutes, N2 metabolism, proteins and nucleic acid, respiration, photophysiology, photosynthesis, photorespiration; biosynthesis, mechanism of action and physiological effects of plant growth regulators.

Genetics: Principles of Mendelian inheritance, linkage, recombination and genetic mapping; extrachromosomal inheritance; eukaryotic genome organization (chromatin structure) and regulation of gene expression, gene mutation, chromosome aberrations (numerical and structural), transposons.

Plant Breeding: Principles, methods - selection, hybridization, heterosis; male sterility, self and inter-specific incompatibility; haploidy; somatic cell hybridization; molecular marker-assisted selection; gene transfer methods viz. direct and vector-mediated, transgenic plants and their applications in agriculture.

Economic Botany: Economically important plants - cereals, pulses, plants yielding fiber, timber, sugar, beverages, oils, rubber, dyes, gums, drugs and narcotics - a general account.

Systematics: Systems of classification (non-phylogenetic vs. phylogenetic - outline), plant groups, molecular systematics.

Plant Pathology: Nature and classification of plant diseases, diseases of important crops caused by fungi, bacteria and viruses, and their control measures, mechanism(s) of pathogenesis and resistance, molecular detection of pathogens; plant-microbe beneficial interactions.

Ecology and Plant Geography: Ecosystems - types, dynamics, degradation, ecological succession; food chains; vegetation types of the world; pollution and global warming; speciation and extinction, conservation strategies, cryopreservation.

SECTION L. MICROBIOLOGY

Historical perspective - Discovery of the microbial world; Controversy over spontaneous generation; Role of microorganisms in transformation of organic matter and in the causation of diseases.

Methods in microbiology - Pure culture techniques; Theory and practice of sterilization; Principles of microbial nutrition; Construction of culture media; Enrichment culture techniques for isolation of chemoautotrophs, chemoheterotrophs and photosynthetic microorganisms.

Microbial evolution, systematics and taxonomy - Evolution of earth and earliest life forms; Primitive organisms and their metabolic strategies; New approaches to bacterial taxonomic classification including ribotyping; Nomenclature.

Microbial diversity - Bacteria, archea and their broad classification; Eukaryotic microbes, yeast, fungi, slime mold and protozoa; Viruses and their classification.

Microbial growth -The definition of growth, mathematical expression of growth, growth curve, measurement of growth and growth yields; Synchronous growth; Continuous culture.

Nutrition and metabolism - Overview of metabolism; Microbial nutrition; Energy classes of microorganisms; Culture media; Energetics, modes of ATP generation; ATP generation by heterotrophs; Fermentation; Glycolysis; Respiration; The citric acid cycle; Electron transport systems; Alternate modes of energy generation; Pathways (anabolism) in the biosynthesis of amino acids, purines, pyrimidines and fatty acids.

Metabolic diversity among microorganisms - Photosynthesis in microorganisms; Role of chlorophylls, carotenoids and phycobilins; Calvin cycle; Chemolithotrophy; Hydrogen- iron-nitrite-oxidizing bacteria; Nitrate and sulfate reduction; Methanogenesis and acetogenesis.

Prokaryotic cells: structure-function - Cells walls of eubacteria (peptidoglycan) and related molecules; Outer-membrane of gram-negative bacteria; Cell wall and cell membrane synthesis; Flagella and motility; Cell inclusions like endospores, gas vesicles.

Microbial diseases and host parasite relationships - Normal microflora of skin; Oral cavity; Gastrointestinal tract; Entry of pathogens into the host; Infectious disease transmission; Respiratory infections caused by bacteria and viruses; Tuberculosis; Sexually transmitted diseases including AIDS; Diseases transmitted by animals (Rabies, plague), insects and ticks (rikettsias, Lyme disease, malaria); Food and water borne diseases; Public health and water quality; Pahtogenic fungi; Emerging and resurgent infectious diseases.

Chemotherapy/Antibiotics - Antimicrobial agents; Sulfa drugs; Antibiotics; Pencillins and cephalosporins; Broad-spectrum antibiotics; Antibiotics from prokaryotes; Antifungal antibiotics; Mode of action; Resistance to antibiotics.

Microbial genetics - Genes, mutation and mutagenesis - UV and chemical mutagnes; Types of mutations; Ames test for mutagenesis; Methods of genetic analysis. Bacterial genetic system - Transformation; Conjugation; Transduction; Recombination; Plasmids and Transposons; Bacterial genetic map with reference to E. coli. Viruses and their genetic system - Phage ? and its life cycle; RNA phages; RNA viruses; Retroviruses; Genetic systems of yeast and Neurospora; Extrachromosomal inheritance and mitochondrial genetics; Basic concept of genomics.

SECTION M. ZOOLOGY

Animal world: Animal diversity, distribution, systematic and classification of animals, the phylogenetic relationship.

Evolution: Origin of life, history of life on earth, evolutionary theories, natural selection, adaptation, speciation.

Genetics: Principles of inheritance, molecular basis of heredity, the genetic material, transmission of genetic material, mutations, cytoplasmic inheritance.

Biochemistry and Molecular Biology: Nucleic acids, proteins and other biological macromolecules. Replication, transcription and translation, regulation of gene expression, organization of genome, Kreb's cycle, glycolysis, enzyme catalysis, hormones and their action.

Cell Biology: Structure of cell, cellular organelles and their structure and function, cell cycle, cell division, cellular differentiation, chromosome and chromatin structure. Eukaryotic gene organisation and expression.

Animal Anatomy and Physiology: Comparative physiology, the respiratory system, circulatory system, digestive system, the nervous system, the excretory system, the endocrine system, the reproductive system, the skeletal system, osmoregulation.

Parasitology and Immunology: Nature of parasite, host-parasite relation, protozoan and helminthic parasites, the immune response, cellular and humoral immune response, evolution of the immune system.

Development Biology: Embryonic development, cellular differentiation, organogenesis, metamorphosis, genetic basis of development.

Ecology: The ecosystem, habitats the food chain, population dynamics, species diversity, zoogeography, biogeochemical cycles, conservation biology.

Animal Behaviour: Types of behaviours, courtship, mating and territoriality, instinct, learning and memory, social behaviour across the animal taxa, communication, pheromones, evolution of animal behaviour.

IT - INFORMATION TECHNOLOGY

ENGINEERING MATHEMATICS

Mathematical Logic: Propositional Logic; First Order Logic.

Probability: Conditional Probability; Mean, Median, Mode and Standard Deviation; Random Variables; Distributions; uniform, normal, exponential, Poisson, Binomial.

Set Theory & Algebra: Sets; Relations; Functions; Groups; Partial Orders; Lattice; Boolean Algebra.

Combinatorics: Permutations; Combinations; Counting; Summation; generating functions; recurrence relations; asymptotics.

Graph Theory: Connectivity; spanning trees; Cut vertices & edges; covering; matching; independent sets; Colouring; Planarity; Isomorphism.

Linear Algebra: Algebra of matrices, determinants, systems of linear equations, Eigen values and Eigen vectors.

Numerical Methods: LU decomposition for systems of linear equations; numerical solutions of non linear algebraic equations by Secant, Bisection and Newton-Raphson Methods; Numerical integration by trapezoidal and Simpson's rules.

Calculus: Limit, Continuity & differentiability, Mean value Theorems, Theorems of integral calculus, evaluation of definite & improper integrals, Partial derivatives, Total derivatives, maxima & minima.

FORMAL LANGUAGES AND AUTOMATA

Regular Languages: finite automata, regular expressions, regular grammar.

Context free languages: push down automata, context free grammars

COMPUTER HARDWARE

Digital Logic: Logic functions, minimization, design and synthesis of combinatorial and sequential circuits, number representation and computer arithmetic (fixed and floating point)

Computer organization: Machine instructions and addressing modes, ALU and data path, hardwired and microprogrammed control, memory interface, I/O interface (interrupt and DMA mode), serial communication interface, instruction pipelining, cache, main and secondary storage

SOFTWARE SYSTEMS

Data structures and Algorithms: the notion of abstract data types, stack, queue, list, set, string, tree, binary search tree, heap, graph, tree and graph traversals, connected components, spanning trees, shortest paths, hashing, sorting, searching, design techniques (greedy, dynamic, divide and conquer), asymptotic analysis (best, worst, average cases) of time and space, upper and lower bounds, intractability

Programming Methodology: C programming, program control (iteration, recursion, functions), scope, binding, parameter passing, elementary concepts of object oriented programming

Operating Systems (in the context of Unix): classical concepts (concurrency, synchronization, deadlock), processes, threads and interprocess communication, CPU scheduling, memory management, file systems, I/O systems, protection and security

Information Systems and Software Engineering: information gathering, requirement and feasibility analysis, data flow diagrams, process specifications, input/output design, process life cycle, planning and managing the project, design, coding, testing, implementation, maintenance.

Databases: relational model, database design, integrity constraints, normal forms, query languages (SQL), file structures (sequential, indexed), b-trees, transaction and concurrency control

Data Communication: data encoding and transmission, data link control, multiplexing, packet switching, LAN architecture, LAN systems (Ethernet, token ring), Network devices: switches, gateways, routers

Networks: ISO/OSI stack, sliding window protocols, routing protocols, TCP/UDP, application layer protocols & systems (http, smtp, dns, ftp), network security

Web technologies: three tier web based architecture; JSP, ASP, J2EE, .NET systems; html, XML

AG - AGRICULTURAL ENGINEERING

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

FARM MACHINERY AND POWER:

Sources of power on the farm-human, animal, mechanical, electrical, wind, solar and biomass; design and selection of machine elements - gears, pulleys, chains and sprockets and belts; overload safety devices used in farm machinery; measurement of force, torque, speed, displacement and acceleration on machine elements.

Soil tillage; forces acting on a tillage tool; hitch systems and hitching of tillage implements; functional requirements, principles of working, construction and operation of manual, animal and power operated equipment for tillage. sowing, planting, fertilizer application, inter-cultivation, spraying, mowing, chaff cutting, harvesting, threshing and transport; testing of agricultural machinery and equipment; calculation of performance parameters -field capacity, efficiency, application rate and losses; cost analysis of implements and tractors.

Thermodynamic principles of I.C. engines; I.C. engine cycles; engine components; fuels and combustion; lubricants and their properties; I.C. engine systems - fuel, cooling, lubrication, ignition, electrical, intake and exhaust; selection, operation, maintenance and repair of I.C. engines; power efficiencies and measurement; calculation of power, torque, fuel consumption, heat load and power losses.

Tractors and power tillers - type, selection, maintenance and repair; tractor clutches and brakes; power transmission systems - gear trains, differential, final drives and power take-off; mechanics of tractor chassis; traction theory; three point hitches- free link and restrained link operations; mechanical steering and hydraulic control systems used in tractors; human engineering and safety in tractor design; tractor tests and performance.

SOIL AND WATER CONSERVATION ENGINEERING:

Ideal and real fluids, properties of fluids; hydrostatic pressure and its measurement; hydrostatic forces on plane and curved surface; continuity equation; Bernoulli's theorem; laminar and turbulent flow in pipes, Darcy-Weisbach and Hazen-Williams equations, Moody's diagram; flow through orifices and notches; flow in open channels.

Engineering properties of soils, fundamental definitions and relationships; index properties of soils; permeability and seepage analysis; shear strength, Mohr's circle of stresses; active and passive earth pressures; stability of slopes.

Hydrological cycle; precipitation measurement, analysis of precipitation data; abstraction from precipitation; runoff; hydrograph analysis, unit hydrograph theory and application; stream flow measurement; flood routing, hydrological reservoir and channel routing.

Mechanics of soil erosion, factors affecting erosion; soil loss estimation; biological and engineering measures to control erosion, terraces and bunds; vegetative waterways; gully control structures, drop, drop inlet and chute spillways; farm ponds; earthen dams; principles of watershed management.

Water requirement of crops; consumptive use and evapo-transpiration; irrigation scheduling; irrigation efficiencies; design of prismatic and silt loaded channels; methods of irrigation water application; design and evaluation of irrigation methods; drainage coefficient; surface and subsurface drainage systems; leaching requirement and salinity control; irrigation and drainage water quality; classification of pumps; pump characteristics; pump selection; types of aquifer; evaluation of aquifer properties; well hydraulics; ground water recharge.

AGRICULTURAL PROCESSING AND FOOD ENGINEERING:

Steady state heat transfer in conduction, convection and radiation; transient heat transfer in simple geometry; condensation and boiling heat transfer; working principles of heat exchangers; diffusive and convective mass transfer; simultaneous heat and mass transfer in agricultural processing operations.

Material and energy balances in food processing systems; water activity, sorption and desorption isotherms; centrifugal separation of solids, liquids and gases; kinetics of microbial death - pasteurisation and sterilization of liquid foods; preservation of food by cooling and freezing; psychrometry - properties of air-vapour mixture; concentration and dehydration of liquid foods - evaporators, tray, drum and spray dryers.

Mechanics and energy requirement in size reduction of granular solids; particle size analysis for comminuted solids; size separation by screening; fluidisation of granular solids; cleaning and grading efficiency and effectiveness of grain cleaners; conditioning and hydrothermal treatments for grains; dehydration of food grains; processes and machines for processing of cereals, pulses and oilseeds; design considerations for grain silos.

AR - ARCHITECTURE AND PLANNING

City planning: Historical development of cities; principles of city planning; new towns; survey methods, site planning, planning regulations and building bye-laws.

Housing: Concept of shelter; housing policies and design; community planning; role of government agencies; finance and management.

Landscape Design: Principles of landscape design and site planning; history and landscape styles; landscape elements and materials; planting design.

Computer Aided Design: Application of computers in architecture and planning; understanding elements of hardware and software; computer graphics; programming languages - C and Visual Basic and usage of packages such as AutoCAD.

Environmental and Building Science: Elements of environmental science; ecological principles concerning environment; role of micro-climate in design; climatic control through design elements; thermal comfort; elements of solar architecture; principles of lighting and illumination; basic principles of architectural acoustics; air pollution, noise pollution and their control.

Visual and Urban Design: Principles of visual composition; proportion, scale, rhythm, symmetry, harmony, balance, form and colour; sense of place and space, division of space; focal point, vista, imageability, visual survey.

History of Architecture: Indian - Indus valley, Vedic, Buddhist, Indo-Aryan, Dravidian and Mughal periods; European - Egyptian, Greek, Roman, medieval and renaissance periods.

Development of Contemporary Architecture: Architectural developments and impacts on society since industrial revolution; influence of modern art on architecture; works of national and international architects; post modernism in architecture.

Building Services: Water supply, Sewerage and Drainage systems; Sanitary fittings and fixtures; principles of electrification of buildings; elevators, their standards and uses; air-conditioning systems; fire fighting systems.

Building Construction and Management: Building construction techniques, methods and details; building systems and prefabrication of building elements; principles of modular coordination; estimation, specification, valuation, professional practice; project management, PERT, CPM.

Materials and Structural Systems: Behavioural characteristics of all types of building materials e.g. mud, timber, bamboo, brick, concrete, steel, glass, FRP; principles of strength of materials; design of structural elements in wood, steel and RCC; elastic and limit state design; complex structural systems; principles of pre-stressing.

Planning Theory: Planning process; multilevel planning; comprehensive planning; central place theory; settlement pattern; land use and land utilization.

Techniques of Planning: Planning surveys; Preparation of urban and regional structure plans, development plans, action plans; site planning principles and design; statistical methods; application of remote sensing techniques in urban and regional planning.

Traffic and Transportation Planning: Principles of traffic engineering and transportation planning; methods of conducting surveys; design of roads, intersections and parking areas; hierarchy of roads and levels of services; traffic and transport management in urban areas; traffic safety and traffic laws; public transportation planning; modes of transportation.

Services and Amenities: Principles and design of water supply systems, sewerage systems, solid waste disposal systems, power supply and communication systems; Health, education, recreation and demography related standards at various levels of the settlements.

Development Administration and Management: Planning laws; development control and zoning regulations; laws relating to land acquisition; development enforcements, land ceiling; regional and urban plan preparations; planning and municipal administration; taxation, revenue resources and fiscal management; public participation and role of NGO.

CE - CIVIL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

STRUCTURAL ENGINEERING

Mechanics: Bending moments and shear forces in statically determinate beams; simple stress and strain: relationship; stress and strain in two dimensions, principal stresses, stress transformation, Mohr's circle; simple bending theory; flexural shear stress; thin-walled pressure vessels; uniform torsion.

Structural Analysis: Analysis of statically determinate trusses, arches and frames; displacements in statically determinate structures and analysis of statically indeterminate structures by force/energy methods; analysis by displacement methods (slope-deflection and moment-distribution methods); influence lines for determinate and indeterminate structures; basic concepts of matrix methods of structural analysis.

Concrete Structures: Basic working stress and limit states design concepts; analysis of ultimate load capacity and design of members subject to flexure, shear, compression and torsion (beams, columns and isolated footings); basic elements of prestressed concrete: analysis of beam sections at transfer and service loads.

Steel Structures: Analysis and design of tension and compression members, beams and beam-columns, column bases; connections - simple and eccentric, beam-column connections, plate girders and trusses; plastic analysis of beams and frames.

GEOTECHNICAL ENGINEERING

Soil Mechanics: Origin of soils; soil classification; three-phase system, fundamental definitions, relationship and inter-relationships; permeability and seepage; effective stress principle: consolidation, compaction; shear strength.

Foundation Engineering: Sub-surface investigation - scope, drilling bore holes, sampling, penetrometer tests, plate load test; earth pressure theories, effect of water table, layered soils; stability of slopes - infinite slopes, finite slopes; foundation types - foundation design requirements; shallow foundations; bearing capacity, effect of shape, water table and other factors, stress distribution, settlement analysis in sands and clays; deep foundations - pile types, dynamic and static formulae, load capacity of piles in sands and clays.

WATER RESOURCES ENGINEERING

Fluid Mechanics and Hydraulics: Hydrostatics, applications of Bernoulli equation, laminar and turbulent flow in pipes, pipe networks; concept of boundary layer and its growth; uniform flow, critical flow and gradually varied flow in channels, specific energy concept, hydraulic jump; forces on immersed bodies; flow measurement in channels; tanks and pipes; dimensional analysis and hydraulic modeling. Applications of momentum equation, potential flow, kinematics of flow; velocity triangles and specific speed of pumps and turbines.

Hydrology: Hydrologic cycle; rainfall; evaporation infiltration, unit hydrographs, flood estimation, reservoir design, reservoir and channel routing, well hydraulics.

Irrigation: Duty, delta, estimation of evapo-transpiration; crop water requirements; design of lined and unlined canals; waterways; head works, gravity dams and Ogee spillways. Designs of weirs on permeable foundation, irrigation methods.

ENVIRONMENTAL ENGINEERING

Water requirements; quality and standards, basic unit processes and operations for water treatment, distribution of water. Sewage and sewerage treatment: quantity and characteristic of waste water sewerage; primary and secondary treatment of waste water; sludge disposal; effluent discharge standards.

TRANSPORTATION ENGINEERING

Highway planning; geometric design of highways; testing and specifications of paving materials; design of flexible and rigid pavements.

CH - CHEMICAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

CHEMICAL ENGINEERING

Process Calculations and Thermodynamics: Laws of conservation of mass and energy; use of tie components; recycle, bypass and purge calculations; degree of freedom analysis.

First and Second laws of thermodynamics and their applications; equations of state and thermodynamic properties of real systems; phase equilibria; fugacity, excess properties and correlations of activity coefficients; chemical reaction equilibria.

Fluid Mechanics and Mechanical Operations: Fluid statics, Newtonian and non-Newtonian fluids, Bernoulli equation, Macroscopic friction factors, energy balance, dimensional analysis, shell balances, flow through pipeline systems, flow meters, pumps and compressors, packed and fluidized beds, elementary boundary layer theory, size reduction and size separation; free and hindered settling; centrifuge and cyclones; thickening and classification, filtration, mixing and agitation; conveying of solids.

Heat Transfer: Conduction, convection and radiation, heat transfer coefficients, steady and unsteady heat conduction, boiling, condensation and evaporation; types of heat exchangers and evaporators and their design.

Mass Transfer: Fick's law, molecular diffusion in fluids, mass transfer coefficients, film, penetration and surface renewal theories; momentum, heat and mass transfer analogies; stagewise and continuous contacting and stage efficiencies; HTU & NTU concepts design and operation of equipment for distillation, absorption, leaching, liquid-liquid extraction, crystallization, drying, humidification, dehumidification and adsorption.

Chemical Reaction Engineering: Theories of reaction rates; kinetics of homogeneous reactions, interpretation of kinetic data, single and multiple reactions in ideal reactors, non-ideal reactors; residence time; non-isothermal reactors; kinetics of heterogeneous catalytic reactions; diffusion effects in catalysis.

Instrumentation and Process Control: Measurement of process variables; sensors, transducers and their dynamics, dynamics of simple systems, dynamics such as CSTRs, transfer functions and responses of simple systems, process reaction curve, controller modes (P, PI, and PID);

control valves; analysis of closed loop systems including stability, frequency response (including Bode plots) and controller tuning, cascade, feed forward control.

Plant Design and Economics: Design and sizing of chemical engineering equipment such as compressors, heat exchangers, multistage contactors; principles of process economics and cost estimation including total annualized cost, cost indexes, rate of return, payback period, discounted cash flow, optimization in Design.

Chemical Technology: Inorganic chemical industries; sulfuric acid, NaOH, fertilizers (Ammonia, Urea, SSP and TSP); natural products industries (Pulp and Paper, Sugar, Oil, and Fats); petroleum refining and petrochemicals; polymerization industries; polyethylene, polypropylene, PVC and polyester synthetic fibers.

CS - COMPUTER SCIENCE AND ENGINEERING

ENGINEERING MATHEMATICS

Mathematical Logic: Propositional Logic; First Order Logic.

Probability: Conditional Probability; Mean, Median, Mode and Standard Deviation; Random Variables; Distributions; uniform, normal, exponential, Poisson, Binomial.

Set Theory & Algebra: Sets; Relations; Functions; Groups; Partial Orders; Lattice; Boolean Algebra.

Combinatorics: Permutations; Combinations; Counting; Summation; generating functions; recurrence relations; asymptotics.

Graph Theory: Connectivity; spanning trees; Cut vertices & edges; covering; matching; independent sets; Colouring; Planarity; Isomorphism.

Linear Algebra: Algebra of matrices, determinants, systems of linear equations, Eigen values and Eigen vectors.

Numerical Methods: LU decomposition for systems of linear equations; numerical solutions of non linear algebraic equations by Secant, Bisection and Newton-Raphson Methods; Numerical integration by trapezoidal and Simpson's rules.

Calculus: Limit, Continuity & differentiability, Mean value Theorems, Theorems of integral calculus, evaluation of definite & improper integrals, Partial derivatives, Total derivatives, maxima & minima.

THEORY OF COMPUTATION

Formal Languages and Automata Theory: Regular languages and finite automata, Context free languages and Push-down automata, Recursively enumerable sets and Turing machines, Un-decidability;

Analysis of Algorithms and Computational Complexity: Asymptotic analysis (best, worst, average case) of time and space, Upper and lower bounds on the complexity of specific problems, NP-completeness.

COMPUTER HARDWARE

Digital Logic: Logic functions, Minimization, Design and synthesis of Combinational and Sequential circuits; Number representation and Computer Arithmetic (fixed and floating point);

Computer Organization: Machine instructions and addressing modes, ALU and Data-path, hardwired and micro-programmed control, Memory interface, I/O interface (Interrupt and DMA mode), Serial communication interface, Instruction pipelining, Cache, main and secondary storage.

SOFTWARE SYSTEMS

Data structures: Notion of abstract data types, Stack, Queue, List, Set, String, Tree, Binary search tree, Heap, Graph;

Programming Methodology: C programming, Program control (iteration, recursion, Functions), Scope, Binding, Parameter passing, Elementary concepts of Object oriented, Functional and Logic Programming;

Algorithms for problem solving: Tree and graph traversals, Connected components, Spanning trees, Shortest paths; Hashing, Sorting, Searching; Design techniques (Greedy, Dynamic Programming, Divide-and-conquer);

Compiler Design: Lexical analysis, Parsing, Syntax directed translation, Runtime environment, Code generation, Linking (static and dynamic); Operating Systems: Classical concepts (concurrency, synchronization, deadlock), Processes, threads and Inter-process communication, CPU scheduling, Memory management, File systems, I/O systems, Protection and security.

Databases: Relational model (ER-model, relational algebra, tuple calculus), Database design (integrity constraints, normal forms), Query languages (SQL), File structures (sequential files, indexing, B+ trees), Transactions and concurrency control;

Computer Networks: ISO/OSI stack, sliding window protocol, LAN Technologies (Ethernet, Token ring), TCP/UDP, IP, Basic concepts of switches, gateways, and routers.

CH - CHEMISTRY

PHYSICAL CHEMISTRY

Structure: Quantum theory - principles and techniques; applications to particle in a box, harmonic oscillator, rigid rotor and hydrogen atom; valence bond and molecular orbital theories and Huckel approximation, approximate techniques: variation and perturbation; symmetry, point groups; rotational, vibrational, electronic, NMR and ESR spectroscopy.

Equilibrium: First law of thermodynamics, heat, energy and work; second law of thermodynamics and entropy; third law and absolute entropy; free energy; partial molar quantities; ideal and non-ideal solutions; phase transformation: phase rule and phase diagrams- one, two, and three component systems; activity, activity coefficient, fugacity and fugacity coefficient ; chemical equilibrium, response of chemical equilibrium to temperature and pressure; colligative properties; kinetic theory of gases; thermodynamics of electrochemical cells; standard electrode potentials: applications - corrosion and energy conversion; molecular partition function (translational, rotational, vibrational and electronic).

Kinetics: Rates of chemical reactions, theories of reaction rates, collision and transition state theory; temperature dependence of chemical reactions; elementary reactions, consecutive elementary reactions; steady state approximation, kinetics of photochemical reactions and free radical polymerization, homogenous and heterogeneous catalysis.

INORGANIC CHEMISTRY

Non-Transition Elements: General characteristics, structure and reactions of simple and industrially important compounds, boranes, carboranes, silicates, silicones, diamond and graphite; hydrides, oxides and oxoacids of N, P, S and halogens; boron nitride, borazines and phosphazenes; xenon compounds. Shapes of molecules, hard-soft acid base concept.

Transition Elements: General characteristics of d and f block elements; coordination chemistry: structure and isomerism, stability, theories of metal-ligand bonding (CFT and LFT), electronic spectra and magnetic properties of transition metal complexes and lanthanides; metal carbonyls, metal-metal bonds and metal atom clusters, metallocenes; transition metal complexes with bonds to hydrogen, alkyls, alkenes, and arenes; metal carbenes; use of organometallic compounds as catalysts in organic synthesis; mechanisms of substitution and electron transfer reactions of coordination complexes. Role of metals with special reference to Na, K, Mg, Ca, Fe, Co, Zn, and Mo in biological systems.

Solids: Crystal systems and lattices, Miller planes, crystal packing, crystal defects; Bragg's Law; ionic crystals, band theory, metals and semiconductors. Spinels.

Instrumental methods of analysis: atomic absorption, UV-visible spectrometry, chromatographic and electro-analytical methods.

ORGANIC CHEMISTRY

Synthesis, reactions and mechanisms involving the following: Alkenes, alkynes, arenes, alcohols, phenols, aldehydes, ketones, carboxylic acids and their derivatives; halides, nitro compounds and amines; stereochemical and conformational effects on reactivity and specificity; reactions with diborane and peracids. Michael reaction, Robinson annulation, reactivity umpolung, acyl anion equivalents; molecular rearrangements involving electron deficient atoms.

Photochemistry: Basic principles, photochemistry of olefins, carbonyl compounds, arenes, photo oxidation and reduction.

Pericyclic reactions: Cycloadditions, electrocyclic reactions, sigmatropic reactions; Woodward-Hoffmann rules.

Heterocycles: Structural properties and reactions of furan, pyrrole, thiophene, pyridine, indole.

Biomolecules: Structure, properties and reactions of mono- and di-saccharides, physico-chemical properties of amino acids, structural features of proteins and nucleic acids.

Spectroscopy: Principles and applications of IR, UV-visible, NMR and mass spectrometry in the determination of structures of organic compounds.

EC - ELECTRONICS AND COMMUNICATION ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix Algebra, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Mean value theorems, Theorems of integral calculus, Evaluation of definite and improper integrals, Partial Derivatives, Maxima and minima, Multiple integrals, Fourier series. Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equation (linear and nonlinear), Higher order linear differential equations with constant coefficients, Method of variation of parameters, Cauchy's and Euler's equations, Initial and boundary value problems, Partial Differential Equations and variable separable method.

Complex variables: Analytic functions, Cauchy's integral theorem and integral formula, Taylor's and Laurent' series, Residue theorem, solution integrals.

Probability and Statistics: Sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Discrete and continuous distributions, Poisson, Normal and Binomial distribution, Correlation and regression analysis.

Numerical Methods: Solutions of non-linear algebraic equations, single and multi-step methods for differential equations.

Transform Theory: Fourier transform, Laplace transform, Z-transform.

ELECTRONICS & COMMUNICATION ENGINEERING

Networks: Network graphs: matrices associated with graphs; incidence, fundamental cut set and fundamental circuit matrices. Solution methods: nodal and mesh analysis. Network theorems: superposition, Thevenin and Norton's maximum power transfer, Wye-Delta transformation. Steady state sinusoidal analysis using phasors. Linear constant coefficient differential equations; time domain analysis of simple RLC circuits, Solution of network equations using Laplace transform: frequency domain analysis of RLC circuits. 2-port network parameters: driving point and transfer functions. State equations for networks.

Electronic Devices: Energy bands in silicon, intrinsic and extrinsic silicon. Carrier transport in silicon: diffusion current, drift current, mobility, resistivity. Generation and recombination of carriers. p-n junction diode, Zener diode, tunnel diode, BJT, JFET, MOS capacitor, MOSFET, LED, p-I-n and avalanche photo diode, LASERs. Device technology: integrated circuits fabrication process, oxidation, diffusion, ion implantation, photolithography, n-tub, p-tub and twin-tub CMOS process.

Analog Circuits: Equivalent circuits (large and small-signal) of diodes, BJTs, JFETs, and MOSFETs. Simple diode circuits, clipping, clamping, rectifier. Biasing and bias stability of transistor and FET amplifiers. Amplifiers: single-and multi-stage, differential, operational, feedback and power. Analysis of amplifiers; frequency response of amplifiers. Simple op-amp circuits. Filters. Sinusoidal oscillators; criterion for oscillation; single-transistor and op-amp configurations. Function generators and wave-shaping circuits. Power supplies.

Digital circuits: Boolean algebra, minimization of Boolean functions; logic gates digital IC families (DTL, TTL, ECL, MOS, CMOS). Combinational circuits: arithmetic circuits, code converters, multiplexers and decoders. Sequential circuits: latches and flip-flops, counters and shift-registers. Sample and hold circuits, ADCs, DACs. Semiconductor memories. Microprocessor(8085): architecture, programming, memory and I/O interfacing.

Signals and Systems: Definitions and properties of Laplace transform, continuous-time and discrete-time Fourier series, continuous-time and discrete-time Fourier Transform, z-transform. Sampling theorems. Linear Time-Invariant (LTI) Systems: definitions and properties; casuality, stability, impulse response, convolution, poles and zeros frequency response, group delay, phase delay. Signal transmission through LTI systems. Random signals and noise: probability, random variables, probability density function, autocorrelation, power spectral density.

Controls Systems: Basic control system components; block diagrammatic description, reduction of block diagrams. Open loop and closed loop (feedback) systems and stability analysis of these systems. Signal flow graphs and their use in determining transfer functions of systems; transient and steady state analysis of LTI control systems and frequency response. Tools and techniques for LTI control system analysis: root loci, Routh-Hurwitz criterion, Bode and Nyquist plots. Control system compensators: elements of lead and lag compensation, elements of Proportional-Integral-Derivative(PID) control. State variable representation and solution of state equation of LTI control systems.

Communications: Analog communication systems: amplitude and angle modulation and demodulation systems, spectral analysis of these operations, superheterodyne receivers; elements of hardware, realizations of analog communication systems; signal-to-noise ratio (SNR) calculations for amplitude modulation (AM) and frequency modulation (FM) for low noise conditions. Digital communication systems: pulse code modulation (PCM), differential pulse code modulation (DPCM), delta modulation (DM); digital modulation schemes-amplitude, phase and frequency shift keying schemes (ASK, PSK, FSK), matched filter receivers, bandwith consideration and probability of error calculations for these schemes.

Electromagnetics: Elements of vector calculus: divergence and curl; Gauss' and Stokes' theorems, Maxwell's equations: differential and integral forms. Wave equation, Poynting vector. Plane waves: propagation through various media; reflection and refraction; phase and group velocity; skin depth. Transmission lines: characteristic impedance; impedance transformation; Smith chart; impedance matching; pulse excitation. Waveguides: modes in rectangular waveguides; boundary conditions; cut-off frequencies; dispersion relations. Antennas: Dipole antennas; antenna arrays; radiation pattern; reciprocity theorem, antenna gain.

EE - ELECTRICAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix Algebra, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Mean value theorems, Theorems of integral calculus, Evaluation of definite and improper integrals, Partial Derivatives, Maxima and minima, Multiple integrals, Fourier series. Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equation (linear and nonlinear), Higher order linear differential equations with constant coefficients, Method of variation of parameters, Cauchy's and Euler's equations, Initial and boundary value problems, Partial Differential Equations and variable separable method.

Complex variables: Analytic functions, Cauchy's integral theorem and integral formula, Taylor's and Laurent' series, Residue theorem, solution integrals.

Probability and Statistics: Sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Discrete and continuous distributions, Poisson, Normal and Binomial distribution, Correlation and regression analysis.

Numerical Methods: Solutions of non-linear algebraic equations, single and multi-step methods for differential equations.

Transform Theory: Fourier transform, Laplace transform, Z-transform.

ELECTRICAL ENGINEERING

Electrical Circuits and Fields: Network graph, KCL, KVL, node/ cut set, mesh/ tie set analysis, transient response of d.c. and a.c. networks; sinusoidal steady-state analysis; resonance in electrical circuits; concepts of ideal voltage and current sources, network theorems, driving point, immittance and transfer functions of two port networks, elementary concepts of filters; three phase circuits; Fourier series and its application; Gauss theorem, electric field intensity and potential due to point, line, plane and spherical charge distribution, dielectrics, capacitance calculations for simple configurations; Ampere's and Biot-Savart's law, inductance calculations for simple configurations.

Electrical Machines: Single phase transformer - equivalent circuit, phasor diagram, tests, regulation and efficiency; three phase transformers - connections, parallel operation; auto transformer and three-winding transformer; principles of energy conversion, windings of rotating machines: D. C. generators and motors - characteristics, starting and speed control, armature reaction and commutation; three phase induction motors-performance characteristics, starting and speed control; single-phase induction motors; synchronous generators-performance, regulation, parallel operation; synchronous motors - starting, characteristics, applications, synchronous condensers; fractional horse power motors; permanent magnet and stepper motors.

Power Systems: Electric power generation - thermal, hydro, nuclear; transmission line parameters; steady-state performance of overhead transmission lines and cables and surge propagation; distribution systems, insulators, bundle conductors, corona and radio interference effects; per-unit quantities; bus admittance and impedance matrices; load flow; voltage control and power factor correction; economic operation; symmetrical components, analysis of symmetrical and unsymmetrical faults; principles of over current, differential and distance protections; concept of solid state relays and digital protection; circuit breakers; concept of system stability-swing curves and equal area criterion; basic concepts of HVDC transmission.

Control Systems: Principles of feedback; transfer function; block diagrams: steady-state errors; stability-Routh and Nyquist criteria; Bode plots; compensation; root loci; elementary state variable formulation; state transition matrix and response for Linear Time Invariant systems.

Electrical and Electronic Measurements: Bridges and potentiometers, PMMC, moving iron, dynamometer and induction type instruments; measurement of voltage, current, power, energy and power factor; instrument transformers; digital voltmeters and multimeters; phase, time and frequency measurement; Q-meter, oscilloscopes, potentiometric recorders, error analysis.

Analog and Digital Electronics: Characteristics of diodes, BJT, FET, SCR; amplifiers-biasing, equivalent circuit and frequency response; oscillators and feedback amplifiers, operational amplifiers- characteristics and applications; simple active filters; VCOs and timers; combinational and sequential logic circuits, multiplexer, Schmitt trigger, multivibrators, sample and hold circuits, A/D and D/A converters; microprocessors and their applications.

Power Electronics and Electric Drives: Semiconductor power devices-diodes, transistors, thyristors, triacs, GTOs, MOSFETs and IGBTs - static characteristics and principles of operation; triggering circuits; phase control rectifiers; bridge converters-fully controlled and half controlled; principles of choppers and inverters, basic concepts of adjustable speed dc and ac drives.

GG - GEOLOGY AND GEOPHYSICS

PART - I

Earth and planetary system; size, shape, internal structure and composition of the earth; atmosphere and greenhouse effect; isostasy; elements of seismology; continents and continental processes; physical oceanography; palaeomagnetism, continental drift plate tectonics, geothermal energy.

Weathering; soil formation; action of river, wind and glacier; oceans and oceanic features; earthquakes, volcanoes, orogeny and mountain building; elements of structural geology; crystallography; classification, composition and properties of minerals and rocks; engineering properties of rocks and soils, role of geology in the construction of engineering structures.

Processes of ore formation, occurrence and distribution of ores on land and on ocean floor; coal and petroleum resources in India; ground water geology including well hydraulics, geological time scale and geochronology; stratigraphic principles and stratigraphy of India; basics concepts of gravity, magnetic and electrical prospecting for ores and ground water.

PART - IIA: GEOLOGY

Crystal symmetry, forms, twinning; crystal chemistry; optical mineralogy, classification of minerals, diagnostic properties of rock minerals.

Mineralogy, structure, texture and classification of igneous, sedimentary and metamorphic rock, their origin and evolution; application of thermodynamics; structure and petrology of sedimentary rocks; sedimentary processes and environments, sedimentary facies, basin studies; basement cover relationship;

Primary and secondary structures; geometry and genesis of folds, faults, joints, unconformities, cleavage, schistosity and lineation; methods of projection. Tectonites and their significance; shear zone; superposed folding.

Morphology, classification and geological significance of important invertebrates, vertebrates, microfossils and palaeoflora; stratigraphic principles and Indian stratigraphy; geomorphic processes and agents; development and evolution of landforms; slope and drainage; processes on deep oceanic and near-shore regions; quantitative and applied geomorphology; air photo interpretation and remote sensing; chemical and optical properties of ore minerals; formation and localization of ore deposits; prospecting and exploration of economic minerals; coal and petroleum geology; origin and distribution of mineral and fuel deposits in India; ore dressing and mineral economics.

Cosmic abundance; meteorites; geochemical evolution of the earth; geochemical cycles; distribution of major, minor and trace elements; isotope geochemistry; geochemistry of waters including solution equilibria and water rock interaction.

Engineering properties of rocks and soils; rocks as construction material; geology of dams, tunnels and excavation sites; natural hazards; the fly ash problem; ground water geology and exploration; water quality; impact of human activity; Remote sensing techniques for the interpretation of landforms and resource management.

PART - II B: GEOPHYSICS

The earth as a planet; different motions of the earth; gravity filed of the earth and its shape; geochronology; isostasy, seismology and interior of the earth; variation of density, velocity, pressure, temperature, electrical and magnetic properties inside the earth; earthquakes-causes and measurements; zonation and seismic hazards; geomagnetic field, palaeomagnetism; oceanic and continental lithosphere; plate tectonics; heat flow; upper and lower atmospheric phenomena.

Theories of scalar and vector potential fields; Laplace, Maxwell and Helmholtz equations for solution of different types of boundary value problems for Cartesian, cylindrical and spherical polar coordinates; Green's theorem; Image theory; integral equations and conformal transformations in potential theory; Eikonal equation and ray theory.

'G' and 'g' units of measurement, density of rocks, gravimeters, preparation, analysis and interpretation of gravity maps; derivative maps, analytical continuation; gravity anomaly type curves; calculation of mass.

Earth's magnetic field, units of measurement, magnetic susceptibility of rocks, magnetometers, corrections, preparation of magnetic maps, magnetic anomaly type curve, analytical continuation, interpretation and application; magnetic well logging.

Conduction of electricity through rocks, electrical conductivities of metals, metallic, non-metallic and rock forming minerals, D.C. resistivity units and methods of measurement, electrode configuration for sounding and profiling, application of filter theory, interpretation of resistivity field data, application; self potential origin, classification, field measurement, interpretation of induced polarization time frequency, phase domain; IP units and methods of measurement, interpretation and application; ground-water exploration.

Origin of electromagnetic field elliptic polarization, methods of measurement for different source-receiver configuration components in EM measurements, interpretation and applications; earth's natural electromagnetic field, tellurics, magneto-tellurics; geomagnetic depth sounding principles, methods of measurement, processing of data and interpretation.

Seismic methods of prospecting: Reflection, refraction and CDP surveys; land and marine seismic sources, generation and propagation of elastic waves, velocity increasing with depth, geophones, hydrophones, recording instruments (DFS), digital formats, field layouts, seismic noises and noise profile analysis, optimum geophone grouping, noise cancellation by shot and geophone arrays, 2D and 3D seismic data acquisition and processing, CDP stacking charts, binning, filtering, dip-moveout, static and dynamic corrections, deconvolution, migration, signal processing, Fourier and Hilbert transforms, attribute analysis, bright and dim spots, seismic stratigraphy, high resolution seismics, VSP.

Principles and techniques of geophysical well-logging, SP, resistivity, induction, micro gamma ray, neutron, density, sonic, temperature, dip meter, caliper, nuclear magnetic, cement bond logging. Quantitative evaluation of formations from well logs; well hydraulics and application of geophysical methods for groundwater study; application of bore hole geophysics in ground water, mineral and oil exploration. Remote sensing techniques and application of remote sensing methods in geophysics.

IN - INSTRUMENTATION ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix Algebra, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Mean value theorems, Theorems of integral calculus, Evaluation of definite and improper integrals, Partial Derivatives, Maxima and minima, Multiple integrals, Fourier series. Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equation (linear and nonlinear), Higher order linear differential equations with constant coefficients, Method of variation of parameters, Cauchy's and Euler's equations, Initial and boundary value problems, Partial Differential Equations and variable separable method.

Complex variables: Analytic functions, Cauchy's integral theorem and integral formula, Taylor's and Laurent' series, Residue theorem, solution integrals.

Probability and Statistics: Sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Discrete and continuous distributions, Poisson, Normal and Binomial distribution, Correlation and regression analysis.

Numerical Methods: Solutions of non-linear algebraic equations, single and multi-step methods for differential equations.

Transform Theory: Fourier transform, Laplace transform, Z-transform.

INSTRUMENTATION ENGINEERING

Measurement Basics and Metrology: Static and dynamic characteristics of measurement systems. Standards and calibration. Error and uncertainty analysis, statistical analysis of data, and curve fitting. Linear and angular measurements; Measurement of straightness, flatness, roundness and roughness.

Transducers, Mechanical Measurements and Industrial Instrumentation: Transducers - elastic, resistive, inductive, capacitive, thermo-electric, piezoelectric, photoelectric, electro-mechanical, electro-chemical, and ultrasonic. Measurement of displacement, velocity (linear and rotational), acceleration, shock, vibration, force, torque, power, strain, stress, pressure, flow, temperature, humidity, viscosity, and density. energy storing elements, suspension systems and dampers.

Analog Electronics: Characteristics of diodes, BJTs, JFETs and MOSFETs; Diode circuits; Amplifiers: single and multi-stage, feedback; Frequency response; Operational amplifiers - design, characteristic, linear and non-linear applications: difference amplifiers; instrumentation amplifiers; precision rectifiers, I-to-V converters, active filters, oscillators, comparators, signal generators, wave shaping circuits.

Digital Electronics: Combinational logic circuits, minimization of Boolean functions; IC families (TTL, MOS, CMOS), arithmetic circuits, multiplexer and decoders. Sequential circuits: flip-flops, counters, shift registers. Schmitt trigger, timers, and multivibrators. Analog switches, multiplexers, S/H circuits. Analog-to-digital and digital-to-analog converters. Basics of computer organization and architecture. 8-bit microprocessor (8085), applications, memory, I/O interfacing, and microcontrollers.

Signals and Systems: Vectors and matrices; Fourier series; Fourier transforms; Ordinary differential equations. Impulse and frequency responses of first and second order systems. Laplace transform and transfer function, convolution and correlation. Amplitude and frequency modulations and demodulations. Discrete time systems, difference equations, impulse and frequency responses; Z-transforms and transfer functions; IIR and FIR filters.

Electrical and Electronic Measurements: Measurement of R, L and C; bridges and potentiometers. Measurement of voltage, current, power, power factor, and energy; Instrument transformers; Q meter, waveform analyzers. Digital volt-meters and multi-meters. Time, phase and frequency measurements; Oscilloscope. Noise and interference in instrumentation.

Control Systems & Process Control: Principles of feedback; transfer function, signal flow graphs. Stability criteria, Bode plots, root-loci, Routh and Nyquist criteria. Compensation techniques; State space analysis. System components: mechanical, hydraulic, pneumatic, electrical and electronic; Servos and synchros; Stepper motors. On-off, cascade, P, PI, PID and feed-forward controls. Controller tuning and general frequency response.

Analytical, Optical and Biomedical Instrumentation: Principles of spectrometry, UV, visible, IR mass spectrometry, X-ray methods; nuclear radiation measurements, gas, solid and semi conductor lasers and their characteristics, interferometers, basics of fibre optics, transducers in biomedical applications, cardiovascular system measurements, instrumentation for clinical laboratory.

MA - MATHEMATICS

Linear Algebra: Finite dimensional vector spaces. Linear transformations and their matrix representations, rank; systems of linear equations, eigenvalues and eigenvectors, minimal polynomial, Cayley-Hamilton theorem, diagonalisation, Hermitian, Skew-Hermitian and unitary matrices. Finite dimensional inner product spaces, self-adjoint and Normal linear operators, spectral theorem, Quadratic forms.

Complex Analysis: Analytic functions, conformal mappings, bilinear transformations, complex integration: Cauchy's integral theorem and formula, Liouville's theorem, maximum modulus principle, Taylor and Laurent's series, residue theorem and applications for evaluating real integrals.

Real Analysis: Sequences and series of functions, uniform convergence, power series, Fourier series, functions of several variables, maxima, minima, multiple integrals, line, surface and volume integrals, theorems of Green, Stokes and Gauss; metric spaces, completeness, Weierstrass approximation theorem, compactness. Lebesgue measure, measurable functions; Lebesgue integral, Fatou's lemma, dominated convergence theorem.

Ordinary Differential Equations: First order ordinary differential equations, existence and uniqueness theorems, systems of linear first order ordinary differential equations, linear ordinary differential equations of higher order with constant coefficients; linear second order ordinary differential equations with variable coefficients, method of Laplace transforms for solving ordinary differential equations, series solutions; Legendre and Bessel functions and their orthogonality, Sturm Liouville system, Greeen's functions.

Algebra: Normal subgroups and homomorphisms theorems, automorphisms. Group actions, sylow's theorems and their applications groups of order less than or equal to 20, Finite p-groups. Euclidean domains, Principal ideal domains and unique factorizations domains. Prime ideals and maximal ideals in commutative rings.

Functional Analysis: Banach spaces, Hahn-Banach theorems, open mapping and closed graph theorems, principle of uniform boundedness; Hilbert spaces, orthonormal sets, Riesz representation theorem, self-adjoint, unitary and normal linear operators on Hilbert Spaces.

Numerical Analysis: Numerical solution of algebraic and transcendental equations; bisection, secant method, Newton-Raphson method, fixed point iteration, interpolation: existence and error of polynomial interpolation, Lagrange, Newton, Hermite(osculatory)interpolations; numerical differentiation and integration, Trapezoidal and Simpson rules; Gaussian quadrature; (Gauss-Legendre and Gauss-Chebyshev), method of undetermined parameters, least square and orthonormal polynomial approximation; numerical solution of systems of linear equations: direct and iterative methods, (Jacobi Gauss-Seidel and SOR) with convergence; matrix eigenvalue problems: Jacobi and Given's methods, numerical solution of ordinary differential equations: initial value problems, Taylor series method, Runge-Kutta methods, predictor-corrector methods; convergence and stability.

Partial Differential Equations: Linear and quasilinear first order partial differential equations, method of characteristics; second order linear equations in two variables and their classification; Cauchy, Dirichlet and Neumann problems, Green's functions; solutions of Laplace, wave and diffusion equations in two variables Fourier series and transform methods of solutions of the above equations and applications to physical problems.

Mechanics: Forces in three dimensions, Poinsot central axis, virtual work, Lagrange's equations for holonomic systems, theory of small oscillations, Hamiltonian equations;

Topology: Basic concepts of topology, product topology, connectedness, compactness, countability and separation axioms, Urysohn's Lemma, Tietze extension theorem, metrization theorems, Tychonoff theorem on compactness of product spaces.

Probability and Statistics: Probability space, conditional probability, Bayes' theorem, independence, Random variables, joint and conditional distributions, standard probability distributions and their properties, expectation, conditional expectation, moments. Weak and strong law of large numbers, central limit theorem. Sampling distributions, UMVU estimators, sufficiency and consistency, maximum likelihood estimators. Testing of hypotheses, Neyman-Pearson tests, monotone likelihood ratio, likelihood ratio tests, standard parametric tests based on normal, X2 ,t, F-distributions. Linear regression and test for linearity of regression. Interval estimation.

Linear Programming: Linear programming problem and its formulation, convex sets their properties, graphical method, basic feasible solution, simplex method, big-M and two phase methods, infeasible and unbounded LPP's, alternate optima. Dual problem and duality theorems, dual simplex method and its application in post optimality analysis, interpretation of dual variables. Balanced and unbalanced transportation problems, unimodular property and u-v method for solving transportation problems. Hungarian method for solving assignment problems.

Calculus of Variations and Integral Equations: Variational problems with fixed boundaries; sufficient conditions for extremum, Linear integral equations of Fredholm and Volterra type, their iterative solutions. Fredholm alternative.

ME - MECHANICAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

APPLIED MECHANICS AND DESIGN

Engineering Mechanics: Equivalent force systems, free-body concepts, equations of equilibrium, trusses and frames, virtual work and minimum potential energy. Kinematics and dynamics of particles and rigid bodies, impulse and momentum (linear and angular), energy methods, central force motion.

Strength of Materials: Stress and strain, stress-strain relationship and elastic constants, Mohr's circle for plane stress and plane strain, shear force and bending moment diagrams, bending and shear stresses, deflection of beams, torsion of circular shafts, thin and thick cylinders, Euler's theory of columns, strain energy methods, thermal stresses.

Theory of Machines: Displacement, velocity and acceleration, analysis of plane mechanisms, dynamic analysis of slider-crank mechanism, planar cams and followers, gear tooth profiles, kinematics of gears, governors and flywheels, balancing of reciprocating and rotating masses.

Vibrations: Free and forced vibration of single degree freedom systems, effect of damping, vibration isolation, resonance, critical speed of rotors.

Design of Machine Elements: Design for static and dynamic loading, failure theories, fatigue strength; design of bolted, riveted and welded joints; design of shafts and keys; design of spur gears, rolling and sliding contact bearings; brakes and clutches; belt, rope and chain drives.

FLUID MECHANICS AND THERMAL SCIENCES

Fluid Mechanics: Fluid properties, fluid statics, manometry, buoyancy; control-volume analysis of mass, momentum and energy; fluid acceleration; differential equations of continuity and momentum; Bernoulli's equation; viscous flow of incompressible fluids; boundary layer; elementary turbulent flow; flow through pipes, head losses in pipes, bends etc.

Heat-Transfer: Modes of heat transfer; one dimensional heat conduction, resistance concept, electrical analogy, unsteady heat conduction, fins; dimensionless parameters in free and forced convective heat transfer, various correlations for heat transfer in flow over flat plates and through pipes; thermal boundary layer; effect of turbulence; radiative heat transfer, black and grey surfaces, shape factors, network analysis; heat exchanger performance, LMTD and NTU methods.

Thermodynamics: Zeroth, First and Second laws of thermodynamics; thermodynamic system and processes; irreversibility and availability; behaviour of ideal and real gases, properties of pure substances, calculation of work and heat in ideal processes; analysis of thermodynamic cycles related to energy conversion; Carnot, Rankine, Otto, Diesel, Brayton and vapour compression cycles.

Power Plant Engineering: Steam generators; steam power cycles; steam turbines; impulse and reaction principles, velocity diagrams, pressure and velocity compounding; reheating and reheat factor; condensers and feed heaters.

I.C. Engines: Requirements and suitability of fuels in IC engines, fuel ratings, fuel-air mixture requirements; normal combustion in SI and CI engines; engine performance calculations.

Refrigeration and air-conditioning: Refrigerant compressors, expansion devices, condensers and evaporators; properties of moist air, psychrometric chart, basic psychometric processes.

Turbomachinery: Components of gas turbines; compression processes, centrifugal and axial flow compressors; axial flow turbines, elementary theory; hydraulic turbines; Euler-turbine equation; specific speed, Pelton-wheel, Francis and Kaplan turbines; centrifugal pumps.

MANUFACTURING AND INDUSTRIAL ENGINEERING

Engineering Materials: Structure and properties of engineering materials and their applications, heat treatment.

Metal Casting: Casting processes (expendable and non-expendable) -pattern, moulds and cores, heating and pouring, solidification and cooling, gating design, design considerations, defects.

Forming Processes: Stress-strain diagrams for ductile and brittle material, Plastic deformation and yield criteria, fundamentals of hot and cold working processes, Bulk metal forming processes (forging, rolling, extrusion, drawing), sheet metal working processes (punching, blanking, bending, deep drawing, coining, spinning, load estimation using homogeneous deformation methods, defects). processing of powder metals- atomization, compaction, sintering, secondary and finishing operations. forming and shaping of plastics- extrusion, injection moulding.

Joining Processes: Physics of welding, fusion and non-fusion welding processes, brazing and soldering, adhesive bonding, design considerations in welding, weld quality defects.

Machining and Machine Tool Operations: Mechanics of machining, single and multi-point cutting tools, tool geometry and materials, tool life and wear, cutting fluids, machinability, economics of machining, non-traditional machining processes.

Metrology and Inspection: Limits, fits and tolerances, linear and angular measurements, comparators, gauge design, interferometry, form and finish measurement, measurement of screw threads, alignment and testing methods.

Tool Engineering: Principles of work holding, design of jigs and fixtures.

Computer Integrated Manufacturing: Basic concepts of CAD, CAM and their integration tools.

Manufacturing Analysis: Part-print analysis, tolerance analysis in manufacturing and assembly, time and cost analysis.

Work-Study: Method study, work measurement, time study, work sampling, job evaluation, merit rating.

Production Planning and Control: Forecasting models, aggregate production planning, master scheduling, materials requirements planning.

Inventory Control: Deterministic and probabilistic models, safety stock inventory control systems.

Operations Research: Linear programming, simplex and duplex method, transportation, assignment, network flow models, simple queuing models, PERT and CPM

MN - MINING ENGINEERING

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

MINING ENGINEERING

Mechanics: Equivalent force systems, equations of equilibrium, two dimensional frames and trusses, free body diagrams, friction forces, particle kinematics and dynamics.

Mine Development, Geomechanics and Strata Control: Drivages for underground mine development, drilling methods and machines, explosives, blasting devices and practices, shaft sinking. Physico-mechanical properties of rocks, rock mass classification, ground control instrumentation and stress measurement techniques, theories of rock failure, ground vibrations, stress distribution around mine openings, subsidence, design of supports in roadways and workings, stability of open pits, slopes.

Mining Methods and Machinery: Surface mining - layout, development, loading, transportation and mechanization, continuous surface mining systems. Underground coal mining - bord and pillar system, longwall mining, thick seam mining methods. Underground metal mining: different stoping methods, stope mechanization, ore handling systems, mine filling. Generation and transmission of mechanical, hydraulic, and pneumatic power. Materials handling - haulages, conveyors, ropeways, face and development machinery, hoisting systems, and pumps.

Ventilation, Underground Hazards and Surface Environment: Underground atmosphere, heat load sources and thermal environment, air cooling, mechanics of air flow distribution, natural and mechanical ventilation, mine fans and their usage, auxiliary ventilation. Subsurface hazards from fires, explosions, gases, dust, and inundation, rescue apparatus and practices, safety in mines, accident analysis, noise, mine lighting. Air and water pollution: causes, dispersion, quality standards, and control.

Surveying, Mine Planning and Systems Engineering: Fundamentals of engineering surveying, Levels and levelling, Theodolite, tacheometry, triangulation, contouring, errors and adjustments, correlation, underground surveying, curves, photogrammetry, field astronomy, GPS fundamentals. Principles of planning - Sampling methods and practices, reserve estimation techniques, basics of geostatistics, optimization of facility location, cash flow concepts and mine valuation, open pit design. Work study, concepts of reliability, reliability of series and parallel systems. Linear programming, transportation and assignment problems, queueing, network analysis, inventory control.

MT - METALLURGICAL ENGINEERING

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

METALLURGICAL ENGINEERING

Thermodynamics and Rate Processes: Laws of thermodynamics, activity, equilibrium constant, applications to metallurgical systems, solutions, phase equilibria, basic kinetic laws, order of reactions, rate constants and rate limiting steps principles of electro chemistry, aqueous, corrosion and protection of metals, oxidation and high temperature corrosion - characterization and control; momentum transfer - concepts of viscosity, shell balances, Bernoulli's equation; heat transfer - conduction, convection and heat transfer coefficient relations, radiation, mass transfer - diffusion and Fick's laws.

Extractive Metallurgy: Flotation, gravity and other methods of mineral processing; agglomeration, pyro-hydro-and electro-metallurgical processes; material and energy balances; principles and processes for the extraction of non-ferrous metals - aluminium, copper, zinc, lead, magnesium, nickel, titanium and other rare metals; iron and steel making - principles, blast furnace, direct reduction processes, primary and secondary steel making, deoxidation and inclusion in steel; ingot and continuous casting; stainless steel making, design of furnaces; fuels and refractories.

Physical Metallurgy: Crystal structure and bonding characteristics of metals, alloys, ceramics and polymers; solid solutions; solidification; phase transformation and binary phase diagrams; principles of heat treatment of steels, aluminum alloys and cast irons; recovery, recrystallization and grain growth; industrially important ferrous and non-ferrous alloys; elements of X-ray and electron diffraction; principles of scanning and transmission electron microscopy; elements of ceramics, composites and electronic materials; electronic basis of thermal, optical, electrical and magnetic properties of materials.

Mechanical Metallurgy: Elements of elasticity and plasticity; defects in crystals; elements of dislocation theory - types of dislocations, slip and twinning, stress fields of dislocations, dislocation interactions and reactions, methods of seeing dislocations; strengthening mechanisms; tensile, fatigue and creep behaviour; superplasticity; fracture - Griffith theory, ductile to brittle transition, fracture toughness; failure analysis; mechanical testing - tension, compression, torsion, hardness, impact, creep, fatigue, fracture toughness and formability tests.

Manufacturing Processes: Metal casting - patterns, moulds, melting, gating, feeding and casting processes, defects and castings, hot and cold working of metals; Metal forming - fundamentals of metal forming, rolling wire drawing, extrusion, forming, sheet metal forming processes, defects in forming; Metal joining - soldering, brazing and welding, common welding processes, welding metallurgy, problems associated with welding of steels and aluminium alloys, defects in welding, powder metallurgy; NDT methods - ultrasonic, radiography, eddy current, acoustic emission and magnetic.

PH - PHYSICS

Mathematical Physics: Linear vector space, matrices; vector calculus; linear differential equations; elements of complex analysis; Laplace transforms, Fourier analysis, elementary ideas about tensors.

Classical Mechanics: Conservation laws; central forces; collisions and scattering in laboratory and centre of mass reference frames; mechanics of system of particles; rigid body dynamics; moment of inertia tensor; noninertial frames and pseudo forces; variational principle; Lagrange's and Hamilton's formalisms; equation of motion, cyclic coordinates, Poisson bracket; periodic motion, small oscillations, normal modes; wave equation and wave propagation; special theory of relativity - Lorentz transformations, relativistic kinematics, mass-energy equivalence.

Electromagnetic Theory: Laplace and Poisson equations; conductors and dielectrics; boundary value problems; Ampere's and Biot-Savart's laws; Faraday's law; Maxwell's equations; scalar and vector potentials; Coulomb and Lorentz gauges; boundary conditions at interfaces; electromagnetic waves; interference, diffraction and polarization; radiation from moving charges.

Quantum Mechanics: Physical basis of quantum mechanics; uncertainty principle; Schrodinger equation; one and three dimensional potential problems; Particle in a box, harmonic oscillator, hydrogen atom; linear vectors and operators in Hilbert space; angular momentum and spin; addition of angular momentum; time independent perturbation theory; elementary scattering theory.

Atomic and Molecular Physics: Spectra of one-and many-electron atoms; LS and jj coupling; hyperfine structure; Zeeman and Stark effects; electric dipole transitions and selection rules; X-ray spectra; rotational and vibrational spectra of diatomic molecules; electronic transition in diatomic molecules, Franck-Condon principle; Raman effect; NMR and ESR; lasers.

Thermodynamics and Statistical Physics: Laws of thermodynamics; macrostates, phase space; probability ensembles; partition function, free energy, calculation of thermodynamic quantities; classical and quantum statistics; degenerate Fermi gas; black body radiation and Planck's distribution law; Bose-Einstein condensation; first and second order phase transitions, critical point.

Solid State Physics: Elements of crystallography; diffraction methods for structure determination; bonding in solids; elastic properties of solids; defects in crystals; lattice vibrations and thermal properties of solids; free electron theory; band theory of solids; metals, semiconductors and insulators; transport properties; optical, dielectric and magnetic properties of solids; elements of superconductivity.

Nuclear and Particle Physics: Rutheford scattering; basic properties of nuclei; radioactive decay; nuclear forces; two nucleon problem; nuclear reactions; conservation laws; fission and fusion; nuclear models; particle accelerators, detectors; elementary particles; photons, baryons, mesons and leptons; Quark model.

Electronics: Network analysis; semiconductor devices; bipolar transistors; FETs; power supplies, amplifier, oscillators; operational amplifiers; elements of digital electronics; logic circuits.

PI - PRODUCTION AND INDUSTRIAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

GENERAL ENGINEERING:

Engineering Materials: Structure and properties of engineering materials and their applications; effect of strain, strain rate and temperature on mechanical properties of metals and alloys; heat treatment of metals and alloys.

Applied Mechanics: Engineering mechanics - equivalent force systems, free body concepts, equations of equilibrium, virtual work and minimum potential energy; strength of materials-stress, strain and their relationship, Mohr's circle, deflection of beams, bending and shear stress, Euler's theory of columns.

Theory of Machines and Design: Analysis of planar mechanisms, plane cams and followers; governers and fly wheels; design of elements-failure theories; design of bolted, riveted and welded joints; design of shafts, keys, belt drives, brakes and clutches.

Thermal Engineering: Fluid machines - fluid statics, Bernoulli's equation, flow through pipes, equations of continuity and momentum; Thermodynamics - zeroth, First and Second laws of thermodynamics, thermodynamic system and processes, calculation of work and heat for systems and control volumes; Heat transfer - fundamentals of conduction, convection and radiation.

PRODUCTION ENGINEERING

Metal Casting: Casting processes; patterns-materials; allowances; moulds and cores - materials, making and testing; melting and founding of cast iron, steels and nonferrous metals and alloys; solidification; design of casting, gating and risering; casting defects and inspection.

Metal working: Stress-strain in elastic and plastic deformation; deformation mechanisms; hot and cold working-forging, rolling, extrusion, wire and tube drawing; sheet metal working; analysis of rolling, forging, extrusion and wire /rod drawing; metal working defects, high energy rate forming processes-explosive, magnetic, electro and electrohydraulic.

Metal Joining Processes: Welding processes - gas shielded metal arc, TIG, MIG, submerged arc, electroslag, thermit, resistance, pressure and forge welding; thermal cutting; other joining processes - soldering, brazing, braze welding; welding codes, welding symbols, design of welded joints, defects and inspection; introduction to modern welding processes - friction, ultrasonic, explosive, electron beam, laser and plasma.

Machining and Machine Tool Operations: Machining processes-turning, drilling, boring, milling, shaping, planing, sawing, gear cutting, thread production, broaching, grinding, lapping, honing super finishing; mechanics of cutting- Merchant's analysis, geometry of cutting tools, cutting forces, power requirements; selection of process parameters; tool materials, tool wear and tool life, cutting fluids, machinability; nontraditional machining processes and hybrid processes- EDM, CHM, ECM, USM, LBM, EBM, AJM, PAM AND WJM; economics of machining.

Metrology and Inspection: Limits and fits, linear and angular measurements by mechanical and optical methods, comparators; design of limit gauges; interferometry; measurement of straightness, flatness, roundness, squareness and symmetry; surface finish measurement; inspection of screw threads and gears; alignment testing.

Powder Metallurgy and Processing of Plastics: Production of powders, compaction, sintering; Polymers and composites; injection, compression and blow molding, extrusion, calendaring and thermoforming; molding of composites.

Tool Engineering: Work-holding-location and clamping; principles and methods; design of jigs and fixtures; design of press working tools, forging dies.

Manufacturing Analysis: Sources of errors in manufacturing; process capability; part-print analysis; tolerance analysis in manufacturing and assembly; process planning; parameter selection and comparison of production alternatives; time and cost analysis; Issues in choosing manufacturing technologies and strategies.

Computer Integrated Manufacturing: Basic concepts of CAD, CAM, CAPP, group technology, NC, CNC, DNC, FMS, Robotics and CIM.

INDUSTRIAL ENGINEERING

Product Design and Development: Principles of good product design, component and tolerance design; efficiency, quality and cost considerations; product life cycle; standardization, simplification, diversification, value analysis, concurrent engineering.

Engineering Economy and Costing: Financial statements; elementary cost accounting, methods of depreciation; break-even analysis, techniques for evaluation of capital investments.

Work System Design: Taylor's scientific management, Gilbreths's contributions; productivity concepts and measurements; method study, micro-motion study, principles of motion economy; human factors engineering, ergonomics; work measurement - time study, PMTS, work sampling; job evaluation, merit rating, wage administration, incentive systems; business process reengineering.

Logistics and Facility Design: Facility location factors, evaluation of alternatives, types of plant layout, evaluation; computer aided layout; assembly line balancing; material handling systems; supply chain management.

Production Planning and Inventory Control: Inventory Function costs, classifications - deterministic and probabilistic models; quantity discount; safety stock; inventory control system; Forecasting techniques - causal and time series models, moving average, exponential smoothing; trend and seasonality; aggregate production planning; master scheduling; bill of materials and material requirement planning; order control and flow control, routing, scheduling and priority dispatching; JIT; Kanban PULL systems; bottleneck scheduling and theory of constraints.

Operation Research: Linear programming - problem formulation, simplex method, duality and sensitivity analysis; transportation; assignment; network flow models, constrained optimization and Lagrange multipliers; simple queuing models; dynamic programming; simulation; PERT and CPM, time-cost trade-off, resource leveling.

Quality Control: Taguchi method; design of experiments; quality costs, statistical quality assurance, process control charts, acceptance sampling, zero defects; quality circles, total quality management.

Reliability and Maintenance: Reliability, availability and maintainability; probabilistic failure and repair times; system reliability; preventive maintenance and replacement, TPM.

Management Information System: Value of information; information storage and retrieval system - database and data structures; interactive systems; knowledge based systems.

Intellectual Property System: Definition of intellectual property, importance of IPR; TRIPS, and its implications, WIPO and Global IP structure, and IPS in India; patent, copyright, industrial design and trademark; meanings, rules and procedures, terms, infringements and remedies.

PY - PHARMACEUTICAL SCIENCES

Natural Products: Pharmacognosy & Phytochemistry - Chemistry, tests, isolation, characterization and estimation of phytopharmaceuticals belonging to the group of Alkaloids, Glycosides, Terpenoids, Steroids, Bioflavanoids, Purines, Guggul lipids. Pharmacognosy of crude drugs which contain the above constituents. Standardisation of raw materials and herbal products. WHO guide lines. Quantitative microscopy including modern techniques used for evaluation. Biotechnological principles and techniques for plant development Tissue culture.

Pharmacology: General pharmacological principles including Toxicology. Drug interaction. Pharmacology of drugs acting on Central nervous system, Cardiovascular system, Autonomic nervous system, Gastro intestinal system and Respiratory system. Pharmacology of Autocoids, Hormones, Chemotherapeutic agents including anticancer drugs. Bioassays. Immuno Pharmacology.

Medicinal Chemistry: Structure, nomenclature, classification, synthesis, SAR and metabolism of the following category of drugs which are official in Indian Pharmacopoeia and British Pharmacopoeia Hypnotics and Sedatives, Analgesics, NSAIDS, Neuroleptics, Antidepressants, Anxiolytics, Anticonvulsants, Antihistaminics, Local anaesthetics, Cardio Vascular drugs - Antianginal agents Vasodilators, Adrenergic & cholinergic drugs, Cardiotonic agents, Diuretics, Antihypertensive drugs, Hypoglycemic agents, Antilipedmic agents, Coagulants, Anticoagulants, Antiplatelet agents. Chemotherapeutic agents - Antibiotics, Antibacterials, Sulphadrugs. Antiproliozoal drugs, Antiviral, Antitubercular, Antimalarial, Anticancer, Antiamoebic drugs. Diagnostic agents. Preparation and storage and uses of official Radiopharmaceuticals. Vitamins and Hormones.

Pharmaceutics: Development, manufacturing standards, labeling, packing as per the pharmacopoeal requirements, Storage of different dosage forms and new drug delivery systems. Biopharmaceutics and Pharmacokinetics and their importance in formulation. Formulation and preparation of cosmetics - lipstick, shampoo, creams, nail preparations and dentifrices. Pharmaceutical calculations.

Pharmaceutical Jurisprudence: Legal aspects of manufacture, storage, sale of drugs. D and C act and rules. Pharmacy act.

Pharmaceutical Analysis: Principles, instrumentation and applications of the following. Absorption spectroscopy (UV, visible & IR), Fluorimetry, Flame photometry, Potentiometry, Conductometry and Plarography. Pharmacopoeial assays. Principles of NMR, ESR, Mass spectroscopy, X-ray diffraction analysis and different chromatographic methods.

Biochemistry and Clinical Pharmacy: Biochemical role of hormones, Vitamins, Enzymes, Nucleic acids. Bioenergetics. General principles of immunology. Immunological techniques. Adverse drug interaction.

Microbiology: Principles and methods of microbiological assays of the Pharmacopoeia. Methods of preparation of official sera and vaccines. Serological and diagnostic tests. Applications of microorganisms in Bio Conversions and in Pharmaceutical industry.

TF - TEXTILE ENGINEERING AND FIBRE SCIENCE

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

TEXTILE ENGINEERING & FIBRE SCIENCE

Textile Fibres: Classification of textile fibres according to their nature and origin; general characteristics of textile fibres-their chemical and physical structures and their properties; essential characteristics of fibre forming polymers; uses of natural and man-made fibres; physical and chemical methods of fibre and blend identification and blend analysis.

Melt Spinning processes with special reference to polyamide and polyester fibres; wet and dry spinning of viscose and acrylic fibres; post spinning operations-drawing, heat setting, texturing- false twist and air-jet, tow-to-top conversion. Methods of investigating fibre structure e.g. X-ray diffraction, birefringence, optical and electron microscopy, I.R. absorption, thermal methods; structure and morphology and principal natural and man-made fibres, mechanical properties of fibres, moisture sorption in fibres; fibre structure and property correlation.

Textile Testing: Sampling techniques, sample size and sampling errors; measurement of fibre length, fineness, crimp, strength and reflectance; measurement of cotton fibre maturity ad trash content; HVI and AFIS for fibre testing. Measurement of yarn count, twist and hairiness; tensile testing of fibres, yarn and fabrics; evenness testing of slivers, rovings and yarns; testing equipment for measurement test methods of fabric properties like thickness, compressibility, air permeability, drape, crease recovery, tear strength bursting strength and abrasion resistance. Correlation analysis, significance tests and analysis of variance; frequency distributions and control charts.

Yarn Manufacture and Yarn Structure: Modern methods of opening, cleaning and blending of fibrous materials; the technology of carding with particular reference to modern developments; causes of irregularity introduced by drafting, the development of modern drafting systems; principles and techniques of preparing material for combing; recent development in combers; functions and synchronization of various mechanisms concerned with roving production; forces acting on yarn and traveller, ring and traveller designs; causes of end breakages; properties of doubles yarns; new methods of yarn production such as rotor spinning, air jet spinning and friction spinning.

Yarn diameter; specific volume, packing coefficient; twist-strength relationship; fibre orientation in yarn; fibre migration.

Fabric Manufacture and Fabric Structure: Principles of cheese and cone winding processes and machines; random and precision winding; package faults and their remedies; yarn clearers and tensioners; different systems of yarn splicing; features of modern cone winding machines; different types of warping creels; features of modern beam and sectional warping machines; different sizing systems, sizing of spun and filament yarns, modern sizing machines; principles of pirn winding processes and machines; primary and secondary motions of loom, effect of their settings and timings on fabric formation, fabric appearance and weaving performance; dobby and jacquard shedding; mechanics of weft insertion with shuttle; warp and weft stop motions, warp protection, weft replenishment; functional principles of weft insertion systems of shuttleless weaving machines, principles of multiphase and circular looms. Principles of weft and warp knitting; basic weft and warp knitted structures; classification, production and areas of application of nonwoven fabrics.

Basic woven fabric constructions and their derivatives; crepe, cord, terry, gauze, lino and double cloth constructions.

Peirce's equations for fabric geometry; thickness, cover and maximum sett of woven fabrics

Textile Chemical Processing: Preparatory processes for natural-and and their blends; mercerization of cotton; machines for yarn and fabric mercerization.

Dyeing and printing of natural- and synthetic- fibre fabrics and their blends with different dye classes; dyeing and printing machines; styles of printing; fastness properties of dyed and printed textile materials.

Finishing of textile materials, wash and wear, durable press, soil release, water repellent, flame retardant and antistatic finishes; shrink-resistance finish for wool; heat setting of synthetic-fibre fabrics, finishing machines; energy efficient processes; pollution control.

XE - ENGINERING SCIENCES

The syllabi of the sections of this paper are as follows:

SECTION A. ENGINEERING MATHEMATICS (Compulsory)

Linear Algebra : Determinates, algebra of matrices, rank, inverse, system of linear equations, symmetric, skew-symmetric and orthogonal matrices. Hermitian, skew-hermitian and unitary matrices. eigenvalues and eigenvectors, diagonalisation of matrices, Cayley-Hamiltonian, quadratic forms.

Calculus : Functions of single variables, limit, continuity and differentiability, Mean value theorems, Intermediate forms and L'Hospital rule, Maxima and minima, Taylor's series, Fundamental and mean value-theorems of integral calculus. Evaluation of definite and improper integrals, Beta and Gamma functions, Functions of two variables, limit, continuity, partial derivatives, Euler's theorem for homogeneous functions, total derivatives, maxima and minima, Lagrange method of multipliers, double and triple integrals and their applications, sequence and series, tests for convergence, power series, Fourier Series, Fourier integrals.

Complex variable: Analytic functions, Cauchy's integral theorem and integral formula without proof. Taylor's and Laurent' series, Residue theorem (without proof) with application to the evaluation of real integarls.

Vector Calculus: Gradient, divergence and curl, vector identities, directional derivatives, line, surface and volume integrals, Stokes, Gauss and Green's theorems (without proofs) with applications.

Ordinary Differential Equations: First order equation (linear and nonlinear), higher order linear differential equations with constant coefficients, method of variation of paramaters, Cauchy's and Euler's equations, initial and boundary value problems, power series solutions, Legendre polynomials and Bessel's functions of the first kind.

Partial Differential Equations: Variables separable method, solutions of one dimensional heat, wave and Laplace equations.

Probability and Statistics: Definitions of probability and simple theorems, conditional probability, mean, mode and standard deviation, random variables, discrete and continuous distributions, Poisson, normal and Binomial distribution, correlation and regression

Numerical Methods: L-U decomposition for systems of linear equations,Newton-Raphson method, numerical integration(trapezoidal and Simpson's rule), numerical methods for first order differential equation (Euler method)

SECTION B. COMPUTATIONAL SCIENCE

Numerical Methods: Truncation errors, round off errors and their propagation; Interpolation; Lagrange, Newton's forward, backward and divided difference formulas, least square curve fitting, solution of non-linear equations of one variables using bisection, false position, secant and Newton Raphson methods; Rate of convergence of these methods, general iterative methods. Simple and multiple roots of polynomials. Solutions of system of linear algebraic equations using Gauss elimination methods, Jacobi and Gauss-Seidel iterative methods and their rate of convergence; ill conditioned and well conditioned system. eigen values and eigen vectors using power methods. Numerical integration using trapezoidal, Simpson's rule and other quadrature formulas. Numerical Differentiation. Solution of boundary value problems. Solution of initial value problems of ordinary differential equations using Euler's method, predictor corrector and Runge Kutta method.

Programming : Elementary concepts and terminology of a computer system and system software, Fortran77 and C programming.

Fortran : Program organization, arithmetic statements, transfer of control, Do loops, subscripted variables, functions and subroutines.

C language : Basic data types and declarations, flow of control- iterative statement, conditional statement, unconditional branching, arrays, functions and procedures.

SECTION C. ELECTRICAL SCIENCES

Electric Circuits: Ideal voltage and current sources; RLC circuits, steady state and transient analysis of DC circuits, network theorems; alternating currents and voltages, single-phase AC circuits, resonance; three-phase circuits.

Magnetic circuits: Mmf and flux, and their relationship with voltage and current; transformer, equivalent circuit of a practical transformer, three-phase transformer connections.

Electrical machines: Principle of operation, characteristics, efficiency and regulation of DC and synchronous machines; equivalent circuit and performance of three-phase and single-phase induction motors.

Electronic Circuits: Characteristics of p-n junction diodes, zener diodes, bipolar junction transistors (BJT) and junction field effect transistors (JFET); MOSFET's structure, characteristics, and operations; rectifiers, filters, and regulated power supplies; biasing circuits, different configurations of transistor amplifiers, class A, B and C of power amplifiers; linear applications of operational amplifiers; oscillators; tuned and phase shift types.

Digital circuits: Number systems, Boolean algebra; logic gates, combinational circuits, flip-flops (RS, JK, D and T) counters.

Measuring instruments: Moving coil, moving iron, and dynamometer type instruments; shunts, instrument transformers, cathode ray oscilloscopes; D/A and A/D converters.

SECTION D. FLUID MECHANICS

Fluid Properties: Relation between stress and strain rate for Newtonian fluids

Hydrostatics, buoyancy, manometry

Concept of local and convective accelerations; control volume analysis for mass, momentum and energy conservation.

Differential equations of continuity and momentum (Euler's equation of motion); concept of fluid rotation, stream function, potential function; Bernoulli's equation and its applications.

Qualitative ideas of boundary layers and its separation; streamlined and bluff bodies; drag and lift forces.

Fully-developed pipe flow; laminar and turbulent flows; friction factor; Darcy Weisbach relation; Moody's friction chart; losses in pipe fittings; flow measurements using venturimeter and orifice plates.

Dimensional analysis; similitude and concept of dynamic similarity; importance of dimensionless numbers in model studies.

SECTION E. MATERIALS SCIENCE

Atomic structure and bonding in materials: metals, ceramics and polymers.

Structure of materials: Crystal systems, unit cells and space lattice; determination of structures of simple crystals by X-ray diffraction; Miller indices for planes and directions. Packing geometry in metallic, ionic and covalent solids.

Concept of amorphous, single and polycrystalline structures and their effects on properties of materials.

Imperfections in crystalline solids and their role in influencing various properties.

Fick´s laws of diffusion and applications of diffusion in sintering, doping of semiconductors and surface hardening of metals.

Alloys: solid solution and solubility limit. Binary phase diagram, intermediate phases and intermetallic compounds; iron-iron carbide phase diagram. Phase transformation in steels. Cold and hot working of metals, recovery, recrystallization and grain growth.

Properties and applications of ferrous and nonferrous alloys.

Structure, properties, processing and applications of traditional and advanced ceramics.

Polymers: classification, polymerization, structure and properties, additives for polymer products, processing and application.

Composites: properties and application of various composites.

Corrosion and environmental degradation of materials (metals, ceramics and polymers).

Mechanical properties of materials: Stress-strain diagrams of metallic, ceramic and polymeric materials, modulus of elasticity, yield strength, plastic deformation and toughness, tensile strength and elongation at break; viscoelasticity, hardness, impact strength. ductile and brittle fracture. creep and fatigue properties of materials.

Heat capacity, thermal conductivity, thermal expansion of materials.

Concept of energy band diagram for materials; conductors, semiconductors and insulators in terms of energy bands. Electrical conductivity, effect of temperature on conductivity in materials, intrinsic and extrinsic semiconductors, dielectric properties of materials.

Refraction, reflection, absorption and transmission of electromagnetic radiation in solids.

Origin of magnetism in metallic and ceramic materials, paramagnetism, diamagnetism, antiferromagnetism, ferromagnetism, ferrimagnetism in materials and magnetic hysteresis.

Advanced materials: Smart materials exhibiting ferroelectric, piezoelectric, optoelectronic, semiconducting behaviour; lasers and optical fibers; photoconductivity and superconductivity in materials.

SECTION F. SOLID MECHANICS

Equivalent force systems; free-body diagrams; equilibrium equations; analysis of determinate and indeterminate trusses and frames; friction.

Simple relative motion of particles; force as function of position, time and speed; force acting on a body in motion; laws of motion; law of conservation of energy; law of conservation of momentum

Stresses and strains; principal stresses and strains; Mohr's circle; generalized Hooke's Law; equilibrium equations; compatibility conditions; yield criteria.

Axial, shear and bending moment diagrams; axial, shear and bending stresses; deflection (for symmetric bending); torsion in circular shafts; thin cylinders; energy methods (Castigliano's Theorems); Euler buckling.

SECTION G. THERMODYNAMICS

Basic Concepts: Continuum, macroscopic approach, thermodynamic system (closed and open or control volume); thermodynamic properties and equilibrium; state of a system, state diagram, path and process; different modes of work; Zeroth law of thermodynamics; concept of temperature; heat.

First Law of Thermodynamics: Energy, enthalpy, specific heats, first law applied to systems and control volumes, steady and unsteady flow analysis.

Second Law of Thermodynamics: Kelvin-Planck and Clausius statements, reversible and irreversible processes, Carnot theorems, thermodynamic temperature scale, Clausius inequality and concept of entropy, principle of increase of entropy; availability and irreversibility.

Properties of Pure Substances: Thermodynamic properties of pure substances in solid, liquid and vapour phases, P-V-T behaviour of simple compressible substances, phase rule, thermodynamic property tables and charts, ideal and real gases, equations of state, compressibility chart.

Thermodynamic Relations: T-ds relations, Maxwell equations, Joule-Thomson coefficient, coefficient of volume expansion, adiabatic and isothermal compressibilities, Clapeyron equation.

Ideal Gas Mixtures: Dalton's and Amagat's laws, calculations of properties, air-water vapour mixtures.

XL - LIFE SCIENCES

The syllabi of the Sections of this paper are as follows:

SECTION H. CHEMISTRY (Compulsory)

Atomic structure and periodicity: Quantum chemistry; Planck's quantum theory, wave particle duality, uncertainty principle, quantum mechanical model of hydrogen atom; electronic configuration of atoms; periodic table and periodic properties; ionization energy, election affinity, electronegativity, atomic size.

Structure and bonding: Ionic and covalent bonding M.O. and V.B. approaches for diatomic molecules, VSEPR theory and shape of molecules, hybridisation, resonance, dipole moment, structure parameters such as bond length, bond angle and bond energy, hydrogen bonding, van der Waals interactions. Ionic solids; ionic radii, lattice energy (Born-Haber Cycle).

s.p. and d Block Elements: Oxides, halides and hydrides of alkali and alkaline earth metals, B, Al, S, N, P and S, silicones, general characteristics of 3d elements, coordination complexes: valence bond and crystal field theory, color, geometry and magnetic properties.

Chemical Equilibria: Colligative properties of solutions, ionic equilibria in solution, solubility product, common ion effect, hydrolysis of salts, pH, buffer and their applications in chemical analysis.

Electrochemistry: Conductance, Kohlrausch law, Half Cell potentials, emf, Nernst equation, galvanic cells, thermodynamic aspects and their applications.

Reaction Kinetics: Rate constant, order of reaction, molecularity, activation energy, zero, first and second order kinetics, equilibrium constants (Kc, Kp and Kx) for homogeneous reactions, catalysis and elementary enzyme reactions.

Thermodynamics: First law, reversible and irreversible processes, internal energy, enthalpy, Kirchoff's equation, heat of reaction, Hess law, heat of formation, Second law, entropy, free energy, and work function. Gibbs-Helmholtz equation, Clausius-Clapeyron equation, free energy change and equilibrium constant, Troutons rule, Third law of thermodynamics.

Mechanistic Basis of Organic Reactions: Elementary treatment of SN1, SN2, E1 and E2 reactions, Hoffmann and Saytzeff rules, Addition reactions, Markonikoff rule and Kharash effect, Diels-Alder reaction, aromatic electrophilic substitution, orientation effect as exemplified by various functional groups.

Structure-Reactivity Correlations: Acids and bases, electronic and steric effects, optical and geometrical isomerism, tautomerism, concept of aromaticity

SECTION I. BIOCHEMISTRY

Organization of life. Importance of water. Cell structure and organelles. Structure and function of biomolecules: Carbohydrates, Lipids, Proteins and Nucleic acids. Biochemical separation techniques. Spectroscopic methods; UV-visible and fluorescence. Protein structure, folding and function: Myoglobin, Hemoglobin, Lysozyme, ribonuclease A, Carboxypeptidase and Chymotrypsin. Enzyme kinetics and regulation, Coenzymes.

Metabolism and bioenergitics. Generation and utilization of ATP. Photosynthesis. Major metabolic pathways and their regulation. Biological membranes. Transport across membranes. Signal transduction; hormones and neurotransmitters.

DNA replication, transcription and translation. Biochemical regulation of gene expression. Recombinant DNA technology and applications. Genomics and Proteomics.

The immune system. Active and passive immunity. Complement system. Antobody structure, function and diversity. Cells of the immune system: T, B and macrophages. T and B cell activation. Major histocompatibilty complex. T cell receptor. Immunological techniques: Immunodiffusion, immunoelectrophoresis, RIA and ELISA.

SECTION J. BIOTECHNOLOGY

Recombinant DNA technology for the production of therapeutic proteins. Micro array technology. Heterologous protein expression systems in bacteria, yeast etc.

Architecture of plant genome; plant tissue culture techniques; methods of gene transfer into plant cells; manipulation of phenotypic traits in plants; plant cell fermentations and production of secondary metabolites using suspension/ immobilized cell culture; methods for plant micro propagation; crop improvement and development of transgenic plants. Expression of animal proteins in plants.

Animal cell metabolism and regulation; cell cycle; primary cell culture; nutritional requirements for animal cell culture; techniques for the mass culture of animal cell lines; production of vaccines; growth hormones and interferons using animal cell culture; cytokines-production and therapeutic uses; hybridoma technology; vectors for gene transfer and expression in animal cells. Transgenic animals and molecular pharming.

Microbial production of industrial enzymes; methods for immobilization of enzymes; kinetics of soluble and immobilized enzymes; application of soluble and immobilized enzymes; enzyme-based sensors.

Microbial growth kinetics; batch, fed batch and continuous culture of microbial cells; media for industrial fermentations; sterilization of air and media; design features and operation of stirred tank, air-lift and fluidized bed reactors; aeration and agitation in aerobic fermentations; recovery and purification of fermentation products- filtration, centrifugation, cell disintegration, solvent extraction and chromatographic separations; industrial fermentations for the production of ethanol, citric acid, lysine, penicillin and other biomolecules; simple calculations based on material and energy balance of fermentation processes; application of microbes in the management of domestic and industrial wastes.

SECTION K. BOTANY

Anatomy: Roots, stem and leaves of land plants, meristems, vascular system, their ontogeny, structure and functions. Plant cell structure, organisation, organelles, cytoskeleton, cell wall and membranes.

Development: Cell cycle, cell division, senescence, hormonal regulation of growth; life cycle of an angiosperm, pollination, fertilization, embryogenesis, seed formation, seed storage proteins, seed dormancy and germination. Concept of cellular totipotency, organogenesis and somatic embryogenesis, somaclonal variation, embryo culture, in vitro fertilization.

Physiology and Biochemistry: Plant water relations, transport of minerals and solutes, N2 metabolism, proteins and nucleic acid, respiration, photophysiology, photosynthesis, photorespiration; biosynthesis, mechanism of action and physiological effects of plant growth regulators.

Genetics: Principles of Mendelian inheritance, linkage, recombination and genetic mapping; extrachromosomal inheritance; eukaryotic genome organization (chromatin structure) and regulation of gene expression, gene mutation, chromosome aberrations (numerical and structural), transposons.

Plant Breeding: Principles, methods - selection, hybridization, heterosis; male sterility, self and inter-specific incompatibility; haploidy; somatic cell hybridization; molecular marker-assisted selection; gene transfer methods viz. direct and vector-mediated, transgenic plants and their applications in agriculture.

Economic Botany: Economically important plants - cereals, pulses, plants yielding fiber, timber, sugar, beverages, oils, rubber, dyes, gums, drugs and narcotics - a general account.

Systematics: Systems of classification (non-phylogenetic vs. phylogenetic - outline), plant groups, molecular systematics.

Plant Pathology: Nature and classification of plant diseases, diseases of important crops caused by fungi, bacteria and viruses, and their control measures, mechanism(s) of pathogenesis and resistance, molecular detection of pathogens; plant-microbe beneficial interactions.

Ecology and Plant Geography: Ecosystems - types, dynamics, degradation, ecological succession; food chains; vegetation types of the world; pollution and global warming; speciation and extinction, conservation strategies, cryopreservation.

SECTION L. MICROBIOLOGY

Historical perspective - Discovery of the microbial world; Controversy over spontaneous generation; Role of microorganisms in transformation of organic matter and in the causation of diseases.

Methods in microbiology - Pure culture techniques; Theory and practice of sterilization; Principles of microbial nutrition; Construction of culture media; Enrichment culture techniques for isolation of chemoautotrophs, chemoheterotrophs and photosynthetic microorganisms.

Microbial evolution, systematics and taxonomy - Evolution of earth and earliest life forms; Primitive organisms and their metabolic strategies; New approaches to bacterial taxonomic classification including ribotyping; Nomenclature.

Microbial diversity - Bacteria, archea and their broad classification; Eukaryotic microbes, yeast, fungi, slime mold and protozoa; Viruses and their classification.

Microbial growth -The definition of growth, mathematical expression of growth, growth curve, measurement of growth and growth yields; Synchronous growth; Continuous culture.

Nutrition and metabolism - Overview of metabolism; Microbial nutrition; Energy classes of microorganisms; Culture media; Energetics, modes of ATP generation; ATP generation by heterotrophs; Fermentation; Glycolysis; Respiration; The citric acid cycle; Electron transport systems; Alternate modes of energy generation; Pathways (anabolism) in the biosynthesis of amino acids, purines, pyrimidines and fatty acids.

Metabolic diversity among microorganisms - Photosynthesis in microorganisms; Role of chlorophylls, carotenoids and phycobilins; Calvin cycle; Chemolithotrophy; Hydrogen- iron- nitrite-oxidizing bacteria; Nitrate and sulfate reduction; Methanogenesis and acetogenesis.

Prokaryotic cells: structure-function - Cells walls of eubacteria (peptidoglycan) and related molecules; Outer-membrane of gram-negative bacteria; Cell wall and cell membrane synthesis; Flagella and motility; Cell inclusions like endospores, gas vesicles.

Microbial diseases and host parasite relationships - Normal microflora of skin; Oral cavity; Gastrointestinal tract; Entry of pathogens into the host; Infectious disease transmission; Respiratory infections caused by bacteria and viruses; Tuberculosis; Sexually transmitted diseases including AIDS; Diseases transmitted by animals (Rabies, plague), insects and ticks (rikettsias, Lyme disease, malaria); Food and water borne diseases; Public health and water quality; Pahtogenic fungi; Emerging and resurgent infectious diseases.

Chemotherapy/Antibiotics - Antimicrobial agents; Sulfa drugs; Antibiotics; Pencillins and cephalosporins; Broad-spectrum antibiotics; Antibiotics from prokaryotes; Antifungal antibiotics; Mode of action; Resistance to antibiotics.

Microbial genetics - Genes, mutation and mutagenesis - UV and chemical mutagnes; Types of mutations; Ames test for mutagenesis; Methods of genetic analysis. Bacterial genetic system - Transformation; Conjugation; Transduction; Recombination; Plasmids and Transposons; Bacterial genetic map with reference to E. coli. Viruses and their genetic system - Phage ? and its life cycle; RNA phages; RNA viruses; Retroviruses; Genetic systems of yeast and Neurospora; Extrachromosomal inheritance and mitochondrial genetics; Basic concept of genomics.

SECTION M. ZOOLOGY

Animal world: Animal diversity, distribution, systematic and classification of animals, the phylogenetic relationship.

Evolution: Origin of life, history of life on earth, evolutionary theories, natural selection, adaptation, speciation.

Genetics: Principles of inheritance, molecular basis of heredity, the genetic material, transmission of genetic material, mutations, cytoplasmic inheritance.

Biochemistry and Molecular Biology: Nucleic acids, proteins and other biological macromolecules. Replication, transcription and translation, regulation of gene expression, organization of genome, Kreb's cycle, glycolysis, enzyme catalysis, hormones and their action.

Cell Biology: Structure of cell, cellular organelles and their structure and function, cell cycle, cell division, cellular differentiation, chromosome and chromatin structure. Eukaryotic gene organisation and expression.

Animal Anatomy and Physiology: Comparative physiology, the respiratory system, circulatory system, digestive system, the nervous system, the excretory system, the endocrine system, the reproductive system, the skeletal system, osmoregulation.

Parasitology and Immunology: Nature of parasite, host-parasite relation, protozoan and helminthic parasites, the immune response, cellular and humoral immune response, evolution of the immune system.

Development Biology: Embryonic development, cellular differentiation, organogenesis, metamorphosis, genetic basis of development.

Ecology: The ecosystem, habitats the food chain, population dynamics, species diversity, zoogeography, biogeochemical cycles, conservation biology.

Animal Behaviour: Types of behaviours, courtship, mating and territoriality, instinct, learning and memory, social behaviour across the animal taxa, communication, pheromones, evolution of animal behaviour.

IT - INFORMATION TECHNOLOGY

ENGINEERING MATHEMATICS

Mathematical Logic: Propositional Logic; First Order Logic.

Probability: Conditional Probability; Mean, Median, Mode and Standard Deviation; Random Variables; Distributions; uniform, normal, exponential, Poisson, Binomial.

Set Theory & Algebra: Sets; Relations; Functions; Groups; Partial Orders; Lattice; Boolean Algebra.

Combinatorics: Permutations; Combinations; Counting; Summation; generating functions; recurrence relations; asymptotics.

Graph Theory: Connectivity; spanning trees; Cut vertices & edges; covering; matching; independent sets; Colouring; Planarity; Isomorphism.

Linear Algebra: Algebra of matrices, determinants, systems of linear equations, Eigen values and Eigen vectors.

Numerical Methods: LU decomposition for systems of linear equations; numerical solutions of non linear algebraic equations by Secant, Bisection and Newton-Raphson Methods; Numerical integration by trapezoidal and Simpson's rules.

Calculus: Limit, Continuity & differentiability, Mean value Theorems, Theorems of integral calculus, evaluation of definite & improper integrals, Partial derivatives, Total derivatives, maxima & minima.

FORMAL LANGUAGES AND AUTOMATA

Regular Languages: finite automata, regular expressions, regular grammar.

Context free languages: push down automata, context free grammars

COMPUTER HARDWARE

Digital Logic: Logic functions, minimization, design and synthesis of combinatorial and sequential circuits, number representation and computer arithmetic (fixed and floating point)

Computer organization: Machine instructions and addressing modes, ALU and data path, hardwired and microprogrammed control, memory interface, I/O interface (interrupt and DMA mode), serial communication interface, instruction pipelining, cache, main and secondary storage

SOFTWARE SYSTEMS

Data structures and Algorithms: the notion of abstract data types, stack, queue, list, set, string, tree, binary search tree, heap, graph, tree and graph traversals, connected components, spanning trees, shortest paths, hashing, sorting, searching, design techniques (greedy, dynamic, divide and conquer), asymptotic analysis (best, worst, average cases) of time and space, upper and lower bounds, intractability

Programming Methodology: C programming, program control (iteration, recursion, functions), scope, binding, parameter passing, elementary concepts of object oriented programming

Operating Systems (in the context of Unix): classical concepts (concurrency, synchronization, deadlock), processes, threads and interprocess communication, CPU scheduling, memory management, file systems, I/O systems, protection and security

Information Systems and Software Engineering: information gathering, requirement and feasibility analysis, data flow diagrams, process specifications, input/output design, process life cycle, planning and managing the project, design, coding, testing, implementation, maintenance.

Databases: relational model, database design, integrity constraints, normal forms, query languages (SQL), file structures (sequential, indexed), b-trees, transaction and concurrency control

Data Communication: data encoding and transmission, data link control, multiplexing, packet switching, LAN architecture, LAN systems (Ethernet, token ring), Network devices: switches, gateways, routers

Networks: ISO/OSI stack, sliding window protocols, routing protocols, TCP/UDP, application layer protocols & systems (http, smtp, dns, ftp), network security

Web technologies: three tier web based architecture; JSP, ASP, J2EE, .NET systems; html, XML

AG - AGRICULTURAL ENGINEERING

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

FARM MACHINERY AND POWER:

Sources of power on the farm-human, animal, mechanical, electrical, wind, solar and biomass;

design and selection of machine elements - gears, pulleys, chains and sprockets and belts; overload safety devices used in farm machinery; measurement of force, torque, speed, displacement and acceleration on machine elements.

Soil tillage; forces acting on a tillage tool; hitch systems and hitching of tillage implements; functional requirements, principles of working, construction and operation of manual, animal and power operated equipment for tillage. sowing, planting, fertilizer application, inter-cultivation, spraying, mowing, chaff cutting, harvesting, threshing and transport; testing of agricultural machinery and equipment; calculation of performance parameters -field capacity, efficiency, application rate and losses; cost analysis of implements and tractors.

Thermodynamic principles of I.C. engines; I.C. engine cycles; engine components; fuels and combustion; lubricants and their properties; I.C. engine systems - fuel, cooling, lubrication, ignition, electrical, intake and exhaust; selection, operation, maintenance and repair of I.C. engines; power efficiencies and measurement; calculation of power, torque, fuel consumption, heat load and power losses.

Tractors and power tillers - type, selection, maintenance and repair; tractor clutches and brakes; power transmission systems - gear trains, differential, final drives and power take-off; mechanics of tractor chassis; traction theory; three point hitches- free link and restrained link operations; mechanical steering and hydraulic control systems used in tractors; human engineering and safety in tractor design; tractor tests and performance.

SOIL AND WATER CONSERVATION ENGINEERING:

Ideal and real fluids, properties of fluids; hydrostatic pressure and its measurement; hydrostatic forces on plane and curved surface; continuity equation; Bernoulli's theorem; laminar and turbulent flow in pipes, Darcy-Weisbach and Hazen-Williams equations, Moody's diagram; flow through orifices and notches; flow in open channels.

Engineering properties of soils, fundamental definitions and relationships; index properties of soils; permeability and seepage analysis; shear strength, Mohr's circle of stresses; active and passive earth pressures; stability of slopes.

Hydrological cycle; precipitation measurement, analysis of precipitation data; abstraction from precipitation; runoff; hydrograph analysis, unit hydrograph theory and application; stream flow measurement; flood routing, hydrological reservoir and channel routing.

Mechanics of soil erosion, factors affecting erosion; soil loss estimation; biological and engineering measures to control erosion, terraces and bunds; vegetative waterways; gully control structures, drop, drop inlet and chute spillways; farm ponds; earthen dams; principles of watershed management.

Water requirement of crops; consumptive use and evapo-transpiration; irrigation scheduling; irrigation efficiencies; design of prismatic and silt loaded channels; methods of irrigation water application; design and evaluation of irrigation methods; drainage coefficient; surface and subsurface drainage systems; leaching requirement and salinity control; irrigation and drainage water quality; classification of pumps; pump characteristics; pump selection; types of aquifer; evaluation of aquifer properties; well hydraulics; ground water recharge.

AGRICULTURAL PROCESSING AND FOOD ENGINEERING:

Steady state heat transfer in conduction, convection and radiation; transient heat transfer in simple geometry; condensation and boiling heat transfer; working principles of heat exchangers; diffusive and convective mass transfer; simultaneous heat and mass transfer in agricultural processing operations.

Material and energy balances in food processing systems; water activity, sorption and desorption isotherms; centrifugal separation of solids, liquids and gases; kinetics of microbial death - pasteurisation and sterilization of liquid foods; preservation of food by cooling and freezing; psychrometry - properties of air-vapour mixture; concentration and dehydration of liquid foods - evaporators, tray, drum and spray dryers.

Mechanics and energy requirement in size reduction of granular solids; particle size analysis for comminuted solids; size separation by screening; fluidisation of granular solids; cleaning and grading efficiency and effectiveness of grain cleaners; conditioning and hydrothermal treatments for grains; dehydration of food grains; processes and machines for processing of cereals, pulses and oilseeds; design considerations for grain silos.

AR - ARCHITECTURE AND PLANNING

City planning: Historical development of cities; principles of city planning; new towns; survey methods, site planning, planning regulations and building bye-laws.

Housing: Concept of shelter; housing policies and design; community planning; role of government agencies; finance and management.

Landscape Design: Principles of landscape design and site planning; history and landscape styles; landscape elements and materials; planting design.

Computer Aided Design: Application of computers in architecture and planning; understanding elements of hardware and software; computer graphics; programming languages - C and Visual Basic and usage of packages such as AutoCAD.

Environmental and Building Science: Elements of environmental science; ecological principles concerning environment; role of micro-climate in design; climatic control through design elements; thermal comfort; elements of solar architecture; principles of lighting and illumination; basic principles of architectural acoustics; air pollution, noise pollution and their control.

Visual and Urban Design: Principles of visual composition; proportion, scale, rhythm, symmetry, harmony, balance, form and colour; sense of place and space, division of space; focal point, vista, imageability, visual survey.

History of Architecture: Indian - Indus valley, Vedic, Buddhist, Indo-Aryan, Dravidian and Mughal periods; European - Egyptian, Greek, Roman, medieval and renaissance periods.

Development of Contemporary Architecture: Architectural developments and impacts on society since industrial revolution; influence of modern art on architecture; works of national and international architects; post modernism in architecture.

Building Services: Water supply, Sewerage and Drainage systems; Sanitary fittings and fixtures; principles of electrification of buildings; elevators, their standards and uses; air-conditioning systems; fire fighting systems.

Building Construction and Management: Building construction techniques, methods and details; building systems and prefabrication of building elements; principles of modular coordination; estimation, specification, valuation, professional practice; project management, PERT, CPM.

Materials and Structural Systems: Behavioural characteristics of all types of building materials e.g. mud, timber, bamboo, brick, concrete, steel, glass, FRP; principles of strength of materials; design of structural elements in wood, steel and RCC; elastic and limit state design; complex structural systems; principles of pre-stressing.

Planning Theory: Planning process; multilevel planning; comprehensive planning; central place theory; settlement pattern; land use and land utilization.

Techniques of Planning: Planning surveys; Preparation of urban and regional structure plans, development plans, action plans; site planning principles and design; statistical methods; application of remote sensing techniques in urban and regional planning.

Traffic and Transportation Planning: Principles of traffic engineering and transportation planning; methods of conducting surveys; design of roads, intersections and parking areas; hierarchy of roads and levels of services; traffic and transport management in urban areas; traffic safety and traffic laws; public transportation planning; modes of transportation.

Services and Amenities: Principles and design of water supply systems, sewerage systems, solid waste disposal systems, power supply and communication systems; Health, education, recreation and demography related standards at various levels of the settlements.

Development Administration and Management: Planning laws; development control and zoning regulations; laws relating to land acquisition; development enforcements, land ceiling; regional and urban plan preparations; planning and municipal administration; taxation, revenue resources and fiscal management; public participation and role of NGO.

CE - CIVIL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

STRUCTURAL ENGINEERING

Mechanics: Bending moments and shear forces in statically determinate beams; simple stress and strain: relationship; stress and strain in two dimensions, principal stresses, stress transformation, Mohr's circle; simple bending theory; flexural shear stress; thin-walled pressure vessels; uniform torsion.

Structural Analysis: Analysis of statically determinate trusses, arches and frames; displacements in statically determinate structures and analysis of statically indeterminate structures by force/energy methods; analysis by displacement methods (slope-deflection and moment-distribution methods); influence lines for determinate and indeterminate structures; basic concepts of matrix methods of structural analysis.

Concrete Structures: Basic working stress and limit states design concepts; analysis of ultimate load capacity and design of members subject to flexure, shear, compression and torsion (beams, columns and isolated footings); basic elements of prestressed concrete: analysis of beam sections at transfer and service loads.

Steel Structures: Analysis and design of tension and compression members, beams and beam-columns, column bases; connections - simple and eccentric, beam-column connections, plate girders and trusses; plastic analysis of beams and frames.

GEOTECHNICAL ENGINEERING

Soil Mechanics: Origin of soils; soil classification; three-phase system, fundamental definitions, relationship and inter-relationships; permeability and seepage; effective stress principle: consolidation, compaction; shear strength.

Foundation Engineering: Sub-surface investigation - scope, drilling bore holes, sampling, penetrometer tests, plate load test; earth pressure theories, effect of water table, layered soils; stability of slopes - infinite slopes, finite slopes; foundation types - foundation design requirements; shallow foundations; bearing capacity, effect of shape, water table and other factors, stress distribution, settlement analysis in sands and clays; deep foundations - pile types, dynamic and static formulae, load capacity of piles in sands and clays.

WATER RESOURCES ENGINEERING

Fluid Mechanics and Hydraulics: Hydrostatics, applications of Bernoulli equation, laminar and turbulent flow in pipes, pipe networks; concept of boundary layer and its growth; uniform flow, critical flow and gradually varied flow in channels, specific energy concept, hydraulic jump; forces on immersed bodies; flow measurement in channels; tanks and pipes; dimensional analysis and hydraulic modeling. Applications of momentum equation, potential flow, kinematics of flow; velocity triangles and specific speed of pumps and turbines.

Hydrology: Hydrologic cycle; rainfall; evaporation infiltration, unit hydrographs, flood estimation, reservoir design, reservoir and channel routing, well hydraulics.

Irrigation: Duty, delta, estimation of evapo-transpiration; crop water requirements; design of lined and unlined canals; waterways; head works, gravity dams and Ogee spillways. Designs of weirs on permeable foundation, irrigation methods.

ENVIRONMENTAL ENGINEERING

Water requirements; quality and standards, basic unit processes and operations for water treatment, distribution of water. Sewage and sewerage treatment: quantity and characteristic of waste water sewerage; primary and secondary treatment of waste water; sludge disposal; effluent discharge standards.

TRANSPORTATION ENGINEERING

Highway planning; geometric design of highways; testing and specifications of paving materials; design of flexible and rigid pavements.

CH - CHEMICAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative,

Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

CHEMICAL ENGINEERING

Process Calculations and Thermodynamics: Laws of conservation of mass and energy; use of tie components; recycle, bypass and purge calculations; degree of freedom analysis.

First and Second laws of thermodynamics and their applications; equations of state and thermodynamic properties of real systems; phase equilibria; fugacity, excess properties and correlations of activity coefficients; chemical reaction equilibria.

Fluid Mechanics and Mechanical Operations: Fluid statics, Newtonian and non-Newtonian fluids, Bernoulli equation, Macroscopic friction factors, energy balance, dimensional analysis, shell balances, flow through pipeline systems, flow meters, pumps and compressors, packed and fluidized beds, elementary boundary layer theory, size reduction and size separation; free and hindered settling; centrifuge and cyclones; thickening and classification, filtration, mixing and agitation; conveying of solids.

Heat Transfer: Conduction, convection and radiation, heat transfer coefficients, steady and unsteady heat conduction, boiling, condensation and evaporation; types of heat exchangers and evaporators and their design.

Mass Transfer: Fick's law, molecular diffusion in fluids, mass transfer coefficients, film, penetration and surface renewal theories; momentum, heat and mass transfer analogies; stagewise and continuous contacting and stage efficiencies; HTU & NTU concepts design and operation of equipment for distillation, absorption, leaching, liquid-liquid extraction, crystallization, drying, humidification, dehumidification and adsorption.

Chemical Reaction Engineering: Theories of reaction rates; kinetics of homogeneous reactions, interpretation of kinetic data, single and multiple reactions in ideal reactors, non-ideal reactors; residence time; non-isothermal reactors; kinetics of heterogeneous catalytic reactions; diffusion effects in catalysis.

Instrumentation and Process Control: Measurement of process variables; sensors, transducers and their dynamics, dynamics of simple systems, dynamics such as CSTRs, transfer functions and responses of simple systems, process reaction curve, controller modes (P, PI, and PID); control valves; analysis of closed loop systems including stability, frequency response (including Bode plots) and controller tuning, cascade, feed forward control.

Plant Design and Economics: Design and sizing of chemical engineering equipment such as compressors, heat exchangers, multistage contactors; principles of process economics and cost estimation including total annualized cost, cost indexes, rate of return, payback period, discounted cash flow, optimization in Design.

Chemical Technology: Inorganic chemical industries; sulfuric acid, NaOH, fertilizers (Ammonia, Urea, SSP and TSP); natural products industries (Pulp and Paper, Sugar, Oil, and Fats); petroleum refining and petrochemicals; polymerization industries; polyethylene, polypropylene, PVC and polyester synthetic fibers.

CS - COMPUTER SCIENCE AND ENGINEERING

ENGINEERING MATHEMATICS

Mathematical Logic: Propositional Logic; First Order Logic.

Probability: Conditional Probability; Mean, Median, Mode and Standard Deviation; Random Variables; Distributions; uniform, normal, exponential, Poisson, Binomial.

Set Theory & Algebra: Sets; Relations; Functions; Groups; Partial Orders; Lattice; Boolean Algebra.

Combinatorics: Permutations; Combinations; Counting; Summation; generating functions; recurrence relations; asymptotics.

Graph Theory: Connectivity; spanning trees; Cut vertices & edges; covering; matching; independent sets; Colouring; Planarity; Isomorphism.

Linear Algebra: Algebra of matrices, determinants, systems of linear equations, Eigen values and Eigen vectors.

Numerical Methods: LU decomposition for systems of linear equations; numerical solutions of non linear algebraic equations by Secant, Bisection and Newton-Raphson Methods; Numerical integration by trapezoidal and Simpson's rules.

Calculus: Limit, Continuity & differentiability, Mean value Theorems, Theorems of integral calculus, evaluation of definite & improper integrals, Partial derivatives, Total derivatives, maxima & minima.

THEORY OF COMPUTATION

Formal Languages and Automata Theory: Regular languages and finite automata, Context free languages and Push-down automata, Recursively enumerable sets and Turing machines, Un-decidability;

Analysis of Algorithms and Computational Complexity: Asymptotic analysis (best, worst, average case) of time and space, Upper and lower bounds on the complexity of specific problems, NP-completeness.

COMPUTER HARDWARE

Digital Logic: Logic functions, Minimization, Design and synthesis of Combinational and Sequential circuits; Number representation and Computer Arithmetic (fixed and floating point);

Computer Organization: Machine instructions and addressing modes, ALU and Data-path, hardwired and micro-programmed control, Memory interface, I/O interface (Interrupt and DMA mode), Serial communication interface, Instruction pipelining, Cache, main and secondary storage.

SOFTWARE SYSTEMS

Data structures: Notion of abstract data types, Stack, Queue, List, Set, String, Tree, Binary search tree, Heap, Graph;

Programming Methodology: C programming, Program control (iteration, recursion, Functions), Scope, Binding, Parameter passing, Elementary concepts of Object oriented, Functional and Logic Programming;

Algorithms for problem solving: Tree and graph traversals, Connected components, Spanning trees, Shortest paths; Hashing, Sorting, Searching; Design techniques (Greedy, Dynamic Programming, Divide-and-conquer);

Compiler Design: Lexical analysis, Parsing, Syntax directed translation, Runtime environment, Code generation, Linking (static and dynamic); Operating Systems: Classical concepts (concurrency, synchronization, deadlock), Processes, threads and Inter-process communication, CPU scheduling, Memory management, File systems, I/O systems, Protection and security.

Databases: Relational model (ER-model, relational algebra, tuple calculus), Database design (integrity constraints, normal forms), Query languages (SQL), File structures (sequential files, indexing, B+ trees), Transactions and concurrency control;

Computer Networks: ISO/OSI stack, sliding window protocol, LAN Technologies (Ethernet, Token ring), TCP/UDP, IP, Basic concepts of switches, gateways, and routers.

CH - CHEMISTRY

PHYSICAL CHEMISTRY

Structure: Quantum theory - principles and techniques; applications to particle in a box, harmonic oscillator, rigid rotor and hydrogen atom; valence bond and molecular orbital theories and Huckel approximation, approximate techniques: variation and perturbation; symmetry, point groups; rotational, vibrational, electronic, NMR and ESR spectroscopy.

Equilibrium: First law of thermodynamics, heat, energy and work; second law of thermodynamics and entropy; third law and absolute entropy; free energy; partial molar quantities; ideal and non-ideal solutions; phase transformation: phase rule and phase diagrams- one, two, and three component systems; activity, activity coefficient, fugacity and fugacity coefficient ; chemical equilibrium, response of chemical equilibrium to temperature and pressure; colligative properties; kinetic theory of gases; thermodynamics of electrochemical cells; standard electrode potentials: applications - corrosion and energy conversion; molecular partition function (translational, rotational, vibrational and electronic).

Kinetics: Rates of chemical reactions, theories of reaction rates, collision and transition state theory; temperature dependence of chemical reactions; elementary reactions, consecutive elementary reactions; steady state approximation, kinetics of photochemical reactions and free radical polymerization, homogenous and heterogeneous catalysis.

INORGANIC CHEMISTRY

Non-Transition Elements: General characteristics, structure and reactions of simple and industrially important compounds, boranes, carboranes, silicates, silicones, diamond and graphite; hydrides, oxides and oxoacids of N, P, S and halogens; boron nitride, borazines and phosphazenes; xenon compounds. Shapes of molecules, hard-soft acid base concept.

Transition Elements: General characteristics of d and f block elements; coordination chemistry: structure and isomerism, stability, theories of metal-ligand bonding (CFT and LFT), electronic spectra and magnetic properties of transition metal complexes and lanthanides; metal carbonyls, metal-metal bonds and metal atom clusters, metallocenes; transition metal complexes with bonds to hydrogen, alkyls, alkenes, and arenes; metal carbenes; use of organometallic compounds as catalysts in organic synthesis; mechanisms of substitution and electron transfer reactions of coordination complexes. Role of metals with special reference to Na, K, Mg, Ca, Fe, Co, Zn, and Mo in biological systems.

Solids: Crystal systems and lattices, Miller planes, crystal packing, crystal defects; Bragg's Law; ionic crystals, band theory, metals and semiconductors. Spinels.

Instrumental methods of analysis: atomic absorption, UV-visible spectrometry, chromatographic and electro-analytical methods.

ORGANIC CHEMISTRY

Synthesis, reactions and mechanisms involving the following: Alkenes, alkynes, arenes, alcohols, phenols, aldehydes, ketones, carboxylic acids and their derivatives; halides, nitro compounds and amines; stereochemical and conformational effects on reactivity and specificity; reactions with diborane and peracids. Michael reaction, Robinson annulation, reactivity umpolung, acyl anion equivalents; molecular rearrangements involving electron deficient atoms.

Photochemistry: Basic principles, photochemistry of olefins, carbonyl compounds, arenes, photo oxidation and reduction.

Pericyclic reactions: Cycloadditions, electrocyclic reactions, sigmatropic reactions; Woodward-Hoffmann rules.

Heterocycles: Structural properties and reactions of furan, pyrrole, thiophene, pyridine, indole.

Biomolecules: Structure, properties and reactions of mono- and di-saccharides, physico-chemical properties of amino acids, structural features of proteins and nucleic acids.

Spectroscopy: Principles and applications of IR, UV-visible, NMR and mass spectrometry in the determination of structures of organic compounds.

EC - ELECTRONICS AND COMMUNICATION ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix Algebra, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Mean value theorems, Theorems of integral calculus, Evaluation of definite and improper integrals, Partial Derivatives, Maxima and minima, Multiple integrals, Fourier series. Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equation (linear and nonlinear), Higher order linear differential equations with constant coefficients, Method of variation of parameters, Cauchy's and Euler's equations, Initial and boundary value problems, Partial Differential Equations and variable separable method.

Complex variables: Analytic functions, Cauchy's integral theorem and integral formula, Taylor's and Laurent' series, Residue theorem, solution integrals.

Probability and Statistics: Sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Discrete and continuous distributions, Poisson, Normal and Binomial distribution, Correlation and regression analysis.

Numerical Methods: Solutions of non-linear algebraic equations, single and multi-step methods for differential equations.

Transform Theory: Fourier transform, Laplace transform, Z-transform.

ELECTRONICS & COMMUNICATION ENGINEERING

Networks: Network graphs: matrices associated with graphs; incidence, fundamental cut set and fundamental circuit matrices. Solution methods: nodal and mesh analysis. Network theorems: superposition, Thevenin and Norton's maximum power transfer, Wye-Delta transformation. Steady state sinusoidal analysis using phasors. Linear constant coefficient differential equations; time domain analysis of simple RLC circuits, Solution of network equations using Laplace transform: frequency domain analysis of RLC circuits. 2-port network parameters: driving point and transfer functions. State equations for networks.

Electronic Devices: Energy bands in silicon, intrinsic and extrinsic silicon. Carrier transport in silicon: diffusion current, drift current, mobility, resistivity. Generation and recombination of carriers. p-n junction diode, Zener diode, tunnel diode, BJT, JFET, MOS capacitor, MOSFET, LED, p-I-n and avalanche photo diode, LASERs. Device technology: integrated circuits fabrication process, oxidation, diffusion, ion implantation, photolithography, n-tub, p-tub and twin-tub CMOS process.

Analog Circuits: Equivalent circuits (large and small-signal) of diodes, BJTs, JFETs, and MOSFETs. Simple diode circuits, clipping, clamping, rectifier. Biasing and bias stability of transistor and FET amplifiers. Amplifiers: single-and multi-stage, differential, operational, feedback and power. Analysis of amplifiers; frequency response of amplifiers. Simple op-amp circuits. Filters. Sinusoidal oscillators; criterion for oscillation; single-transistor and op-amp configurations. Function generators and wave-shaping circuits. Power supplies.

Digital circuits: Boolean algebra, minimization of Boolean functions; logic gates digital IC families (DTL, TTL, ECL, MOS, CMOS). Combinational circuits: arithmetic circuits, code converters, multiplexers and decoders. Sequential circuits: latches and flip-flops, counters and shift-registers. Sample and hold circuits, ADCs, DACs. Semiconductor memories. Microprocessor(8085): architecture, programming, memory and I/O interfacing.

Signals and Systems: Definitions and properties of Laplace transform, continuous-time and discrete-time Fourier series, continuous-time and discrete-time Fourier Transform, z-transform. Sampling theorems. Linear Time-Invariant (LTI) Systems: definitions and properties; casuality, stability, impulse response, convolution, poles and zeros frequency response, group delay, phase delay. Signal transmission through LTI systems. Random signals and noise: probability, random variables, probability density function, autocorrelation, power spectral density.

Controls Systems: Basic control system components; block diagrammatic description, reduction of block diagrams. Open loop and closed loop (feedback) systems and stability analysis of these systems. Signal flow graphs and their use in determining transfer functions of systems; transient and steady state analysis of LTI control systems and frequency response. Tools and techniques for LTI control system analysis: root loci, Routh-Hurwitz criterion, Bode and Nyquist plots. Control system compensators: elements of lead and lag compensation, elements of Proportional-Integral-Derivative(PID) control. State variable representation and solution of state equation of LTI control systems.

Communications: Analog communication systems: amplitude and angle modulation and demodulation systems, spectral analysis of these operations, superheterodyne receivers; elements of hardware, realizations of analog communication systems; signal-to-noise ratio (SNR) calculations for amplitude modulation (AM) and frequency modulation (FM) for low noise conditions. Digital communication systems: pulse code modulation (PCM), differential pulse code modulation (DPCM), delta modulation (DM); digital modulation schemes-amplitude, phase and frequency shift keying schemes (ASK, PSK, FSK), matched filter receivers, bandwith consideration and probability of error calculations for these schemes.

Electromagnetics: Elements of vector calculus: divergence and curl; Gauss' and Stokes' theorems, Maxwell's equations: differential and integral forms. Wave equation, Poynting vector. Plane waves: propagation through various media; reflection and refraction; phase and group velocity; skin depth. Transmission lines: characteristic impedance; impedance transformation; Smith chart; impedance matching; pulse excitation. Waveguides: modes in rectangular waveguides; boundary conditions; cut-off frequencies; dispersion relations. Antennas: Dipole antennas; antenna arrays; radiation pattern; reciprocity theorem, antenna gain.

EE - ELECTRICAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix Algebra, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Mean value theorems, Theorems of integral calculus, Evaluation of definite and improper integrals, Partial Derivatives, Maxima and minima, Multiple integrals, Fourier series. Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equation (linear and nonlinear), Higher order linear differential equations with constant coefficients, Method of variation of parameters, Cauchy's and Euler's equations, Initial and boundary value problems, Partial Differential Equations and variable separable method.

Complex variables: Analytic functions, Cauchy's integral theorem and integral formula, Taylor's and Laurent' series, Residue theorem, solution integrals.

Probability and Statistics: Sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Discrete and continuous distributions, Poisson, Normal and Binomial distribution, Correlation and regression analysis.

Numerical Methods: Solutions of non-linear algebraic equations, single and multi-step methods for differential equations.

Transform Theory: Fourier transform, Laplace transform, Z-transform.

ELECTRICAL ENGINEERING

Electrical Circuits and Fields: Network graph, KCL, KVL, node/ cut set, mesh/ tie set analysis, transient response of d.c. and a.c. networks; sinusoidal steady-state analysis; resonance in electrical circuits; concepts of ideal voltage and current sources, network theorems, driving point, immittance and transfer functions of two port networks, elementary concepts of filters; three phase circuits; Fourier series and its application; Gauss theorem, electric field intensity and potential due to point, line, plane and spherical charge distribution, dielectrics, capacitance calculations for simple configurations; Ampere's and Biot-Savart's law, inductance calculations for simple configurations.

Electrical Machines: Single phase transformer - equivalent circuit, phasor diagram, tests, regulation and efficiency; three phase transformers - connections, parallel operation; auto transformer and three-winding transformer; principles of energy conversion, windings of rotating machines: D. C. generators and motors - characteristics, starting and speed control, armature reaction and commutation; three phase induction motors-performance characteristics, starting and speed control; single-phase induction motors; synchronous generators-performance, regulation, parallel operation; synchronous motors - starting, characteristics, applications, synchronous condensers; fractional horse power motors; permanent magnet and stepper motors.

Power Systems: Electric power generation - thermal, hydro, nuclear; transmission line parameters; steady-state performance of overhead transmission lines and cables and surge propagation; distribution systems, insulators, bundle conductors, corona and radio interference effects; per-unit quantities; bus admittance and impedance matrices; load flow; voltage control and power factor correction; economic operation; symmetrical components, analysis of symmetrical and unsymmetrical faults; principles of over current, differential and distance protections; concept of solid state relays and digital protection; circuit breakers; concept of system stability-swing curves and equal area criterion; basic concepts of HVDC transmission.

Control Systems: Principles of feedback; transfer function; block diagrams: steady-state errors; stability-Routh and Nyquist criteria; Bode plots; compensation; root loci; elementary state variable formulation; state transition matrix and response for Linear Time Invariant systems.

Electrical and Electronic Measurements: Bridges and potentiometers, PMMC, moving iron, dynamometer and induction type instruments; measurement of voltage, current, power, energy and power factor; instrument transformers; digital voltmeters and multimeters; phase, time and frequency measurement; Q-meter, oscilloscopes, potentiometric recorders, error analysis.

Analog and Digital Electronics: Characteristics of diodes, BJT, FET, SCR; amplifiers-biasing, equivalent circuit and frequency response; oscillators and feedback amplifiers, operational amplifiers- characteristics and applications; simple active filters; VCOs and timers; combinational and sequential logic circuits, multiplexer, Schmitt trigger, multivibrators, sample and hold circuits, A/D and D/A converters; microprocessors and their applications.

Power Electronics and Electric Drives: Semiconductor power devices-diodes, transistors, thyristors, triacs, GTOs, MOSFETs and IGBTs - static characteristics and principles of operation; triggering circuits; phase control rectifiers; bridge converters-fully controlled and half controlled; principles of choppers and inverters, basic concepts of adjustable speed dc and ac drives.

GG - GEOLOGY AND GEOPHYSICS

PART - I

Earth and planetary system; size, shape, internal structure and composition of the earth; atmosphere and greenhouse effect; isostasy; elements of seismology; continents and continental processes; physical oceanography; palaeomagnetism, continental drift plate tectonics, geothermal energy.

Weathering; soil formation; action of river, wind and glacier; oceans and oceanic features; earthquakes, volcanoes, orogeny and mountain building; elements of structural geology; crystallography; classification, composition and properties of minerals and rocks; engineering properties of rocks and soils, role of geology in the construction of engineering structures.

Processes of ore formation, occurrence and distribution of ores on land and on ocean floor; coal and petroleum resources in India; ground water geology including well hydraulics, geological time scale and geochronology; stratigraphic principles and stratigraphy of India; basics concepts of gravity, magnetic and electrical prospecting for ores and ground water.

PART - IIA: GEOLOGY

Crystal symmetry, forms, twinning; crystal chemistry; optical mineralogy, classification of minerals, diagnostic properties of rock minerals.

Mineralogy, structure, texture and classification of igneous, sedimentary and metamorphic rock, their origin and evolution; application of thermodynamics; structure and petrology of sedimentary rocks; sedimentary processes and environments, sedimentary facies, basin studies; basement cover relationship;

Primary and secondary structures; geometry and genesis of folds, faults, joints, unconformities, cleavage, schistosity and lineation; methods of projection. Tectonites and their significance; shear zone; superposed folding.

Morphology, classification and geological significance of important invertebrates, vertebrates, microfossils and palaeoflora; stratigraphic principles and Indian stratigraphy; geomorphic processes and agents; development and evolution of landforms; slope and drainage; processes on deep oceanic and near-shore regions; quantitative and applied geomorphology; air photo interpretation and remote sensing; chemical and optical properties of ore minerals; formation and localization of ore deposits; prospecting and exploration of economic minerals; coal and petroleum geology; origin and distribution of mineral and fuel deposits in India; ore dressing and mineral economics.

Cosmic abundance; meteorites; geochemical evolution of the earth; geochemical cycles; distribution of major, minor and trace elements; isotope geochemistry; geochemistry of waters including solution equilibria and water rock interaction.

Engineering properties of rocks and soils; rocks as construction material; geology of dams, tunnels and excavation sites; natural hazards; the fly ash problem; ground water geology and exploration; water quality; impact of human activity; Remote sensing techniques for the interpretation of landforms and resource management.

PART - II B: GEOPHYSICS

The earth as a planet; different motions of the earth; gravity filed of the earth and its shape; geochronology; isostasy, seismology and interior of the earth; variation of density, velocity, pressure, temperature, electrical and magnetic properties inside the earth; earthquakes-causes and measurements; zonation and seismic hazards; geomagnetic field, palaeomagnetism; oceanic and continental lithosphere; plate tectonics; heat flow; upper and lower atmospheric phenomena.

Theories of scalar and vector potential fields; Laplace, Maxwell and Helmholtz equations for solution of different types of boundary value problems for Cartesian, cylindrical and spherical polar coordinates; Green's theorem; Image theory; integral equations and conformal transformations in potential theory; Eikonal equation and ray theory.

'G' and 'g' units of measurement, density of rocks, gravimeters, preparation, analysis and interpretation of gravity maps; derivative maps, analytical continuation; gravity anomaly type curves; calculation of mass.

Earth's magnetic field, units of measurement, magnetic susceptibility of rocks, magnetometers, corrections, preparation of magnetic maps, magnetic anomaly type curve, analytical continuation, interpretation and application; magnetic well logging.

Conduction of electricity through rocks, electrical conductivities of metals, metallic, non-metallic and rock forming minerals, D.C. resistivity units and methods of measurement, electrode configuration for sounding and profiling, application of filter theory, interpretation of resistivity field data, application; self potential origin, classification, field measurement, interpretation of induced polarization time frequency, phase domain; IP units and methods of measurement, interpretation and application; ground-water exploration.

Origin of electromagnetic field elliptic polarization, methods of measurement for different source-receiver configuration components in EM measurements, interpretation and applications; earth's natural electromagnetic field, tellurics, magneto-tellurics; geomagnetic depth sounding principles, methods of measurement, processing of data and interpretation.

Seismic methods of prospecting: Reflection, refraction and CDP surveys; land and marine seismic sources, generation and propagation of elastic waves, velocity increasing with depth, geophones, hydrophones, recording instruments (DFS), digital formats, field layouts, seismic noises and noise profile analysis, optimum geophone grouping, noise cancellation by shot and geophone arrays, 2D and 3D seismic data acquisition and processing, CDP stacking charts, binning, filtering, dip-moveout, static and dynamic corrections, deconvolution, migration, signal processing, Fourier and Hilbert transforms, attribute analysis, bright and dim spots, seismic stratigraphy, high resolution seismics, VSP.

Principles and techniques of geophysical well-logging, SP, resistivity, induction, micro gamma ray, neutron, density, sonic, temperature, dip meter, caliper, nuclear magnetic, cement bond logging. Quantitative evaluation of formations from well logs; well hydraulics and application of geophysical methods for groundwater study; application of bore hole geophysics in ground water, mineral and oil exploration. Remote sensing techniques and application of remote sensing methods in geophysics.

IN - INSTRUMENTATION ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix Algebra, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Mean value theorems, Theorems of integral calculus, Evaluation of definite and improper integrals, Partial Derivatives, Maxima and minima, Multiple integrals, Fourier series. Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equation (linear and nonlinear), Higher order linear differential equations with constant coefficients, Method of variation of parameters, Cauchy's and Euler's equations, Initial and boundary value problems, Partial Differential Equations and variable separable method.

Complex variables: Analytic functions, Cauchy's integral theorem and integral formula, Taylor's and Laurent' series, Residue theorem, solution integrals.

Probability and Statistics: Sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Discrete and continuous distributions, Poisson, Normal and Binomial distribution, Correlation and regression analysis.

Numerical Methods: Solutions of non-linear algebraic equations, single and multi-step methods for differential equations.

Transform Theory: Fourier transform, Laplace transform, Z-transform.

INSTRUMENTATION ENGINEERING

Measurement Basics and Metrology: Static and dynamic characteristics of measurement systems. Standards and calibration. Error and uncertainty analysis, statistical analysis of data, and curve fitting. Linear and angular measurements; Measurement of straightness, flatness, roundness and roughness.

Transducers, Mechanical Measurements and Industrial Instrumentation: Transducers - elastic, resistive, inductive, capacitive, thermo-electric, piezoelectric, photoelectric, electro-mechanical, electro-chemical, and ultrasonic. Measurement of displacement, velocity (linear and rotational), acceleration, shock, vibration, force, torque, power, strain, stress, pressure, flow, temperature, humidity, viscosity, and density. energy storing elements, suspension systems and dampers.

Analog Electronics: Characteristics of diodes, BJTs, JFETs and MOSFETs; Diode circuits; Amplifiers: single and multi-stage, feedback; Frequency response; Operational amplifiers - design, characteristic, linear and non-linear applications: difference amplifiers; instrumentation amplifiers; precision rectifiers, I-to-V converters, active filters, oscillators, comparators, signal generators, wave shaping circuits.

Digital Electronics: Combinational logic circuits, minimization of Boolean functions; IC families (TTL, MOS, CMOS), arithmetic circuits, multiplexer and decoders. Sequential circuits: flip-flops, counters, shift registers. Schmitt trigger, timers, and multivibrators. Analog switches, multiplexers, S/H circuits. Analog-to-digital and digital-to-analog converters. Basics of computer organization and architecture. 8-bit microprocessor (8085), applications, memory, I/O interfacing, and microcontrollers.

Signals and Systems: Vectors and matrices; Fourier series; Fourier transforms; Ordinary differential equations. Impulse and frequency responses of first and second order systems. Laplace transform and transfer function, convolution and correlation. Amplitude and frequency modulations and demodulations. Discrete time systems, difference equations, impulse and frequency responses; Z-transforms and transfer functions; IIR and FIR filters.

Electrical and Electronic Measurements: Measurement of R, L and C; bridges and potentiometers. Measurement of voltage, current, power, power factor, and energy; Instrument transformers; Q meter, waveform analyzers. Digital volt-meters and multi-meters. Time, phase and frequency measurements; Oscilloscope. Noise and interference in instrumentation.

Control Systems & Process Control: Principles of feedback; transfer function, signal flow graphs. Stability criteria, Bode plots, root-loci, Routh and Nyquist criteria. Compensation techniques; State space analysis. System components: mechanical, hydraulic, pneumatic, electrical and electronic; Servos and synchros; Stepper motors. On-off, cascade, P, PI, PID and feed-forward controls. Controller tuning and general frequency response.

Analytical, Optical and Biomedical Instrumentation: Principles of spectrometry, UV, visible, IR mass spectrometry, X-ray methods; nuclear radiation measurements, gas, solid and semi conductor lasers and their characteristics, interferometers, basics of fibre optics, transducers in biomedical applications, cardiovascular system measurements, instrumentation for clinical laboratory.

MA - MATHEMATICS

Linear Algebra: Finite dimensional vector spaces. Linear transformations and their matrix representations, rank; systems of linear equations, eigenvalues and eigenvectors, minimal polynomial, Cayley-Hamilton theorem, diagonalisation, Hermitian, Skew-Hermitian and unitary matrices. Finite dimensional inner product spaces, self-adjoint and Normal linear operators, spectral theorem, Quadratic forms.

Complex Analysis: Analytic functions, conformal mappings, bilinear transformations, complex integration: Cauchy's integral theorem and formula, Liouville's theorem, maximum modulus principle, Taylor and Laurent's series, residue theorem and applications for evaluating real integrals.

Real Analysis: Sequences and series of functions, uniform convergence, power series, Fourier series, functions of several variables, maxima, minima, multiple integrals, line, surface and volume integrals, theorems of Green, Stokes and Gauss; metric spaces, completeness, Weierstrass approximation theorem, compactness. Lebesgue measure, measurable functions; Lebesgue integral, Fatou's lemma, dominated convergence theorem.

Ordinary Differential Equations: First order ordinary differential equations, existence and uniqueness theorems, systems of linear first order ordinary differential equations, linear ordinary differential equations of higher order with constant coefficients; linear second order ordinary differential equations with variable coefficients, method of Laplace transforms for solving ordinary differential equations, series solutions; Legendre and Bessel functions and their orthogonality, Sturm Liouville system, Greeen's functions.

Algebra: Normal subgroups and homomorphisms theorems, automorphisms. Group actions, sylow's theorems and their applications groups of order less than or equal to 20, Finite p-groups. Euclidean domains, Principal ideal domains and unique factorizations domains. Prime ideals and maximal ideals in commutative rings.

Functional Analysis: Banach spaces, Hahn-Banach theorems, open mapping and closed graph theorems, principle of uniform boundedness; Hilbert spaces, orthonormal sets, Riesz representation theorem, self-adjoint, unitary and normal linear operators on Hilbert Spaces.

Numerical Analysis: Numerical solution of algebraic and transcendental equations; bisection, secant method, Newton-Raphson method, fixed point iteration, interpolation: existence and error of polynomial interpolation, Lagrange, Newton, Hermite(osculatory)interpolations; numerical differentiation and integration, Trapezoidal and Simpson rules; Gaussian quadrature; (Gauss-Legendre and Gauss-Chebyshev), method of undetermined parameters, least square and orthonormal polynomial approximation; numerical solution of systems of linear equations: direct and iterative methods, (Jacobi Gauss-Seidel and SOR) with convergence; matrix eigenvalue problems: Jacobi and Given's methods, numerical solution of ordinary differential equations: initial value problems, Taylor series method, Runge-Kutta methods, predictor-corrector methods; convergence and stability.

Partial Differential Equations: Linear and quasilinear first order partial differential equations, method of characteristics; second order linear equations in two variables and their classification; Cauchy, Dirichlet and Neumann problems, Green's functions; solutions of Laplace, wave and diffusion equations in two variables Fourier series and transform methods of solutions of the above equations and applications to physical problems.

Mechanics: Forces in three dimensions, Poinsot central axis, virtual work, Lagrange's equations for holonomic systems, theory of small oscillations, Hamiltonian equations;

Topology: Basic concepts of topology, product topology, connectedness, compactness, countability and separation axioms, Urysohn's Lemma, Tietze extension theorem, metrization theorems, Tychonoff theorem on compactness of product spaces.

Probability and Statistics: Probability space, conditional probability, Bayes' theorem, independence, Random variables, joint and conditional distributions, standard probability distributions and their properties, expectation, conditional expectation, moments. Weak and strong law of large numbers, central limit theorem. Sampling distributions, UMVU estimators, sufficiency and consistency, maximum likelihood estimators. Testing of hypotheses, Neyman-Pearson tests, monotone likelihood ratio, likelihood ratio tests, standard parametric tests based on normal, X2 ,t, F-distributions. Linear regression and test for linearity of regression. Interval estimation.

Linear Programming: Linear programming problem and its formulation, convex sets their properties, graphical method, basic feasible solution, simplex method, big-M and two phase methods, infeasible and unbounded LPP's, alternate optima. Dual problem and duality theorems, dual simplex method and its application in post optimality analysis, interpretation of dual variables. Balanced and unbalanced transportation problems, unimodular property and u-v method for solving transportation problems. Hungarian method for solving assignment problems.

Calculus of Variations and Integral Equations: Variational problems with fixed boundaries; sufficient conditions for extremum, Linear integral equations of Fredholm and Volterra type, their iterative solutions. Fredholm alternative.

ME - MECHANICAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

APPLIED MECHANICS AND DESIGN

Engineering Mechanics: Equivalent force systems, free-body concepts, equations of equilibrium, trusses and frames, virtual work and minimum potential energy. Kinematics and dynamics of particles and rigid bodies, impulse and momentum (linear and angular), energy methods, central force motion.

Strength of Materials: Stress and strain, stress-strain relationship and elastic constants, Mohr's circle for plane stress and plane strain, shear force and bending moment diagrams, bending and shear stresses, deflection of beams, torsion of circular shafts, thin and thick cylinders, Euler's theory of columns, strain energy methods, thermal stresses.

Theory of Machines: Displacement, velocity and acceleration, analysis of plane mechanisms, dynamic analysis of slider-crank mechanism, planar cams and followers, gear tooth profiles, kinematics of gears, governors and flywheels, balancing of reciprocating and rotating masses.

Vibrations: Free and forced vibration of single degree freedom systems, effect of damping, vibration isolation, resonance, critical speed of rotors.

Design of Machine Elements: Design for static and dynamic loading, failure theories, fatigue strength; design of bolted, riveted and welded joints; design of shafts and keys; design of spur gears, rolling and sliding contact bearings; brakes and clutches; belt, rope and chain drives.

FLUID MECHANICS AND THERMAL SCIENCES

Fluid Mechanics: Fluid properties, fluid statics, manometry, buoyancy; control-volume analysis of mass, momentum and energy; fluid acceleration; differential equations of continuity and momentum; Bernoulli's equation; viscous flow of incompressible fluids; boundary layer; elementary turbulent flow; flow through pipes, head losses in pipes, bends etc.

Heat-Transfer: Modes of heat transfer; one dimensional heat conduction, resistance concept, electrical analogy, unsteady heat conduction, fins; dimensionless parameters in free and forced convective heat transfer, various correlations for heat transfer in flow over flat plates and through pipes; thermal boundary layer; effect of turbulence; radiative heat transfer, black and grey surfaces, shape factors, network analysis; heat exchanger performance, LMTD and NTU methods.

Thermodynamics: Zeroth, First and Second laws of thermodynamics; thermodynamic system and processes; irreversibility and availability; behaviour of ideal and real gases, properties of pure substances, calculation of work and heat in ideal processes; analysis of thermodynamic cycles related to energy conversion; Carnot, Rankine, Otto, Diesel, Brayton and vapour compression cycles.

Power Plant Engineering: Steam generators; steam power cycles; steam turbines; impulse and reaction principles, velocity diagrams, pressure and velocity compounding; reheating and reheat factor; condensers and feed heaters.

I.C. Engines: Requirements and suitability of fuels in IC engines, fuel ratings, fuel-air mixture requirements; normal combustion in SI and CI engines; engine performance calculations.

Refrigeration and air-conditioning: Refrigerant compressors, expansion devices, condensers and evaporators; properties of moist air, psychrometric chart, basic psychometric processes.

Turbomachinery: Components of gas turbines; compression processes, centrifugal and axial flow compressors; axial flow turbines, elementary theory; hydraulic turbines; Euler-turbine equation; specific speed, Pelton-wheel, Francis and Kaplan turbines; centrifugal pumps.

MANUFACTURING AND INDUSTRIAL ENGINEERING

Engineering Materials: Structure and properties of engineering materials and their applications, heat treatment.

Metal Casting: Casting processes (expendable and non-expendable) -pattern, moulds and cores, heating and pouring, solidification and cooling, gating design, design considerations, defects.

Forming Processes: Stress-strain diagrams for ductile and brittle material, Plastic deformation and yield criteria, fundamentals of hot and cold working processes, Bulk metal forming processes (forging, rolling, extrusion, drawing), sheet metal working processes (punching, blanking, bending, deep drawing, coining, spinning, load estimation using homogeneous deformation methods, defects). processing of powder metals- atomization, compaction, sintering, secondary and finishing operations. forming and shaping of plastics- extrusion, injection moulding.

Joining Processes: Physics of welding, fusion and non-fusion welding processes, brazing and soldering, adhesive bonding, design considerations in welding, weld quality defects.

Machining and Machine Tool Operations: Mechanics of machining, single and multi-point cutting tools, tool geometry and materials, tool life and wear, cutting fluids, machinability, economics of machining, non-traditional machining processes.

Metrology and Inspection: Limits, fits and tolerances, linear and angular measurements, comparators, gauge design, interferometry, form and finish measurement, measurement of screw threads, alignment and testing methods.

Tool Engineering: Principles of work holding, design of jigs and fixtures.

Computer Integrated Manufacturing: Basic concepts of CAD, CAM and their integration tools.

Manufacturing Analysis: Part-print analysis, tolerance analysis in manufacturing and assembly, time and cost analysis.

Work-Study: Method study, work measurement, time study, work sampling, job evaluation, merit rating.

Production Planning and Control: Forecasting models, aggregate production planning, master scheduling, materials requirements planning.

Inventory Control: Deterministic and probabilistic models, safety stock inventory control systems.

Operations Research: Linear programming, simplex and duplex method, transportation, assignment, network flow models, simple queuing models, PERT and CPM

MN - MINING ENGINEERING

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

MINING ENGINEERING

Mechanics: Equivalent force systems, equations of equilibrium, two dimensional frames and trusses, free body diagrams, friction forces, particle kinematics and dynamics.

Mine Development, Geomechanics and Strata Control: Drivages for underground mine development, drilling methods and machines, explosives, blasting devices and practices, shaft sinking. Physico-mechanical properties of rocks, rock mass classification, ground control instrumentation and stress measurement techniques, theories of rock failure, ground vibrations, stress distribution around mine openings, subsidence, design of supports in roadways and workings, stability of open pits, slopes.

Mining Methods and Machinery: Surface mining - layout, development, loading, transportation and mechanization, continuous surface mining systems. Underground coal mining - bord and pillar system, longwall mining, thick seam mining methods. Underground metal mining: different stoping methods, stope mechanization, ore handling systems, mine filling. Generation and transmission of mechanical, hydraulic, and pneumatic power. Materials handling - haulages, conveyors, ropeways, face and development machinery, hoisting systems, and pumps.

Ventilation, Underground Hazards and Surface Environment: Underground atmosphere, heat load sources and thermal environment, air cooling, mechanics of air flow distribution, natural and mechanical ventilation, mine fans and their usage, auxiliary ventilation. Subsurface hazards from fires, explosions, gases, dust, and inundation, rescue apparatus and practices, safety in mines, accident analysis, noise, mine lighting. Air and water pollution: causes, dispersion, quality standards, and control.

Surveying, Mine Planning and Systems Engineering: Fundamentals of engineering surveying, Levels and levelling, Theodolite, tacheometry, triangulation, contouring, errors and adjustments, correlation, underground surveying, curves, photogrammetry, field astronomy, GPS fundamentals. Principles of planning - Sampling methods and practices, reserve estimation techniques, basics of geostatistics, optimization of facility location, cash flow concepts and mine valuation, open pit design. Work study, concepts of reliability, reliability of series and parallel systems. Linear programming, transportation and assignment problems, queueing, network analysis, inventory control.

MT - METALLURGICAL ENGINEERING

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

METALLURGICAL ENGINEERING

Thermodynamics and Rate Processes: Laws of thermodynamics, activity, equilibrium constant, applications to metallurgical systems, solutions, phase equilibria, basic kinetic laws, order of reactions, rate constants and rate limiting steps principles of electro chemistry, aqueous, corrosion and protection of metals, oxidation and high temperature corrosion - characterization and control; momentum transfer - concepts of viscosity, shell balances, Bernoulli's equation; heat transfer - conduction, convection and heat transfer coefficient relations, radiation, mass transfer - diffusion and Fick's laws.

Extractive Metallurgy: Flotation, gravity and other methods of mineral processing; agglomeration, pyro-hydro-and electro-metallurgical processes; material and energy balances; principles and processes for the extraction of non-ferrous metals - aluminium, copper, zinc, lead, magnesium, nickel, titanium and other rare metals; iron and steel making - principles, blast furnace, direct reduction processes, primary and secondary steel making, deoxidation and inclusion in steel; ingot and continuous casting; stainless steel making, design of furnaces; fuels and refractories.

Physical Metallurgy: Crystal structure and bonding characteristics of metals, alloys, ceramics and polymers; solid solutions; solidification; phase transformation and binary phase diagrams; principles of heat treatment of steels, aluminum alloys and cast irons; recovery, recrystallization and grain growth; industrially important ferrous and non-ferrous alloys; elements of X-ray and electron diffraction; principles of scanning and transmission electron microscopy; elements of ceramics, composites and electronic materials; electronic basis of thermal, optical, electrical and magnetic properties of materials.

Mechanical Metallurgy: Elements of elasticity and plasticity; defects in crystals; elements of dislocation theory - types of dislocations, slip and twinning, stress fields of dislocations, dislocation interactions and reactions, methods of seeing dislocations; strengthening mechanisms; tensile, fatigue and creep behaviour; superplasticity; fracture - Griffith theory, ductile to brittle transition, fracture toughness; failure analysis; mechanical testing - tension, compression, torsion, hardness, impact, creep, fatigue, fracture toughness and formability tests.

Manufacturing Processes: Metal casting - patterns, moulds, melting, gating, feeding and casting processes, defects and castings, hot and cold working of metals; Metal forming - fundamentals of metal forming, rolling wire drawing, extrusion, forming, sheet metal forming processes, defects in forming; Metal joining - soldering, brazing and welding, common welding processes, welding metallurgy, problems associated with welding of steels and aluminium alloys, defects in welding, powder metallurgy; NDT methods - ultrasonic, radiography, eddy current, acoustic emission and magnetic.

PH - PHYSICS

Mathematical Physics: Linear vector space, matrices; vector calculus; linear differential equations; elements of complex analysis; Laplace transforms, Fourier analysis, elementary ideas about tensors.

Classical Mechanics: Conservation laws; central forces; collisions and scattering in laboratory and centre of mass reference frames; mechanics of system of particles; rigid body dynamics; moment of inertia tensor; noninertial frames and pseudo forces; variational principle; Lagrange's and Hamilton's formalisms; equation of motion, cyclic coordinates, Poisson bracket; periodic motion, small oscillations, normal modes; wave equation and wave propagation; special theory of relativity - Lorentz transformations, relativistic kinematics, mass-energy equivalence.

Electromagnetic Theory: Laplace and Poisson equations; conductors and dielectrics; boundary value problems; Ampere's and Biot-Savart's laws; Faraday's law; Maxwell's equations; scalar and vector potentials; Coulomb and Lorentz gauges; boundary conditions at interfaces; electromagnetic waves; interference, diffraction and polarization; radiation from moving charges.

Quantum Mechanics: Physical basis of quantum mechanics; uncertainty principle; Schrodinger equation; one and three dimensional potential problems; Particle in a box, harmonic oscillator, hydrogen atom; linear vectors and operators in Hilbert space; angular momentum and spin; addition of angular momentum; time independent perturbation theory; elementary scattering theory.

Atomic and Molecular Physics: Spectra of one-and many-electron atoms; LS and jj coupling; hyperfine structure; Zeeman and Stark effects; electric dipole transitions and selection rules; X-ray spectra; rotational and vibrational spectra of diatomic molecules; electronic transition in diatomic molecules, Franck-Condon principle; Raman effect; NMR and ESR; lasers.

Thermodynamics and Statistical Physics: Laws of thermodynamics; macrostates, phase space; probability ensembles; partition function, free energy, calculation of thermodynamic quantities; classical and quantum statistics; degenerate Fermi gas; black body radiation and Planck's distribution law; Bose-Einstein condensation; first and second order phase transitions, critical point.

Solid State Physics: Elements of crystallography; diffraction methods for structure determination; bonding in solids; elastic properties of solids; defects in crystals; lattice vibrations and thermal properties of solids; free electron theory; band theory of solids; metals, semiconductors and insulators; transport properties; optical, dielectric and magnetic properties of solids; elements of superconductivity.

Nuclear and Particle Physics: Rutheford scattering; basic properties of nuclei; radioactive decay; nuclear forces; two nucleon problem; nuclear reactions; conservation laws; fission and fusion; nuclear models; particle accelerators, detectors; elementary particles; photons, baryons, mesons and leptons; Quark model.

Electronics: Network analysis; semiconductor devices; bipolar transistors; FETs; power supplies, amplifier, oscillators; operational amplifiers; elements of digital electronics; logic circuits.

PI - PRODUCTION AND INDUSTRIAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

GENERAL ENGINEERING:

Engineering Materials: Structure and properties of engineering materials and their applications; effect of strain, strain rate and temperature on mechanical properties of metals and alloys; heat treatment of metals and alloys.

Applied Mechanics: Engineering mechanics - equivalent force systems, free body concepts, equations of equilibrium, virtual work and minimum potential energy; strength of materials-stress, strain and their relationship, Mohr's circle, deflection of beams, bending and shear stress, Euler's theory of columns.

Theory of Machines and Design: Analysis of planar mechanisms, plane cams and followers; governers and fly wheels; design of elements-failure theories; design of bolted, riveted and welded joints; design of shafts, keys, belt drives, brakes and clutches.

Thermal Engineering: Fluid machines - fluid statics, Bernoulli's equation, flow through pipes, equations of continuity and momentum; Thermodynamics - zeroth, First and Second laws of thermodynamics, thermodynamic system and processes, calculation of work and heat for systems and control volumes; Heat transfer - fundamentals of conduction, convection and radiation.

PRODUCTION ENGINEERING

Metal Casting: Casting processes; patterns-materials; allowances; moulds and cores -

materials, making and testing; melting and founding of cast iron, steels and nonferrous metals and alloys; solidification; design of casting, gating and risering; casting defects and inspection.

Metal working: Stress-strain in elastic and plastic deformation; deformation mechanisms; hot and cold working-forging, rolling, extrusion, wire and tube drawing; sheet metal working; analysis of rolling, forging, extrusion and wire /rod drawing; metal working defects, high energy rate forming processes-explosive, magnetic, electro and electrohydraulic.

Metal Joining Processes: Welding processes - gas shielded metal arc, TIG, MIG, submerged arc, electroslag, thermit, resistance, pressure and forge welding; thermal cutting; other joining processes - soldering, brazing, braze welding; welding codes, welding symbols, design of welded joints, defects and inspection; introduction to modern welding processes - friction, ultrasonic, explosive, electron beam, laser and plasma.

Machining and Machine Tool Operations: Machining processes-turning, drilling, boring, milling, shaping, planing, sawing, gear cutting, thread production, broaching, grinding, lapping, honing super finishing; mechanics of cutting- Merchant's analysis, geometry of cutting tools, cutting forces, power requirements; selection of process parameters; tool materials, tool wear and tool life, cutting fluids, machinability; nontraditional machining processes and hybrid processes- EDM, CHM, ECM, USM, LBM, EBM, AJM, PAM AND WJM; economics of machining.

Metrology and Inspection: Limits and fits, linear and angular measurements by mechanical and optical methods, comparators; design of limit gauges; interferometry; measurement of straightness, flatness, roundness, squareness and symmetry; surface finish measurement; inspection of screw threads and gears; alignment testing.

Powder Metallurgy and Processing of Plastics: Production of powders, compaction, sintering; Polymers and composites; injection, compression and blow molding, extrusion, calendaring and thermoforming; molding of composites.

Tool Engineering: Work-holding-location and clamping; principles and methods; design of jigs and fixtures; design of press working tools, forging dies.

Manufacturing Analysis: Sources of errors in manufacturing; process capability; part-print analysis; tolerance analysis in manufacturing and assembly; process planning; parameter selection and comparison of production alternatives; time and cost analysis; Issues in choosing manufacturing technologies and strategies.

Computer Integrated Manufacturing: Basic concepts of CAD, CAM, CAPP, group technology, NC, CNC, DNC, FMS, Robotics and CIM.

INDUSTRIAL ENGINEERING

Product Design and Development: Principles of good product design, component and tolerance design; efficiency, quality and cost considerations; product life cycle; standardization, simplification, diversification, value analysis, concurrent engineering.

Engineering Economy and Costing: Financial statements; elementary cost accounting, methods of depreciation; break-even analysis, techniques for evaluation of capital investments.

Work System Design: Taylor's scientific management, Gilbreths's contributions; productivity concepts and measurements; method study, micro-motion study, principles of motion economy; human factors engineering, ergonomics; work measurement - time study, PMTS, work sampling; job evaluation, merit rating, wage administration, incentive systems; business process reengineering.

Logistics and Facility Design: Facility location factors, evaluation of alternatives, types of plant layout, evaluation; computer aided layout; assembly line balancing; material handling systems; supply chain management.

Production Planning and Inventory Control: Inventory Function costs, classifications - deterministic and probabilistic models; quantity discount; safety stock; inventory control system; Forecasting techniques - causal and time series models, moving average, exponential smoothing; trend and seasonality; aggregate production planning; master scheduling; bill of materials and material requirement planning; order control and flow control, routing, scheduling and priority dispatching; JIT; Kanban PULL systems; bottleneck scheduling and theory of constraints.

Operation Research: Linear programming - problem formulation, simplex method, duality and sensitivity analysis; transportation; assignment; network flow models, constrained optimization and Lagrange multipliers; simple queuing models; dynamic programming; simulation; PERT and CPM, time-cost trade-off, resource leveling.

Quality Control: Taguchi method; design of experiments; quality costs, statistical quality assurance, process control charts, acceptance sampling, zero defects; quality circles, total quality management.

Reliability and Maintenance: Reliability, availability and maintainability; probabilistic failure and repair times; system reliability; preventive maintenance and replacement, TPM.

Management Information System: Value of information; information storage and retrieval system - database and data structures; interactive systems; knowledge based systems.

Intellectual Property System: Definition of intellectual property, importance of IPR; TRIPS, and its implications, WIPO and Global IP structure, and IPS in India; patent, copyright, industrial design and trademark; meanings, rules and procedures, terms, infringements and remedies.

PY - PHARMACEUTICAL SCIENCES

Natural Products: Pharmacognosy & Phytochemistry - Chemistry, tests, isolation, characterization and estimation of phytopharmaceuticals belonging to the group of Alkaloids, Glycosides, Terpenoids, Steroids, Bioflavanoids, Purines, Guggul lipids. Pharmacognosy of crude drugs which contain the above constituents. Standardisation of raw materials and herbal products. WHO guide lines. Quantitative microscopy including modern techniques used for evaluation. Biotechnological principles and techniques for plant development Tissue culture.

Pharmacology: General pharmacological principles including Toxicology. Drug interaction. Pharmacology of drugs acting on Central nervous system, Cardiovascular system, Autonomic nervous system, Gastro intestinal system and Respiratory system. Pharmacology of Autocoids, Hormones, Chemotherapeutic agents including anticancer drugs. Bioassays. Immuno Pharmacology.

Medicinal Chemistry: Structure, nomenclature, classification, synthesis, SAR and metabolism of the following category of drugs which are official in Indian Pharmacopoeia and British Pharmacopoeia Hypnotics and Sedatives, Analgesics, NSAIDS, Neuroleptics, Antidepressants, Anxiolytics, Anticonvulsants, Antihistaminics, Local anaesthetics, Cardio Vascular drugs - Antianginal agents Vasodilators, Adrenergic & cholinergic drugs, Cardiotonic agents, Diuretics, Antihypertensive drugs, Hypoglycemic agents, Antilipedmic agents, Coagulants, Anticoagulants, Antiplatelet agents. Chemotherapeutic agents - Antibiotics, Antibacterials, Sulphadrugs. Antiproliozoal drugs, Antiviral, Antitubercular, Antimalarial, Anticancer, Antiamoebic drugs. Diagnostic agents. Preparation and storage and uses of official Radiopharmaceuticals. Vitamins and Hormones.

Pharmaceutics: Development, manufacturing standards, labeling, packing as per the pharmacopoeal requirements, Storage of different dosage forms and new drug delivery systems. Biopharmaceutics and Pharmacokinetics and their importance in formulation. Formulation and preparation of cosmetics - lipstick, shampoo, creams, nail preparations and dentifrices. Pharmaceutical calculations.

Pharmaceutical Jurisprudence: Legal aspects of manufacture, storage, sale of drugs. D and C act and rules. Pharmacy act.

Pharmaceutical Analysis: Principles, instrumentation and applications of the following. Absorption spectroscopy (UV, visible & IR), Fluorimetry, Flame photometry, Potentiometry, Conductometry and Plarography. Pharmacopoeial assays. Principles of NMR, ESR, Mass spectroscopy, X-ray diffraction analysis and different chromatographic methods.

Biochemistry and Clinical Pharmacy: Biochemical role of hormones, Vitamins, Enzymes, Nucleic acids. Bioenergetics. General principles of immunology. Immunological techniques. Adverse drug interaction.

Microbiology: Principles and methods of microbiological assays of the Pharmacopoeia. Methods of preparation of official sera and vaccines. Serological and diagnostic tests. Applications of microorganisms in Bio Conversions and in Pharmaceutical industry.

TF - TEXTILE ENGINEERING AND FIBRE SCIENCE

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

TEXTILE ENGINEERING & FIBRE SCIENCE

Textile Fibres: Classification of textile fibres according to their nature and origin; general characteristics of textile fibres-their chemical and physical structures and their properties; essential characteristics of fibre forming polymers; uses of natural and man-made fibres; physical and chemical methods of fibre and blend identification and blend analysis.

Melt Spinning processes with special reference to polyamide and polyester fibres; wet and dry spinning of viscose and acrylic fibres; post spinning operations-drawing, heat setting, texturing- false twist and air-jet, tow-to-top conversion. Methods of investigating fibre structure e.g. X-ray diffraction, birefringence, optical and electron microscopy, I.R. absorption, thermal methods; structure and morphology and principal natural and man-made fibres, mechanical properties of fibres, moisture sorption in fibres; fibre structure and property correlation.

Textile Testing: Sampling techniques, sample size and sampling errors; measurement of fibre length, fineness, crimp, strength and reflectance; measurement of cotton fibre maturity ad trash content; HVI and AFIS for fibre testing. Measurement of yarn count, twist and hairiness;

tensile testing of fibres, yarn and fabrics; evenness testing of slivers, rovings and yarns; testing equipment for measurement test methods of fabric properties like thickness, compressibility, air permeability, drape, crease recovery, tear strength bursting strength and abrasion resistance. Correlation analysis, significance tests and analysis of variance; frequency distributions and control charts.

Yarn Manufacture and Yarn Structure: Modern methods of opening, cleaning and blending of fibrous materials; the technology of carding with particular reference to modern developments; causes of irregularity introduced by drafting, the development of modern drafting systems; principles and techniques of preparing material for combing; recent development in combers; functions and synchronization of various mechanisms concerned with roving production; forces acting on yarn and traveller, ring and traveller designs; causes of end breakages; properties of doubles yarns; new methods of yarn production such as rotor spinning, air jet spinning and friction spinning.

Yarn diameter; specific volume, packing coefficient; twist-strength relationship; fibre orientation in yarn; fibre migration.

Fabric Manufacture and Fabric Structure: Principles of cheese and cone winding processes and machines; random and precision winding; package faults and their remedies; yarn clearers and tensioners; different systems of yarn splicing; features of modern cone winding machines; different types of warping creels; features of modern beam and sectional warping machines; different sizing systems, sizing of spun and filament yarns, modern sizing machines; principles of pirn winding processes and machines; primary and secondary motions of loom, effect of their settings and timings on fabric formation, fabric appearance and weaving performance; dobby and jacquard shedding; mechanics of weft insertion with shuttle; warp and weft stop motions, warp protection, weft replenishment; functional principles of weft insertion systems of shuttleless weaving machines, principles of multiphase and circular looms. Principles of weft and warp knitting; basic weft and warp knitted structures; classification, production and areas of application of nonwoven fabrics.

Basic woven fabric constructions and their derivatives; crepe, cord, terry, gauze, lino and double cloth constructions.

Peirce's equations for fabric geometry; thickness, cover and maximum sett of woven fabrics

Textile Chemical Processing: Preparatory processes for natural-and and their blends; mercerization of cotton; machines for yarn and fabric mercerization.

Dyeing and printing of natural- and synthetic- fibre fabrics and their blends with different dye classes; dyeing and printing machines; styles of printing; fastness properties of dyed and printed textile materials.

Finishing of textile materials, wash and wear, durable press, soil release, water repellent, flame retardant and antistatic finishes; shrink-resistance finish for wool; heat setting of synthetic-fibre fabrics, finishing machines; energy efficient processes; pollution control.

XE - ENGINERING SCIENCES

The syllabi of the sections of this paper are as follows:

SECTION A. ENGINEERING MATHEMATICS (Compulsory)

Linear Algebra : Determinates, algebra of matrices, rank, inverse, system of linear equations, symmetric, skew-symmetric and orthogonal matrices. Hermitian, skew-hermitian and unitary matrices. eigenvalues and eigenvectors, diagonalisation of matrices, Cayley-Hamiltonian, quadratic forms.

Calculus : Functions of single variables, limit, continuity and differentiability, Mean value theorems, Intermediate forms and L'Hospital rule, Maxima and minima, Taylor's series, Fundamental and mean value-theorems of integral calculus. Evaluation of definite and improper integrals, Beta and Gamma functions, Functions of two variables, limit, continuity, partial derivatives, Euler's theorem for homogeneous functions, total derivatives, maxima and minima, Lagrange method of multipliers, double and triple integrals and their applications, sequence and series, tests for convergence, power series, Fourier Series, Fourier integrals.

Complex variable: Analytic functions, Cauchy's integral theorem and integral formula without proof. Taylor's and Laurent' series, Residue theorem (without proof) with application to the evaluation of real integarls.

Vector Calculus: Gradient, divergence and curl, vector identities, directional derivatives, line, surface and volume integrals, Stokes, Gauss and Green's theorems (without proofs) with applications.

Ordinary Differential Equations: First order equation (linear and nonlinear), higher order linear differential equations with constant coefficients, method of variation of paramaters, Cauchy's and Euler's equations, initial and boundary value problems, power series solutions, Legendre polynomials and Bessel's functions of the first kind.

Partial Differential Equations: Variables separable method, solutions of one dimensional heat, wave and Laplace equations.

Probability and Statistics: Definitions of probability and simple theorems, conditional probability, mean, mode and standard deviation, random variables, discrete and continuous distributions, Poisson, normal and Binomial distribution, correlation and regression

Numerical Methods: L-U decomposition for systems of linear equations,Newton-Raphson method, numerical integration(trapezoidal and Simpson's rule), numerical methods for first order differential equation (Euler method)

SECTION B. COMPUTATIONAL SCIENCE

Numerical Methods: Truncation errors, round off errors and their propagation; Interpolation; Lagrange, Newton's forward, backward and divided difference formulas, least square curve fitting, solution of non-linear equations of one variables using bisection, false position, secant and Newton Raphson methods; Rate of convergence of these methods, general iterative methods. Simple and multiple roots of polynomials. Solutions of system of linear algebraic equations using Gauss elimination methods, Jacobi and Gauss-Seidel iterative methods and their rate of convergence; ill conditioned and well conditioned system. eigen values and eigen vectors using power methods. Numerical integration using trapezoidal, Simpson's rule and other quadrature formulas. Numerical Differentiation. Solution of boundary value problems. Solution of initial value problems of ordinary differential equations using Euler's method, predictor corrector and Runge Kutta method.

Programming : Elementary concepts and terminology of a computer system and system software, Fortran77 and C programming.

Fortran : Program organization, arithmetic statements, transfer of control, Do loops, subscripted variables, functions and subroutines.

C language : Basic data types and declarations, flow of control- iterative statement, conditional statement, unconditional branching, arrays, functions and procedures.

SECTION C. ELECTRICAL SCIENCES

Electric Circuits: Ideal voltage and current sources; RLC circuits, steady state and transient analysis of DC circuits, network theorems; alternating currents and voltages, single-phase AC circuits, resonance; three-phase circuits.

Magnetic circuits: Mmf and flux, and their relationship with voltage and current; transformer, equivalent circuit of a practical transformer, three-phase transformer connections.

Electrical machines: Principle of operation, characteristics, efficiency and regulation of DC and synchronous machines; equivalent circuit and performance of three-phase and single-phase induction motors.

Electronic Circuits: Characteristics of p-n junction diodes, zener diodes, bipolar junction transistors (BJT) and junction field effect transistors (JFET); MOSFET's structure, characteristics, and operations; rectifiers, filters, and regulated power supplies; biasing circuits, different configurations of transistor amplifiers, class A, B and C of power amplifiers; linear applications of operational amplifiers; oscillators; tuned and phase shift types.

Digital circuits: Number systems, Boolean algebra; logic gates, combinational circuits, flip-flops (RS, JK, D and T) counters.

Measuring instruments: Moving coil, moving iron, and dynamometer type instruments; shunts, instrument transformers, cathode ray oscilloscopes; D/A and A/D converters.

SECTION D. FLUID MECHANICS

Fluid Properties: Relation between stress and strain rate for Newtonian fluids

Hydrostatics, buoyancy, manometry

Concept of local and convective accelerations; control volume analysis for mass, momentum and energy conservation.

Differential equations of continuity and momentum (Euler's equation of motion); concept of fluid rotation, stream function, potential function; Bernoulli's equation and its applications.

Qualitative ideas of boundary layers and its separation; streamlined and bluff bodies; drag and lift forces.

Fully-developed pipe flow; laminar and turbulent flows; friction factor; Darcy Weisbach relation; Moody's friction chart; losses in pipe fittings; flow measurements using venturimeter and orifice plates.

Dimensional analysis; similitude and concept of dynamic similarity; importance of dimensionless numbers in model studies.

SECTION E. MATERIALS SCIENCE

Atomic structure and bonding in materials: metals, ceramics and polymers.

Structure of materials: Crystal systems, unit cells and space lattice; determination of structures of simple crystals by X-ray diffraction; Miller indices for planes and directions. Packing geometry in metallic, ionic and covalent solids.

Concept of amorphous, single and polycrystalline structures and their effects on properties of materials.

Imperfections in crystalline solids and their role in influencing various properties.

Fick´s laws of diffusion and applications of diffusion in sintering, doping of semiconductors and surface hardening of metals.

Alloys: solid solution and solubility limit. Binary phase diagram, intermediate phases and intermetallic compounds; iron-iron carbide phase diagram. Phase transformation in steels. Cold and hot working of metals, recovery, recrystallization and grain growth.

Properties and applications of ferrous and nonferrous alloys.

Structure, properties, processing and applications of traditional and advanced ceramics.

Polymers: classification, polymerization, structure and properties, additives for polymer products, processing and application.

Composites: properties and application of various composites.

Corrosion and environmental degradation of materials (metals, ceramics and polymers).

Mechanical properties of materials: Stress-strain diagrams of metallic, ceramic and polymeric materials, modulus of elasticity, yield strength, plastic deformation and toughness, tensile strength and elongation at break; viscoelasticity, hardness, impact strength. ductile and brittle fracture. creep and fatigue properties of materials.

Heat capacity, thermal conductivity, thermal expansion of materials.

Concept of energy band diagram for materials; conductors, semiconductors and insulators in terms of energy bands. Electrical conductivity, effect of temperature on conductivity in materials, intrinsic and extrinsic semiconductors, dielectric properties of materials.

Refraction, reflection, absorption and transmission of electromagnetic radiation in solids.

Origin of magnetism in metallic and ceramic materials, paramagnetism, diamagnetism, antiferromagnetism, ferromagnetism, ferrimagnetism in materials and magnetic hysteresis.

Advanced materials: Smart materials exhibiting ferroelectric, piezoelectric, optoelectronic, semiconducting behaviour; lasers and optical fibers; photoconductivity and superconductivity in materials.

SECTION F. SOLID MECHANICS

Equivalent force systems; free-body diagrams; equilibrium equations; analysis of determinate and indeterminate trusses and frames; friction.

Simple relative motion of particles; force as function of position, time and speed; force acting on a body in motion; laws of motion; law of conservation of energy; law of conservation of momentum

Stresses and strains; principal stresses and strains; Mohr's circle; generalized Hooke's Law; equilibrium equations; compatibility conditions; yield criteria.

Axial, shear and bending moment diagrams; axial, shear and bending stresses; deflection (for symmetric bending); torsion in circular shafts; thin cylinders; energy methods (Castigliano's Theorems); Euler buckling.

SECTION G. THERMODYNAMICS

Basic Concepts: Continuum, macroscopic approach, thermodynamic system (closed and open or control volume); thermodynamic properties and equilibrium; state of a system, state diagram, path and process; different modes of work; Zeroth law of thermodynamics; concept of temperature; heat.

First Law of Thermodynamics: Energy, enthalpy, specific heats, first law applied to systems and control volumes, steady and unsteady flow analysis.

Second Law of Thermodynamics: Kelvin-Planck and Clausius statements, reversible and irreversible processes, Carnot theorems, thermodynamic temperature scale, Clausius inequality and concept of entropy, principle of increase of entropy; availability and irreversibility.

Properties of Pure Substances: Thermodynamic properties of pure substances in solid, liquid and vapour phases, P-V-T behaviour of simple compressible substances, phase rule, thermodynamic property tables and charts, ideal and real gases, equations of state, compressibility chart.

Thermodynamic Relations: T-ds relations, Maxwell equations, Joule-Thomson coefficient, coefficient of volume expansion, adiabatic and isothermal compressibilities, Clapeyron equation.

Ideal Gas Mixtures: Dalton's and Amagat's laws, calculations of properties, air-water vapour mixtures.

XL - LIFE SCIENCES

The syllabi of the Sections of this paper are as follows:

SECTION H. CHEMISTRY (Compulsory)

Atomic structure and periodicity: Quantum chemistry; Planck's quantum theory, wave particle duality, uncertainty principle, quantum mechanical model of hydrogen atom; electronic configuration of atoms; periodic table and periodic properties; ionization energy, election affinity, electronegativity, atomic size.

Structure and bonding: Ionic and covalent bonding M.O. and V.B. approaches for diatomic molecules, VSEPR theory and shape of molecules, hybridisation, resonance, dipole moment, structure parameters such as bond length, bond angle and bond energy, hydrogen bonding, van der Waals interactions. Ionic solids; ionic radii, lattice energy (Born-Haber Cycle).

s.p. and d Block Elements: Oxides, halides and hydrides of alkali and alkaline earth metals, B, Al, S, N, P and S, silicones, general characteristics of 3d elements, coordination complexes: valence bond and crystal field theory, color, geometry and magnetic properties.

Chemical Equilibria: Colligative properties of solutions, ionic equilibria in solution, solubility product, common ion effect, hydrolysis of salts, pH, buffer and their applications in chemical analysis.

Electrochemistry: Conductance, Kohlrausch law, Half Cell potentials, emf, Nernst equation, galvanic cells, thermodynamic aspects and their applications.

Reaction Kinetics: Rate constant, order of reaction, molecularity, activation energy, zero, first and second order kinetics, equilibrium constants (Kc, Kp and Kx) for homogeneous reactions, catalysis and elementary enzyme reactions.

Thermodynamics: First law, reversible and irreversible processes, internal energy, enthalpy, Kirchoff's equation, heat of reaction, Hess law, heat of formation, Second law, entropy, free energy, and work function. Gibbs-Helmholtz equation, Clausius-Clapeyron equation, free energy change and equilibrium constant, Troutons rule, Third law of thermodynamics.

Mechanistic Basis of Organic Reactions: Elementary treatment of SN1, SN2, E1 and E2 reactions, Hoffmann and Saytzeff rules, Addition reactions, Markonikoff rule and Kharash effect, Diels-Alder reaction, aromatic electrophilic substitution, orientation effect as exemplified by various functional groups.

Structure-Reactivity Correlations: Acids and bases, electronic and steric effects, optical and geometrical isomerism, tautomerism, concept of aromaticity

SECTION I. BIOCHEMISTRY

Organization of life. Importance of water. Cell structure and organelles. Structure and function of biomolecules: Carbohydrates, Lipids, Proteins and Nucleic acids. Biochemical separation techniques. Spectroscopic methods; UV-visible and fluorescence. Protein structure, folding and function: Myoglobin, Hemoglobin, Lysozyme, ribonuclease A, Carboxypeptidase and Chymotrypsin. Enzyme kinetics and regulation, Coenzymes.

Metabolism and bioenergitics. Generation and utilization of ATP. Photosynthesis. Major metabolic pathways and their regulation. Biological membranes. Transport across membranes. Signal transduction; hormones and neurotransmitters.

DNA replication, transcription and translation. Biochemical regulation of gene expression. Recombinant DNA technology and applications. Genomics and Proteomics.

The immune system. Active and passive immunity. Complement system. Antobody structure, function and diversity. Cells of the immune system: T, B and macrophages. T and B cell activation. Major histocompatibilty complex. T cell receptor. Immunological techniques: Immunodiffusion, immunoelectrophoresis, RIA and ELISA.

SECTION J. BIOTECHNOLOGY

Recombinant DNA technology for the production of therapeutic proteins. Micro array technology. Heterologous protein expression systems in bacteria, yeast etc.

Architecture of plant genome; plant tissue culture techniques; methods of gene transfer into plant cells; manipulation of phenotypic traits in plants; plant cell fermentations and production of secondary metabolites using suspension/ immobilized cell culture; methods for plant micro propagation; crop improvement and development of transgenic plants. Expression of animal proteins in plants.

Animal cell metabolism and regulation; cell cycle; primary cell culture; nutritional requirements for animal cell culture; techniques for the mass culture of animal cell lines; production of vaccines; growth hormones and interferons using animal cell culture; cytokines-production and therapeutic uses; hybridoma technology; vectors for gene transfer and expression in animal cells. Transgenic animals and molecular pharming.

Microbial production of industrial enzymes; methods for immobilization of enzymes; kinetics of soluble and immobilized enzymes; application of soluble and immobilized enzymes; enzyme-based sensors.

Microbial growth kinetics; batch, fed batch and continuous culture of microbial cells; media for industrial fermentations; sterilization of air and media; design features and operation of stirred tank, air-lift and fluidized bed reactors; aeration and agitation in aerobic fermentations; recovery and purification of fermentation products- filtration, centrifugation, cell disintegration, solvent extraction and chromatographic separations; industrial fermentations for the production of ethanol, citric acid, lysine, penicillin and other biomolecules; simple calculations based on material and energy balance of fermentation processes; application of microbes in the management of domestic and industrial wastes.

SECTION K. BOTANY

Anatomy: Roots, stem and leaves of land plants, meristems, vascular system, their ontogeny, structure and functions. Plant cell structure, organisation, organelles, cytoskeleton, cell wall and membranes.

Development: Cell cycle, cell division, senescence, hormonal regulation of growth; life cycle of an angiosperm, pollination, fertilization, embryogenesis, seed formation, seed storage proteins, seed dormancy and germination. Concept of cellular totipotency, organogenesis and somatic embryogenesis, somaclonal variation, embryo culture, in vitro fertilization.

Physiology and Biochemistry: Plant water relations, transport of minerals and solutes, N2 metabolism, proteins and nucleic acid, respiration, photophysiology, photosynthesis, photorespiration; biosynthesis, mechanism of action and physiological effects of plant growth regulators.

Genetics: Principles of Mendelian inheritance, linkage, recombination and genetic mapping; extrachromosomal inheritance; eukaryotic genome organization (chromatin structure) and regulation of gene expression, gene mutation, chromosome aberrations (numerical and structural), transposons.

Plant Breeding: Principles, methods - selection, hybridization, heterosis; male sterility, self and inter-specific incompatibility; haploidy; somatic cell hybridization; molecular marker-assisted selection; gene transfer methods viz. direct and vector-mediated, transgenic plants and their applications in agriculture.

Economic Botany: Economically important plants - cereals, pulses, plants yielding fiber, timber, sugar, beverages, oils, rubber, dyes, gums, drugs and narcotics - a general account.

Systematics: Systems of classification (non-phylogenetic vs. phylogenetic - outline), plant groups, molecular systematics.

Plant Pathology: Nature and classification of plant diseases, diseases of important crops caused by fungi, bacteria and viruses, and their control measures, mechanism(s) of pathogenesis and resistance, molecular detection of pathogens; plant-microbe beneficial interactions.

Ecology and Plant Geography: Ecosystems - types, dynamics, degradation, ecological succession; food chains; vegetation types of the world; pollution and global warming; speciation and extinction, conservation strategies, cryopreservation.

SECTION L. MICROBIOLOGY

Historical perspective - Discovery of the microbial world; Controversy over spontaneous generation; Role of microorganisms in transformation of organic matter and in the causation of diseases.

Methods in microbiology - Pure culture techniques; Theory and practice of sterilization; Principles of microbial nutrition; Construction of culture media; Enrichment culture techniques for isolation of chemoautotrophs, chemoheterotrophs and photosynthetic microorganisms.

Microbial evolution, systematics and taxonomy - Evolution of earth and earliest life forms; Primitive organisms and their metabolic strategies; New approaches to bacterial taxonomic classification including ribotyping; Nomenclature.

Microbial diversity - Bacteria, archea and their broad classification; Eukaryotic microbes, yeast, fungi, slime mold and protozoa; Viruses and their classification.

Microbial growth -The definition of growth, mathematical expression of growth, growth curve, measurement of growth and growth yields; Synchronous growth; Continuous culture.

Nutrition and metabolism - Overview of metabolism; Microbial nutrition; Energy classes of microorganisms; Culture media; Energetics, modes of ATP generation; ATP generation by heterotrophs; Fermentation; Glycolysis; Respiration; The citric acid cycle; Electron transport systems; Alternate modes of energy generation; Pathways (anabolism) in the biosynthesis of amino acids, purines, pyrimidines and fatty acids.

Metabolic diversity among microorganisms - Photosynthesis in microorganisms; Role of chlorophylls, carotenoids and phycobilins; Calvin cycle; Chemolithotrophy; Hydrogen- iron- nitrite-oxidizing bacteria; Nitrate and sulfate reduction; Methanogenesis and acetogenesis.

Prokaryotic cells: structure-function - Cells walls of eubacteria (peptidoglycan) and related molecules; Outer-membrane of gram-negative bacteria; Cell wall and cell membrane synthesis; Flagella and motility; Cell inclusions like endospores, gas vesicles.

Microbial diseases and host parasite relationships - Normal microflora of skin; Oral cavity; Gastrointestinal tract; Entry of pathogens into the host; Infectious disease transmission; Respiratory infections caused by bacteria and viruses; Tuberculosis; Sexually transmitted diseases including AIDS; Diseases transmitted by animals (Rabies, plague), insects and ticks (rikettsias, Lyme disease, malaria); Food and water borne diseases; Public health and water quality; Pahtogenic fungi; Emerging and resurgent infectious diseases.

Chemotherapy/Antibiotics - Antimicrobial agents; Sulfa drugs; Antibiotics; Pencillins and cephalosporins; Broad-spectrum antibiotics; Antibiotics from prokaryotes; Antifungal antibiotics; Mode of action; Resistance to antibiotics.

Microbial genetics - Genes, mutation and mutagenesis - UV and chemical mutagnes; Types of mutations; Ames test for mutagenesis; Methods of genetic analysis. Bacterial genetic system - Transformation; Conjugation; Transduction; Recombination; Plasmids and Transposons; Bacterial genetic map with reference to E. coli. Viruses and their genetic system - Phage ? and its life cycle; RNA phages; RNA viruses; Retroviruses; Genetic systems of yeast and Neurospora; Extrachromosomal inheritance and mitochondrial genetics; Basic concept of genomics.

SECTION M. ZOOLOGY

Animal world: Animal diversity, distribution, systematic and classification of animals, the phylogenetic relationship.

Evolution: Origin of life, history of life on earth, evolutionary theories, natural selection, adaptation, speciation.

Genetics: Principles of inheritance, molecular basis of heredity, the genetic material, transmission of genetic material, mutations, cytoplasmic inheritance.

Biochemistry and Molecular Biology: Nucleic acids, proteins and other biological macromolecules. Replication, transcription and translation, regulation of gene expression, organization of genome, Kreb's cycle, glycolysis, enzyme catalysis, hormones and their action.

Cell Biology: Structure of cell, cellular organelles and their structure and function, cell cycle, cell division, cellular differentiation, chromosome and chromatin structure. Eukaryotic gene organisation and expression.

Animal Anatomy and Physiology: Comparative physiology, the respiratory system, circulatory system, digestive system, the nervous system, the excretory system, the endocrine system, the reproductive system, the skeletal system, osmoregulation.

Parasitology and Immunology: Nature of parasite, host-parasite relation, protozoan and helminthic parasites, the immune response, cellular and humoral immune response, evolution of the immune system.

Development Biology: Embryonic development, cellular differentiation, organogenesis, metamorphosis, genetic basis of development.

Ecology: The ecosystem, habitats the food chain, population dynamics, species diversity, zoogeography, biogeochemical cycles, conservation biology.

Animal Behaviour: Types of behaviours, courtship, mating and territoriality, instinct, learning and memory, social behaviour across the animal taxa, communication, pheromones, evolution of animal behaviour.

IT - INFORMATION TECHNOLOGY

ENGINEERING MATHEMATICS

Mathematical Logic: Propositional Logic; First Order Logic.

Probability: Conditional Probability; Mean, Median, Mode and Standard Deviation; Random Variables; Distributions; uniform, normal, exponential, Poisson, Binomial.

Set Theory & Algebra: Sets; Relations; Functions; Groups; Partial Orders; Lattice; Boolean Algebra.

Combinatorics: Permutations; Combinations; Counting; Summation; generating functions; recurrence relations; asymptotics.

Graph Theory: Connectivity; spanning trees; Cut vertices & edges; covering; matching; independent sets; Colouring; Planarity; Isomorphism.

Linear Algebra: Algebra of matrices, determinants, systems of linear equations, Eigen values and Eigen vectors.

Numerical Methods: LU decomposition for systems of linear equations; numerical solutions of non linear algebraic equations by Secant, Bisection and Newton-Raphson Methods; Numerical integration by trapezoidal and Simpson's rules.

Calculus: Limit, Continuity & differentiability, Mean value Theorems, Theorems of integral calculus, evaluation of definite & improper integrals, Partial derivatives, Total derivatives, maxima & minima.

FORMAL LANGUAGES AND AUTOMATA

Regular Languages: finite automata, regular expressions, regular grammar.

Context free languages: push down automata, context free grammars

COMPUTER HARDWARE

Digital Logic: Logic functions, minimization, design and synthesis of combinatorial and sequential circuits, number representation and computer arithmetic (fixed and floating point)

Computer organization: Machine instructions and addressing modes, ALU and data path, hardwired and microprogrammed control, memory interface, I/O interface (interrupt and DMA mode), serial communication interface, instruction pipelining, cache, main and secondary storage

SOFTWARE SYSTEMS

Data structures and Algorithms: the notion of abstract data types, stack, queue, list, set, string, tree, binary search tree, heap, graph, tree and graph traversals, connected components, spanning trees, shortest paths, hashing, sorting, searching, design techniques (greedy, dynamic, divide and conquer), asymptotic analysis (best, worst, average cases) of time and space, upper and lower bounds, intractability

Programming Methodology: C programming, program control (iteration, recursion, functions), scope, binding, parameter passing, elementary concepts of object oriented programming

Operating Systems (in the context of Unix): classical concepts (concurrency, synchronization, deadlock), processes, threads and interprocess communication, CPU scheduling, memory management, file systems, I/O systems, protection and security

Information Systems and Software Engineering: information gathering, requirement and feasibility analysis, data flow diagrams, process specifications, input/output design, process life cycle, planning and managing the project, design, coding, testing, implementation, maintenance.

Databases: relational model, database design, integrity constraints, normal forms, query languages (SQL), file structures (sequential, indexed), b-trees, transaction and concurrency control

Data Communication: data encoding and transmission, data link control, multiplexing, packet switching, LAN architecture, LAN systems (Ethernet, token ring), Network devices: switches, gateways, routers

Networks: ISO/OSI stack, sliding window protocols, routing protocols, TCP/UDP, application layer protocols & systems (http, smtp, dns, ftp), network security

Web technologies: three tier web based architecture; JSP, ASP, J2EE, .NET systems; html, XML

AG - AGRICULTURAL ENGINEERING

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

FARM MACHINERY AND POWER:

Sources of power on the farm-human, animal, mechanical, electrical, wind, solar and biomass; design and selection of machine elements - gears, pulleys, chains and sprockets and belts; overload safety devices used in farm machinery; measurement of force, torque, speed, displacement and acceleration on machine elements.

Soil tillage; forces acting on a tillage tool; hitch systems and hitching of tillage implements; functional requirements, principles of working, construction and operation of manual, animal and power operated equipment for tillage. sowing, planting, fertilizer application, inter-cultivation, spraying, mowing, chaff cutting, harvesting, threshing and transport; testing of agricultural machinery and equipment; calculation of performance parameters -field capacity, efficiency, application rate and losses; cost analysis of implements and tractors.

Thermodynamic principles of I.C. engines; I.C. engine cycles; engine components; fuels and combustion; lubricants and their properties; I.C. engine systems - fuel, cooling, lubrication, ignition, electrical, intake and exhaust; selection, operation, maintenance and repair of I.C. engines; power efficiencies and measurement; calculation of power, torque, fuel consumption, heat load and power losses.

Tractors and power tillers - type, selection, maintenance and repair; tractor clutches and brakes; power transmission systems - gear trains, differential, final drives and power take-off; mechanics of tractor chassis; traction theory; three point hitches- free link and restrained link operations; mechanical steering and hydraulic control systems used in tractors; human engineering and safety in tractor design; tractor tests and performance.

SOIL AND WATER CONSERVATION ENGINEERING:

Ideal and real fluids, properties of fluids; hydrostatic pressure and its measurement; hydrostatic forces on plane and curved surface; continuity equation; Bernoulli's theorem; laminar and turbulent flow in pipes, Darcy-Weisbach and Hazen-Williams equations, Moody's diagram; flow through orifices and notches; flow in open channels.

Engineering properties of soils, fundamental definitions and relationships; index properties of soils; permeability and seepage analysis; shear strength, Mohr's circle of stresses; active and passive earth pressures; stability of slopes.

Hydrological cycle; precipitation measurement, analysis of precipitation data; abstraction from precipitation; runoff; hydrograph analysis, unit hydrograph theory and application; stream flow measurement; flood routing, hydrological reservoir and channel routing.

Mechanics of soil erosion, factors affecting erosion; soil loss estimation; biological and engineering measures to control erosion, terraces and bunds; vegetative waterways; gully control structures, drop, drop inlet and chute spillways; farm ponds; earthen dams; principles of watershed management.

Water requirement of crops; consumptive use and evapo-transpiration; irrigation scheduling; irrigation efficiencies; design of prismatic and silt loaded channels; methods of irrigation water application; design and evaluation of irrigation methods; drainage coefficient; surface and subsurface drainage systems; leaching requirement and salinity control; irrigation and drainage water quality; classification of pumps; pump characteristics; pump selection; types of aquifer; evaluation of aquifer properties; well hydraulics; ground water recharge.

AGRICULTURAL PROCESSING AND FOOD ENGINEERING:

Steady state heat transfer in conduction, convection and radiation; transient heat transfer in simple geometry; condensation and boiling heat transfer; working principles of heat exchangers; diffusive and convective mass transfer; simultaneous heat and mass transfer in agricultural processing operations.

Material and energy balances in food processing systems; water activity, sorption and desorption isotherms; centrifugal separation of solids, liquids and gases; kinetics of microbial death - pasteurisation and sterilization of liquid foods; preservation of food by cooling and freezing; psychrometry - properties of air-vapour mixture; concentration and dehydration of liquid foods - evaporators, tray, drum and spray dryers.

Mechanics and energy requirement in size reduction of granular solids; particle size analysis for comminuted solids; size separation by screening; fluidisation of granular solids; cleaning and grading efficiency and effectiveness of grain cleaners; conditioning and hydrothermal treatments for grains; dehydration of food grains; processes and machines for processing of cereals, pulses and oilseeds; design considerations for grain silos.

AR - ARCHITECTURE AND PLANNING

City planning: Historical development of cities; principles of city planning; new towns; survey methods, site planning, planning regulations and building bye-laws.

Housing: Concept of shelter; housing policies and design; community planning; role of government agencies; finance and management.

Landscape Design: Principles of landscape design and site planning; history and landscape styles; landscape elements and materials; planting design.

Computer Aided Design: Application of computers in architecture and planning; understanding elements of hardware and software; computer graphics; programming languages - C and Visual Basic and usage of packages such as AutoCAD.

Environmental and Building Science: Elements of environmental science; ecological principles concerning environment; role of micro-climate in design; climatic control through design elements; thermal comfort; elements of solar architecture; principles of lighting and illumination; basic principles of architectural acoustics; air pollution, noise pollution and their control.

Visual and Urban Design: Principles of visual composition; proportion, scale, rhythm, symmetry, harmony, balance, form and colour; sense of place and space, division of space; focal point, vista, imageability, visual survey.

History of Architecture: Indian - Indus valley, Vedic, Buddhist, Indo-Aryan, Dravidian and Mughal periods; European - Egyptian, Greek, Roman, medieval and renaissance periods.

Development of Contemporary Architecture: Architectural developments and impacts on society since industrial revolution; influence of modern art on architecture; works of national and international architects; post modernism in architecture.

Building Services: Water supply, Sewerage and Drainage systems; Sanitary fittings and fixtures; principles of electrification of buildings; elevators, their standards and uses; air-conditioning systems; fire fighting systems.

Building Construction and Management: Building construction techniques, methods and details; building systems and prefabrication of building elements; principles of modular coordination; estimation, specification, valuation, professional practice; project management, PERT, CPM.

Materials and Structural Systems: Behavioural characteristics of all types of building materials e.g. mud, timber, bamboo, brick, concrete, steel, glass, FRP; principles of strength of materials; design of structural elements in wood, steel and RCC; elastic and limit state design; complex structural systems; principles of pre-stressing.

Planning Theory: Planning process; multilevel planning; comprehensive planning; central place theory; settlement pattern; land use and land utilization.

Techniques of Planning: Planning surveys; Preparation of urban and regional structure plans, development plans, action plans; site planning principles and design; statistical methods; application of remote sensing techniques in urban and regional planning.

Traffic and Transportation Planning: Principles of traffic engineering and transportation planning; methods of conducting surveys; design of roads, intersections and parking areas;

hierarchy of roads and levels of services; traffic and transport management in urban areas; traffic safety and traffic laws; public transportation planning; modes of transportation.

Services and Amenities: Principles and design of water supply systems, sewerage systems, solid waste disposal systems, power supply and communication systems; Health, education, recreation and demography related standards at various levels of the settlements.

Development Administration and Management: Planning laws; development control and zoning regulations; laws relating to land acquisition; development enforcements, land ceiling; regional and urban plan preparations; planning and municipal administration; taxation, revenue resources and fiscal management; public participation and role of NGO.

CE - CIVIL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

STRUCTURAL ENGINEERING

Mechanics: Bending moments and shear forces in statically determinate beams; simple stress and strain: relationship; stress and strain in two dimensions, principal stresses, stress transformation, Mohr's circle; simple bending theory; flexural shear stress; thin-walled pressure vessels; uniform torsion.

Structural Analysis: Analysis of statically determinate trusses, arches and frames; displacements in statically determinate structures and analysis of statically indeterminate structures by force/energy methods; analysis by displacement methods (slope-deflection and moment-distribution methods); influence lines for determinate and indeterminate structures; basic concepts of matrix methods of structural analysis.

Concrete Structures: Basic working stress and limit states design concepts; analysis of ultimate load capacity and design of members subject to flexure, shear, compression and torsion (beams, columns and isolated footings); basic elements of prestressed concrete: analysis of beam sections at transfer and service loads.

Steel Structures: Analysis and design of tension and compression members, beams and beam-columns, column bases; connections - simple and eccentric, beam-column connections, plate girders and trusses; plastic analysis of beams and frames.

GEOTECHNICAL ENGINEERING

Soil Mechanics: Origin of soils; soil classification; three-phase system, fundamental definitions, relationship and inter-relationships; permeability and seepage; effective stress principle: consolidation, compaction; shear strength.

Foundation Engineering: Sub-surface investigation - scope, drilling bore holes, sampling, penetrometer tests, plate load test; earth pressure theories, effect of water table, layered soils; stability of slopes - infinite slopes, finite slopes; foundation types - foundation design requirements; shallow foundations; bearing capacity, effect of shape, water table and other factors, stress distribution, settlement analysis in sands and clays; deep foundations - pile types, dynamic and static formulae, load capacity of piles in sands and clays.

WATER RESOURCES ENGINEERING

Fluid Mechanics and Hydraulics: Hydrostatics, applications of Bernoulli equation, laminar and turbulent flow in pipes, pipe networks; concept of boundary layer and its growth; uniform flow, critical flow and gradually varied flow in channels, specific energy concept, hydraulic jump; forces on immersed bodies; flow measurement in channels; tanks and pipes; dimensional analysis and hydraulic modeling. Applications of momentum equation, potential flow, kinematics of flow; velocity triangles and specific speed of pumps and turbines.

Hydrology: Hydrologic cycle; rainfall; evaporation infiltration, unit hydrographs, flood estimation, reservoir design, reservoir and channel routing, well hydraulics.

Irrigation: Duty, delta, estimation of evapo-transpiration; crop water requirements; design of lined and unlined canals; waterways; head works, gravity dams and Ogee spillways. Designs of weirs on permeable foundation, irrigation methods.

ENVIRONMENTAL ENGINEERING

Water requirements; quality and standards, basic unit processes and operations for water treatment, distribution of water. Sewage and sewerage treatment: quantity and characteristic of waste water sewerage; primary and secondary treatment of waste water; sludge disposal; effluent discharge standards.

TRANSPORTATION ENGINEERING

Highway planning; geometric design of highways; testing and specifications of paving materials; design of flexible and rigid pavements.

CH - CHEMICAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

CHEMICAL ENGINEERING

Process Calculations and Thermodynamics: Laws of conservation of mass and energy; use of tie components; recycle, bypass and purge calculations; degree of freedom analysis.

First and Second laws of thermodynamics and their applications; equations of state and thermodynamic properties of real systems; phase equilibria; fugacity, excess properties and correlations of activity coefficients; chemical reaction equilibria.

Fluid Mechanics and Mechanical Operations: Fluid statics, Newtonian and non-Newtonian fluids, Bernoulli equation, Macroscopic friction factors, energy balance, dimensional analysis, shell balances, flow through pipeline systems, flow meters, pumps and compressors, packed and fluidized beds, elementary boundary layer theory, size reduction and size separation; free and hindered settling; centrifuge and cyclones; thickening and classification, filtration, mixing and agitation; conveying of solids.

Heat Transfer: Conduction, convection and radiation, heat transfer coefficients, steady and unsteady heat conduction, boiling, condensation and evaporation; types of heat exchangers and evaporators and their design.

Mass Transfer: Fick's law, molecular diffusion in fluids, mass transfer coefficients, film, penetration and surface renewal theories; momentum, heat and mass transfer analogies; stagewise and continuous contacting and stage efficiencies; HTU & NTU concepts design and operation of equipment for distillation, absorption, leaching, liquid-liquid extraction, crystallization, drying, humidification, dehumidification and adsorption.

Chemical Reaction Engineering: Theories of reaction rates; kinetics of homogeneous reactions, interpretation of kinetic data, single and multiple reactions in ideal reactors, non-ideal reactors; residence time; non-isothermal reactors; kinetics of heterogeneous catalytic reactions; diffusion effects in catalysis.

Instrumentation and Process Control: Measurement of process variables; sensors, transducers and their dynamics, dynamics of simple systems, dynamics such as CSTRs, transfer functions and responses of simple systems, process reaction curve, controller modes (P, PI, and PID); control valves; analysis of closed loop systems including stability, frequency response (including Bode plots) and controller tuning, cascade, feed forward control.

Plant Design and Economics: Design and sizing of chemical engineering equipment such as compressors, heat exchangers, multistage contactors; principles of process economics and cost estimation including total annualized cost, cost indexes, rate of return, payback period, discounted cash flow, optimization in Design.

Chemical Technology: Inorganic chemical industries; sulfuric acid, NaOH, fertilizers (Ammonia, Urea, SSP and TSP); natural products industries (Pulp and Paper, Sugar, Oil, and Fats); petroleum refining and petrochemicals; polymerization industries; polyethylene, polypropylene, PVC and polyester synthetic fibers.

CS - COMPUTER SCIENCE AND ENGINEERING

ENGINEERING MATHEMATICS

Mathematical Logic: Propositional Logic; First Order Logic.

Probability: Conditional Probability; Mean, Median, Mode and Standard Deviation; Random Variables; Distributions; uniform, normal, exponential, Poisson, Binomial.

Set Theory & Algebra: Sets; Relations; Functions; Groups; Partial Orders; Lattice; Boolean Algebra.

Combinatorics: Permutations; Combinations; Counting; Summation; generating functions; recurrence relations; asymptotics.

Graph Theory: Connectivity; spanning trees; Cut vertices & edges; covering; matching; independent sets; Colouring; Planarity; Isomorphism.

Linear Algebra: Algebra of matrices, determinants, systems of linear equations, Eigen values and Eigen vectors.

Numerical Methods: LU decomposition for systems of linear equations; numerical solutions of non linear algebraic equations by Secant, Bisection and Newton-Raphson Methods; Numerical integration by trapezoidal and Simpson's rules.

Calculus: Limit, Continuity & differentiability, Mean value Theorems, Theorems of integral calculus, evaluation of definite & improper integrals, Partial derivatives, Total derivatives, maxima & minima.

THEORY OF COMPUTATION

Formal Languages and Automata Theory: Regular languages and finite automata, Context free languages and Push-down automata, Recursively enumerable sets and Turing machines, Un-decidability;

Analysis of Algorithms and Computational Complexity: Asymptotic analysis (best, worst, average case) of time and space, Upper and lower bounds on the complexity of specific problems, NP-completeness.

COMPUTER HARDWARE

Digital Logic: Logic functions, Minimization, Design and synthesis of Combinational and Sequential circuits; Number representation and Computer Arithmetic (fixed and floating point);

Computer Organization: Machine instructions and addressing modes, ALU and Data-path, hardwired and micro-programmed control, Memory interface, I/O interface (Interrupt and DMA mode), Serial communication interface, Instruction pipelining, Cache, main and secondary storage.

SOFTWARE SYSTEMS

Data structures: Notion of abstract data types, Stack, Queue, List, Set, String, Tree, Binary search tree, Heap, Graph;

Programming Methodology: C programming, Program control (iteration, recursion, Functions), Scope, Binding, Parameter passing, Elementary concepts of Object oriented, Functional and Logic Programming;

Algorithms for problem solving: Tree and graph traversals, Connected components, Spanning trees, Shortest paths; Hashing, Sorting, Searching; Design techniques (Greedy, Dynamic Programming, Divide-and-conquer);

Compiler Design: Lexical analysis, Parsing, Syntax directed translation, Runtime environment, Code generation, Linking (static and dynamic); Operating Systems: Classical concepts (concurrency, synchronization, deadlock), Processes, threads and Inter-process communication, CPU scheduling, Memory management, File systems, I/O systems, Protection and security.

Databases: Relational model (ER-model, relational algebra, tuple calculus), Database design (integrity constraints, normal forms), Query languages (SQL), File structures (sequential files, indexing, B+ trees), Transactions and concurrency control;

Computer Networks: ISO/OSI stack, sliding window protocol, LAN Technologies (Ethernet, Token ring), TCP/UDP, IP, Basic concepts of switches, gateways, and routers.

CH - CHEMISTRY

PHYSICAL CHEMISTRY

Structure: Quantum theory - principles and techniques; applications to particle in a box, harmonic oscillator, rigid rotor and hydrogen atom; valence bond and molecular orbital theories and Huckel approximation, approximate techniques: variation and perturbation; symmetry, point groups; rotational, vibrational, electronic, NMR and ESR spectroscopy.

Equilibrium: First law of thermodynamics, heat, energy and work; second law of thermodynamics and entropy; third law and absolute entropy; free energy; partial molar quantities; ideal and non-ideal solutions; phase transformation: phase rule and phase diagrams- one, two, and three component systems; activity, activity coefficient, fugacity and fugacity coefficient ; chemical equilibrium, response of chemical equilibrium to temperature and pressure; colligative properties; kinetic theory of gases; thermodynamics of electrochemical cells; standard electrode potentials: applications - corrosion and energy conversion; molecular partition function (translational, rotational, vibrational and electronic).

Kinetics: Rates of chemical reactions, theories of reaction rates, collision and transition state theory; temperature dependence of chemical reactions; elementary reactions, consecutive elementary reactions; steady state approximation, kinetics of photochemical reactions and free radical polymerization, homogenous and heterogeneous catalysis.

INORGANIC CHEMISTRY

Non-Transition Elements: General characteristics, structure and reactions of simple and industrially important compounds, boranes, carboranes, silicates, silicones, diamond and graphite; hydrides, oxides and oxoacids of N, P, S and halogens; boron nitride, borazines and phosphazenes; xenon compounds. Shapes of molecules, hard-soft acid base concept.

Transition Elements: General characteristics of d and f block elements; coordination chemistry: structure and isomerism, stability, theories of metal-ligand bonding (CFT and LFT), electronic spectra and magnetic properties of transition metal complexes and lanthanides; metal carbonyls, metal-metal bonds and metal atom clusters, metallocenes; transition metal complexes with bonds to hydrogen, alkyls, alkenes, and arenes; metal carbenes; use of organometallic compounds as catalysts in organic synthesis; mechanisms of substitution and electron transfer reactions of coordination complexes. Role of metals with special reference to Na, K, Mg, Ca, Fe, Co, Zn, and Mo in biological systems.

Solids: Crystal systems and lattices, Miller planes, crystal packing, crystal defects; Bragg's Law; ionic crystals, band theory, metals and semiconductors. Spinels.

Instrumental methods of analysis: atomic absorption, UV-visible spectrometry, chromatographic and electro-analytical methods.

ORGANIC CHEMISTRY

Synthesis, reactions and mechanisms involving the following: Alkenes, alkynes, arenes, alcohols, phenols, aldehydes, ketones, carboxylic acids and their derivatives; halides, nitro compounds and amines; stereochemical and conformational effects on reactivity and specificity; reactions with diborane and peracids. Michael reaction, Robinson annulation, reactivity umpolung, acyl anion equivalents; molecular rearrangements involving electron deficient atoms.

Photochemistry: Basic principles, photochemistry of olefins, carbonyl compounds, arenes, photo oxidation and reduction.

Pericyclic reactions: Cycloadditions, electrocyclic reactions, sigmatropic reactions; Woodward-Hoffmann rules.

Heterocycles: Structural properties and reactions of furan, pyrrole, thiophene, pyridine, indole.

Biomolecules: Structure, properties and reactions of mono- and di-saccharides, physico-chemical properties of amino acids, structural features of proteins and nucleic acids.

Spectroscopy: Principles and applications of IR, UV-visible, NMR and mass spectrometry in the determination of structures of organic compounds.

EC - ELECTRONICS AND COMMUNICATION ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix Algebra, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Mean value theorems, Theorems of integral calculus, Evaluation of definite and improper integrals, Partial Derivatives, Maxima and minima, Multiple integrals, Fourier series. Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equation (linear and nonlinear), Higher order linear differential equations with constant coefficients, Method of variation of parameters, Cauchy's and Euler's equations, Initial and boundary value problems, Partial Differential Equations and variable separable method.

Complex variables: Analytic functions, Cauchy's integral theorem and integral formula, Taylor's and Laurent' series, Residue theorem, solution integrals.

Probability and Statistics: Sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Discrete and continuous distributions, Poisson, Normal and Binomial distribution, Correlation and regression analysis.

Numerical Methods: Solutions of non-linear algebraic equations, single and multi-step methods for differential equations.

Transform Theory: Fourier transform, Laplace transform, Z-transform.

ELECTRONICS & COMMUNICATION ENGINEERING

Networks: Network graphs: matrices associated with graphs; incidence, fundamental cut set and fundamental circuit matrices. Solution methods: nodal and mesh analysis. Network theorems: superposition, Thevenin and Norton's maximum power transfer, Wye-Delta transformation. Steady state sinusoidal analysis using phasors. Linear constant coefficient differential equations; time domain analysis of simple RLC circuits, Solution of network equations using Laplace transform: frequency domain analysis of RLC circuits. 2-port network parameters: driving point and transfer functions. State equations for networks.

Electronic Devices: Energy bands in silicon, intrinsic and extrinsic silicon. Carrier transport in silicon: diffusion current, drift current, mobility, resistivity. Generation and recombination of carriers. p-n junction diode, Zener diode, tunnel diode, BJT, JFET, MOS capacitor, MOSFET, LED, p-I-n and avalanche photo diode, LASERs. Device technology: integrated circuits fabrication process, oxidation, diffusion, ion implantation, photolithography, n-tub, p-tub and twin-tub CMOS process.

Analog Circuits: Equivalent circuits (large and small-signal) of diodes, BJTs, JFETs, and MOSFETs. Simple diode circuits, clipping, clamping, rectifier. Biasing and bias stability of transistor and FET amplifiers. Amplifiers: single-and multi-stage, differential, operational, feedback and power. Analysis of amplifiers; frequency response of amplifiers. Simple op-amp circuits. Filters. Sinusoidal oscillators; criterion for oscillation; single-transistor and op-amp configurations. Function generators and wave-shaping circuits. Power supplies.

Digital circuits: Boolean algebra, minimization of Boolean functions; logic gates digital IC families (DTL, TTL, ECL, MOS, CMOS). Combinational circuits: arithmetic circuits, code converters, multiplexers and decoders. Sequential circuits: latches and flip-flops, counters and shift-registers. Sample and hold circuits, ADCs, DACs. Semiconductor memories. Microprocessor(8085): architecture, programming, memory and I/O interfacing.

Signals and Systems: Definitions and properties of Laplace transform, continuous-time and discrete-time Fourier series, continuous-time and discrete-time Fourier Transform, z-transform. Sampling theorems. Linear Time-Invariant (LTI) Systems: definitions and properties; casuality, stability, impulse response, convolution, poles and zeros frequency response, group delay, phase delay. Signal transmission through LTI systems. Random signals and noise: probability, random variables, probability density function, autocorrelation, power spectral density.

Controls Systems: Basic control system components; block diagrammatic description, reduction of block diagrams. Open loop and closed loop (feedback) systems and stability analysis of these systems. Signal flow graphs and their use in determining transfer functions of systems; transient and steady state analysis of LTI control systems and frequency response. Tools and techniques for LTI control system analysis: root loci, Routh-Hurwitz criterion, Bode and Nyquist plots. Control system compensators: elements of lead and lag compensation, elements of Proportional-Integral-Derivative(PID) control. State variable representation and solution of state equation of LTI control systems.

Communications: Analog communication systems: amplitude and angle modulation and demodulation systems, spectral analysis of these operations, superheterodyne receivers; elements of hardware, realizations of analog communication systems; signal-to-noise ratio (SNR) calculations for amplitude modulation (AM) and frequency modulation (FM) for low noise conditions. Digital communication systems: pulse code modulation (PCM), differential pulse code modulation (DPCM), delta modulation (DM); digital modulation schemes-amplitude, phase and frequency shift keying schemes (ASK, PSK, FSK), matched filter receivers, bandwith consideration and probability of error calculations for these schemes.

Electromagnetics: Elements of vector calculus: divergence and curl; Gauss' and Stokes' theorems, Maxwell's equations: differential and integral forms. Wave equation, Poynting vector. Plane waves: propagation through various media; reflection and refraction; phase and group velocity; skin depth. Transmission lines: characteristic impedance; impedance transformation; Smith chart; impedance matching; pulse excitation. Waveguides: modes in rectangular waveguides; boundary conditions; cut-off frequencies; dispersion relations. Antennas: Dipole antennas; antenna arrays; radiation pattern; reciprocity theorem, antenna gain.

EE - ELECTRICAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix Algebra, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Mean value theorems, Theorems of integral calculus, Evaluation of definite and improper integrals, Partial Derivatives, Maxima and minima, Multiple integrals, Fourier series. Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equation (linear and nonlinear), Higher order linear differential equations with constant coefficients, Method of variation of parameters, Cauchy's and Euler's equations, Initial and boundary value problems, Partial Differential Equations and variable separable method.

Complex variables: Analytic functions, Cauchy's integral theorem and integral formula, Taylor's and Laurent' series, Residue theorem, solution integrals.

Probability and Statistics: Sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Discrete and continuous distributions, Poisson, Normal and Binomial distribution, Correlation and regression analysis.

Numerical Methods: Solutions of non-linear algebraic equations, single and multi-step methods for differential equations.

Transform Theory: Fourier transform, Laplace transform, Z-transform.

ELECTRICAL ENGINEERING

Electrical Circuits and Fields: Network graph, KCL, KVL, node/ cut set, mesh/ tie set analysis, transient response of d.c. and a.c. networks; sinusoidal steady-state analysis; resonance in electrical circuits; concepts of ideal voltage and current sources, network theorems, driving point, immittance and transfer functions of two port networks, elementary concepts of filters; three phase circuits; Fourier series and its application; Gauss theorem, electric field intensity and potential due to point, line, plane and spherical charge distribution, dielectrics, capacitance calculations for simple configurations; Ampere's and Biot-Savart's law, inductance calculations for simple configurations.

Electrical Machines: Single phase transformer - equivalent circuit, phasor diagram, tests, regulation and efficiency; three phase transformers - connections, parallel operation; auto transformer and three-winding transformer; principles of energy conversion, windings of rotating machines: D. C. generators and motors - characteristics, starting and speed control, armature reaction and commutation; three phase induction motors-performance characteristics, starting and speed control; single-phase induction motors; synchronous generators-performance, regulation, parallel operation; synchronous motors - starting, characteristics, applications, synchronous condensers; fractional horse power motors; permanent magnet and stepper motors.

Power Systems: Electric power generation - thermal, hydro, nuclear; transmission line parameters; steady-state performance of overhead transmission lines and cables and surge propagation; distribution systems, insulators, bundle conductors, corona and radio interference effects; per-unit quantities; bus admittance and impedance matrices; load flow; voltage control and power factor correction; economic operation; symmetrical components, analysis of symmetrical and unsymmetrical faults; principles of over current, differential and distance protections; concept of solid state relays and digital protection; circuit breakers; concept of system stability-swing curves and equal area criterion; basic concepts of HVDC transmission.

Control Systems: Principles of feedback; transfer function; block diagrams: steady-state errors; stability-Routh and Nyquist criteria; Bode plots; compensation; root loci; elementary state variable formulation; state transition matrix and response for Linear Time Invariant systems.

Electrical and Electronic Measurements: Bridges and potentiometers, PMMC, moving iron, dynamometer and induction type instruments; measurement of voltage, current, power, energy and power factor; instrument transformers; digital voltmeters and multimeters; phase, time and frequency measurement; Q-meter, oscilloscopes, potentiometric recorders, error analysis.

Analog and Digital Electronics: Characteristics of diodes, BJT, FET, SCR; amplifiers-biasing, equivalent circuit and frequency response; oscillators and feedback amplifiers, operational amplifiers- characteristics and applications; simple active filters; VCOs and timers; combinational and sequential logic circuits, multiplexer, Schmitt trigger, multivibrators, sample and hold circuits, A/D and D/A converters; microprocessors and their applications.

Power Electronics and Electric Drives: Semiconductor power devices-diodes, transistors, thyristors, triacs, GTOs, MOSFETs and IGBTs - static characteristics and principles of operation; triggering circuits; phase control rectifiers; bridge converters-fully controlled and half controlled; principles of choppers and inverters, basic concepts of adjustable speed dc and ac drives.

GG - GEOLOGY AND GEOPHYSICS

PART - I

Earth and planetary system; size, shape, internal structure and composition of the earth; atmosphere and greenhouse effect; isostasy; elements of seismology; continents and continental processes; physical oceanography; palaeomagnetism, continental drift plate tectonics, geothermal energy.

Weathering; soil formation; action of river, wind and glacier; oceans and oceanic features; earthquakes, volcanoes, orogeny and mountain building; elements of structural geology; crystallography; classification, composition and properties of minerals and rocks; engineering properties of rocks and soils, role of geology in the construction of engineering structures.

Processes of ore formation, occurrence and distribution of ores on land and on ocean floor; coal and petroleum resources in India; ground water geology including well hydraulics, geological time scale and geochronology; stratigraphic principles and stratigraphy of India; basics concepts of gravity, magnetic and electrical prospecting for ores and ground water.

PART - IIA: GEOLOGY

Crystal symmetry, forms, twinning; crystal chemistry; optical mineralogy, classification of minerals, diagnostic properties of rock minerals.

Mineralogy, structure, texture and classification of igneous, sedimentary and metamorphic rock, their origin and evolution; application of thermodynamics; structure and petrology of sedimentary rocks; sedimentary processes and environments, sedimentary facies, basin studies; basement cover relationship;

Primary and secondary structures; geometry and genesis of folds, faults, joints, unconformities, cleavage, schistosity and lineation; methods of projection. Tectonites and their significance; shear zone; superposed folding.

Morphology, classification and geological significance of important invertebrates, vertebrates, microfossils and palaeoflora; stratigraphic principles and Indian stratigraphy; geomorphic processes and agents; development and evolution of landforms; slope and drainage;

processes on deep oceanic and near-shore regions; quantitative and applied geomorphology; air photo interpretation and remote sensing; chemical and optical properties of ore minerals; formation and localization of ore deposits; prospecting and exploration of economic minerals; coal and petroleum geology; origin and distribution of mineral and fuel deposits in India; ore dressing and mineral economics.

Cosmic abundance; meteorites; geochemical evolution of the earth; geochemical cycles; distribution of major, minor and trace elements; isotope geochemistry; geochemistry of waters including solution equilibria and water rock interaction.

Engineering properties of rocks and soils; rocks as construction material; geology of dams, tunnels and excavation sites; natural hazards; the fly ash problem; ground water geology and exploration; water quality; impact of human activity; Remote sensing techniques for the interpretation of landforms and resource management.

PART - II B: GEOPHYSICS

The earth as a planet; different motions of the earth; gravity filed of the earth and its shape; geochronology; isostasy, seismology and interior of the earth; variation of density, velocity, pressure, temperature, electrical and magnetic properties inside the earth; earthquakes-causes and measurements; zonation and seismic hazards; geomagnetic field, palaeomagnetism; oceanic and continental lithosphere; plate tectonics; heat flow; upper and lower atmospheric phenomena.

Theories of scalar and vector potential fields; Laplace, Maxwell and Helmholtz equations for solution of different types of boundary value problems for Cartesian, cylindrical and spherical polar coordinates; Green's theorem; Image theory; integral equations and conformal transformations in potential theory; Eikonal equation and ray theory.

'G' and 'g' units of measurement, density of rocks, gravimeters, preparation, analysis and interpretation of gravity maps; derivative maps, analytical continuation; gravity anomaly type curves; calculation of mass.

Earth's magnetic field, units of measurement, magnetic susceptibility of rocks, magnetometers, corrections, preparation of magnetic maps, magnetic anomaly type curve, analytical continuation, interpretation and application; magnetic well logging.

Conduction of electricity through rocks, electrical conductivities of metals, metallic, non-metallic and rock forming minerals, D.C. resistivity units and methods of measurement, electrode configuration for sounding and profiling, application of filter theory, interpretation of resistivity field data, application; self potential origin, classification, field measurement, interpretation of induced polarization time frequency, phase domain; IP units and methods of measurement, interpretation and application; ground-water exploration.

Origin of electromagnetic field elliptic polarization, methods of measurement for different source-receiver configuration components in EM measurements, interpretation and applications; earth's natural electromagnetic field, tellurics, magneto-tellurics; geomagnetic depth sounding principles, methods of measurement, processing of data and interpretation.

Seismic methods of prospecting: Reflection, refraction and CDP surveys; land and marine seismic sources, generation and propagation of elastic waves, velocity increasing with depth, geophones, hydrophones, recording instruments (DFS), digital formats, field layouts, seismic noises and noise profile analysis, optimum geophone grouping, noise cancellation by shot and geophone arrays, 2D and 3D seismic data acquisition and processing, CDP stacking charts, binning, filtering, dip-moveout, static and dynamic corrections, deconvolution, migration, signal processing, Fourier and Hilbert transforms, attribute analysis, bright and dim spots, seismic stratigraphy, high resolution seismics, VSP.

Principles and techniques of geophysical well-logging, SP, resistivity, induction, micro gamma ray, neutron, density, sonic, temperature, dip meter, caliper, nuclear magnetic, cement bond logging. Quantitative evaluation of formations from well logs; well hydraulics and application of geophysical methods for groundwater study; application of bore hole geophysics in ground water, mineral and oil exploration. Remote sensing techniques and application of remote sensing methods in geophysics.

IN - INSTRUMENTATION ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix Algebra, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Mean value theorems, Theorems of integral calculus, Evaluation of definite and improper integrals, Partial Derivatives, Maxima and minima, Multiple integrals, Fourier series. Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equation (linear and nonlinear), Higher order linear differential equations with constant coefficients, Method of variation of parameters, Cauchy's and Euler's equations, Initial and boundary value problems, Partial Differential Equations and variable separable method.

Complex variables: Analytic functions, Cauchy's integral theorem and integral formula, Taylor's and Laurent' series, Residue theorem, solution integrals.

Probability and Statistics: Sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Discrete and continuous distributions, Poisson, Normal and Binomial distribution, Correlation and regression analysis.

Numerical Methods: Solutions of non-linear algebraic equations, single and multi-step methods for differential equations.

Transform Theory: Fourier transform, Laplace transform, Z-transform.

INSTRUMENTATION ENGINEERING

Measurement Basics and Metrology: Static and dynamic characteristics of measurement systems. Standards and calibration. Error and uncertainty analysis, statistical analysis of data, and curve fitting. Linear and angular measurements; Measurement of straightness, flatness, roundness and roughness.

Transducers, Mechanical Measurements and Industrial Instrumentation: Transducers - elastic, resistive, inductive, capacitive, thermo-electric, piezoelectric, photoelectric, electro-mechanical, electro-chemical, and ultrasonic. Measurement of displacement, velocity (linear and rotational), acceleration, shock, vibration, force, torque, power, strain, stress, pressure, flow, temperature, humidity, viscosity, and density. energy storing elements, suspension systems and dampers.

Analog Electronics: Characteristics of diodes, BJTs, JFETs and MOSFETs; Diode circuits; Amplifiers: single and multi-stage, feedback; Frequency response; Operational amplifiers - design, characteristic, linear and non-linear applications: difference amplifiers; instrumentation amplifiers; precision rectifiers, I-to-V converters, active filters, oscillators, comparators, signal generators, wave shaping circuits.

Digital Electronics: Combinational logic circuits, minimization of Boolean functions; IC families (TTL, MOS, CMOS), arithmetic circuits, multiplexer and decoders. Sequential circuits: flip-flops, counters, shift registers. Schmitt trigger, timers, and multivibrators. Analog switches, multiplexers, S/H circuits. Analog-to-digital and digital-to-analog converters. Basics of computer organization and architecture. 8-bit microprocessor (8085), applications, memory, I/O interfacing, and microcontrollers.

Signals and Systems: Vectors and matrices; Fourier series; Fourier transforms; Ordinary differential equations. Impulse and frequency responses of first and second order systems. Laplace transform and transfer function, convolution and correlation. Amplitude and frequency modulations and demodulations. Discrete time systems, difference equations, impulse and frequency responses; Z-transforms and transfer functions; IIR and FIR filters.

Electrical and Electronic Measurements: Measurement of R, L and C; bridges and potentiometers. Measurement of voltage, current, power, power factor, and energy; Instrument transformers; Q meter, waveform analyzers. Digital volt-meters and multi-meters. Time, phase and frequency measurements; Oscilloscope. Noise and interference in instrumentation.

Control Systems & Process Control: Principles of feedback; transfer function, signal flow graphs. Stability criteria, Bode plots, root-loci, Routh and Nyquist criteria. Compensation techniques; State space analysis. System components: mechanical, hydraulic, pneumatic, electrical and electronic; Servos and synchros; Stepper motors. On-off, cascade, P, PI, PID and feed-forward controls. Controller tuning and general frequency response.

Analytical, Optical and Biomedical Instrumentation: Principles of spectrometry, UV, visible, IR mass spectrometry, X-ray methods; nuclear radiation measurements, gas, solid and semi conductor lasers and their characteristics, interferometers, basics of fibre optics, transducers in biomedical applications, cardiovascular system measurements, instrumentation for clinical laboratory.

MA - MATHEMATICS

Linear Algebra: Finite dimensional vector spaces. Linear transformations and their matrix representations, rank; systems of linear equations, eigenvalues and eigenvectors, minimal polynomial, Cayley-Hamilton theorem, diagonalisation, Hermitian, Skew-Hermitian and unitary matrices. Finite dimensional inner product spaces, self-adjoint and Normal linear operators, spectral theorem, Quadratic forms.

Complex Analysis: Analytic functions, conformal mappings, bilinear transformations, complex integration: Cauchy's integral theorem and formula, Liouville's theorem, maximum modulus principle, Taylor and Laurent's series, residue theorem and applications for evaluating real integrals.

Real Analysis: Sequences and series of functions, uniform convergence, power series, Fourier series, functions of several variables, maxima, minima, multiple integrals, line, surface and volume integrals, theorems of Green, Stokes and Gauss; metric spaces, completeness, Weierstrass approximation theorem, compactness. Lebesgue measure, measurable functions; Lebesgue integral, Fatou's lemma, dominated convergence theorem.

Ordinary Differential Equations: First order ordinary differential equations, existence and uniqueness theorems, systems of linear first order ordinary differential equations, linear ordinary differential equations of higher order with constant coefficients; linear second order ordinary differential equations with variable coefficients, method of Laplace transforms for solving ordinary differential equations, series solutions; Legendre and Bessel functions and their orthogonality, Sturm Liouville system, Greeen's functions.

Algebra: Normal subgroups and homomorphisms theorems, automorphisms. Group actions, sylow's theorems and their applications groups of order less than or equal to 20, Finite p-groups. Euclidean domains, Principal ideal domains and unique factorizations domains. Prime ideals and maximal ideals in commutative rings.

Functional Analysis: Banach spaces, Hahn-Banach theorems, open mapping and closed graph theorems, principle of uniform boundedness; Hilbert spaces, orthonormal sets, Riesz representation theorem, self-adjoint, unitary and normal linear operators on Hilbert Spaces.

Numerical Analysis: Numerical solution of algebraic and transcendental equations; bisection, secant method, Newton-Raphson method, fixed point iteration, interpolation: existence and error of polynomial interpolation, Lagrange, Newton, Hermite(osculatory)interpolations; numerical differentiation and integration, Trapezoidal and Simpson rules; Gaussian quadrature; (Gauss-Legendre and Gauss-Chebyshev), method of undetermined parameters, least square and orthonormal polynomial approximation; numerical solution of systems of linear equations: direct and iterative methods, (Jacobi Gauss-Seidel and SOR) with convergence; matrix eigenvalue problems: Jacobi and Given's methods, numerical solution of ordinary differential equations: initial value problems, Taylor series method, Runge-Kutta methods, predictor-corrector methods; convergence and stability.

Partial Differential Equations: Linear and quasilinear first order partial differential equations, method of characteristics; second order linear equations in two variables and their classification; Cauchy, Dirichlet and Neumann problems, Green's functions; solutions of Laplace, wave and diffusion equations in two variables Fourier series and transform methods of solutions of the above equations and applications to physical problems.

Mechanics: Forces in three dimensions, Poinsot central axis, virtual work, Lagrange's equations for holonomic systems, theory of small oscillations, Hamiltonian equations;

Topology: Basic concepts of topology, product topology, connectedness, compactness, countability and separation axioms, Urysohn's Lemma, Tietze extension theorem, metrization theorems, Tychonoff theorem on compactness of product spaces.

Probability and Statistics: Probability space, conditional probability, Bayes' theorem, independence, Random variables, joint and conditional distributions, standard probability distributions and their properties, expectation, conditional expectation, moments. Weak and strong law of large numbers, central limit theorem. Sampling distributions, UMVU estimators, sufficiency and consistency, maximum likelihood estimators. Testing of hypotheses, Neyman-Pearson tests, monotone likelihood ratio, likelihood ratio tests, standard parametric tests based on normal, X2 ,t, F-distributions. Linear regression and test for linearity of regression. Interval estimation.

Linear Programming: Linear programming problem and its formulation, convex sets their properties, graphical method, basic feasible solution, simplex method, big-M and two phase methods, infeasible and unbounded LPP's, alternate optima. Dual problem and duality theorems, dual simplex method and its application in post optimality analysis, interpretation of dual variables. Balanced and unbalanced transportation problems, unimodular property and u-v method for solving transportation problems. Hungarian method for solving assignment problems.

Calculus of Variations and Integral Equations: Variational problems with fixed boundaries; sufficient conditions for extremum, Linear integral equations of Fredholm and Volterra type, their iterative solutions. Fredholm alternative.

ME - MECHANICAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

APPLIED MECHANICS AND DESIGN

Engineering Mechanics: Equivalent force systems, free-body concepts, equations of equilibrium, trusses and frames, virtual work and minimum potential energy. Kinematics and dynamics of particles and rigid bodies, impulse and momentum (linear and angular), energy methods, central force motion.

Strength of Materials: Stress and strain, stress-strain relationship and elastic constants, Mohr's circle for plane stress and plane strain, shear force and bending moment diagrams, bending and shear stresses, deflection of beams, torsion of circular shafts, thin and thick cylinders, Euler's theory of columns, strain energy methods, thermal stresses.

Theory of Machines: Displacement, velocity and acceleration, analysis of plane mechanisms, dynamic analysis of slider-crank mechanism, planar cams and followers, gear tooth profiles, kinematics of gears, governors and flywheels, balancing of reciprocating and rotating masses.

Vibrations: Free and forced vibration of single degree freedom systems, effect of damping, vibration isolation, resonance, critical speed of rotors.

Design of Machine Elements: Design for static and dynamic loading, failure theories, fatigue strength; design of bolted, riveted and welded joints; design of shafts and keys; design of spur gears, rolling and sliding contact bearings; brakes and clutches; belt, rope and chain drives.

FLUID MECHANICS AND THERMAL SCIENCES

Fluid Mechanics: Fluid properties, fluid statics, manometry, buoyancy; control-volume analysis of mass, momentum and energy; fluid acceleration; differential equations of continuity and momentum; Bernoulli's equation; viscous flow of incompressible fluids; boundary layer; elementary turbulent flow; flow through pipes, head losses in pipes, bends etc.

Heat-Transfer: Modes of heat transfer; one dimensional heat conduction, resistance concept, electrical analogy, unsteady heat conduction, fins; dimensionless parameters in free and forced convective heat transfer, various correlations for heat transfer in flow over flat plates and through pipes; thermal boundary layer; effect of turbulence; radiative heat transfer, black and grey surfaces, shape factors, network analysis; heat exchanger performance, LMTD and NTU methods.

Thermodynamics: Zeroth, First and Second laws of thermodynamics; thermodynamic system and processes; irreversibility and availability; behaviour of ideal and real gases, properties of pure substances, calculation of work and heat in ideal processes; analysis of thermodynamic cycles related to energy conversion; Carnot, Rankine, Otto, Diesel, Brayton and vapour compression cycles.

Power Plant Engineering: Steam generators; steam power cycles; steam turbines; impulse and reaction principles, velocity diagrams, pressure and velocity compounding; reheating and reheat factor; condensers and feed heaters.

I.C. Engines: Requirements and suitability of fuels in IC engines, fuel ratings, fuel-air mixture requirements; normal combustion in SI and CI engines; engine performance calculations.

Refrigeration and air-conditioning: Refrigerant compressors, expansion devices, condensers and evaporators; properties of moist air, psychrometric chart, basic psychometric processes.

Turbomachinery: Components of gas turbines; compression processes, centrifugal and axial flow compressors; axial flow turbines, elementary theory; hydraulic turbines; Euler-turbine equation; specific speed, Pelton-wheel, Francis and Kaplan turbines; centrifugal pumps.

MANUFACTURING AND INDUSTRIAL ENGINEERING

Engineering Materials: Structure and properties of engineering materials and their applications, heat treatment.

Metal Casting: Casting processes (expendable and non-expendable) -pattern, moulds and cores, heating and pouring, solidification and cooling, gating design, design considerations, defects.

Forming Processes: Stress-strain diagrams for ductile and brittle material, Plastic deformation and yield criteria, fundamentals of hot and cold working processes, Bulk metal forming processes (forging, rolling, extrusion, drawing), sheet metal working processes (punching, blanking, bending, deep drawing, coining, spinning, load estimation using homogeneous deformation methods, defects). processing of powder metals- atomization, compaction, sintering, secondary and finishing operations. forming and shaping of plastics- extrusion, injection moulding.

Joining Processes: Physics of welding, fusion and non-fusion welding processes, brazing and soldering, adhesive bonding, design considerations in welding, weld quality defects.

Machining and Machine Tool Operations: Mechanics of machining, single and multi-point cutting tools, tool geometry and materials, tool life and wear, cutting fluids, machinability, economics of machining, non-traditional machining processes.

Metrology and Inspection: Limits, fits and tolerances, linear and angular measurements, comparators, gauge design, interferometry, form and finish measurement, measurement of screw threads, alignment and testing methods.

Tool Engineering: Principles of work holding, design of jigs and fixtures.

Computer Integrated Manufacturing: Basic concepts of CAD, CAM and their integration tools.

Manufacturing Analysis: Part-print analysis, tolerance analysis in manufacturing and assembly, time and cost analysis.

Work-Study: Method study, work measurement, time study, work sampling, job evaluation, merit rating.

Production Planning and Control: Forecasting models, aggregate production planning, master scheduling, materials requirements planning.

Inventory Control: Deterministic and probabilistic models, safety stock inventory control systems.

Operations Research: Linear programming, simplex and duplex method, transportation, assignment, network flow models, simple queuing models, PERT and CPM

MN - MINING ENGINEERING

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

MINING ENGINEERING

Mechanics: Equivalent force systems, equations of equilibrium, two dimensional frames and trusses, free body diagrams, friction forces, particle kinematics and dynamics.

Mine Development, Geomechanics and Strata Control: Drivages for underground mine development, drilling methods and machines, explosives, blasting devices and practices, shaft sinking. Physico-mechanical properties of rocks, rock mass classification, ground control instrumentation and stress measurement techniques, theories of rock failure, ground vibrations, stress distribution around mine openings, subsidence, design of supports in roadways and workings, stability of open pits, slopes.

Mining Methods and Machinery: Surface mining - layout, development, loading, transportation and mechanization, continuous surface mining systems. Underground coal mining - bord and pillar system, longwall mining, thick seam mining methods. Underground metal mining: different stoping methods, stope mechanization, ore handling systems, mine filling. Generation and transmission of mechanical, hydraulic, and pneumatic power. Materials handling - haulages, conveyors, ropeways, face and development machinery, hoisting systems, and pumps.

Ventilation, Underground Hazards and Surface Environment: Underground atmosphere, heat load sources and thermal environment, air cooling, mechanics of air flow distribution, natural and mechanical ventilation, mine fans and their usage, auxiliary ventilation. Subsurface hazards from fires, explosions, gases, dust, and inundation, rescue apparatus and practices, safety in mines, accident analysis, noise, mine lighting. Air and water pollution: causes, dispersion, quality standards, and control.

Surveying, Mine Planning and Systems Engineering: Fundamentals of engineering surveying, Levels and levelling, Theodolite, tacheometry, triangulation, contouring, errors and adjustments, correlation, underground surveying, curves, photogrammetry, field astronomy, GPS fundamentals. Principles of planning - Sampling methods and practices, reserve estimation techniques, basics of geostatistics, optimization of facility location, cash flow concepts and mine valuation, open pit design. Work study, concepts of reliability, reliability of series and parallel systems. Linear programming, transportation and assignment problems, queueing, network analysis, inventory control.

MT - METALLURGICAL ENGINEERING

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

METALLURGICAL ENGINEERING

Thermodynamics and Rate Processes: Laws of thermodynamics, activity, equilibrium constant, applications to metallurgical systems, solutions, phase equilibria, basic kinetic laws, order of reactions, rate constants and rate limiting steps principles of electro chemistry, aqueous, corrosion and protection of metals, oxidation and high temperature corrosion - characterization and control; momentum transfer - concepts of viscosity, shell balances, Bernoulli's equation; heat transfer - conduction, convection and heat transfer coefficient relations, radiation, mass transfer - diffusion and Fick's laws.

Extractive Metallurgy: Flotation, gravity and other methods of mineral processing; agglomeration, pyro-hydro-and electro-metallurgical processes; material and energy balances; principles and processes for the extraction of non-ferrous metals - aluminium, copper, zinc, lead, magnesium, nickel, titanium and other rare metals; iron and steel making - principles, blast furnace, direct reduction processes, primary and secondary steel making, deoxidation and inclusion in steel; ingot and continuous casting; stainless steel making, design of furnaces; fuels and refractories.

Physical Metallurgy: Crystal structure and bonding characteristics of metals, alloys, ceramics and polymers; solid solutions; solidification; phase transformation and binary phase diagrams; principles of heat treatment of steels, aluminum alloys and cast irons; recovery, recrystallization and grain growth; industrially important ferrous and non-ferrous alloys; elements of X-ray and electron diffraction; principles of scanning and transmission electron microscopy; elements of ceramics, composites and electronic materials; electronic basis of thermal, optical, electrical and magnetic properties of materials.

Mechanical Metallurgy: Elements of elasticity and plasticity; defects in crystals; elements of dislocation theory - types of dislocations, slip and twinning, stress fields of dislocations, dislocation interactions and reactions, methods of seeing dislocations; strengthening mechanisms; tensile, fatigue and creep behaviour; superplasticity; fracture - Griffith theory, ductile to brittle transition, fracture toughness; failure analysis; mechanical testing - tension, compression, torsion, hardness, impact, creep, fatigue, fracture toughness and formability tests.

Manufacturing Processes: Metal casting - patterns, moulds, melting, gating, feeding and casting processes, defects and castings, hot and cold working of metals; Metal forming - fundamentals of metal forming, rolling wire drawing, extrusion, forming, sheet metal forming processes, defects in forming; Metal joining - soldering, brazing and welding, common welding processes, welding metallurgy, problems associated with welding of steels and aluminium alloys, defects in welding, powder metallurgy; NDT methods - ultrasonic, radiography, eddy current, acoustic emission and magnetic.

PH - PHYSICS

Mathematical Physics: Linear vector space, matrices; vector calculus; linear differential equations; elements of complex analysis; Laplace transforms, Fourier analysis, elementary ideas about tensors.

Classical Mechanics: Conservation laws; central forces; collisions and scattering in laboratory and centre of mass reference frames; mechanics of system of particles; rigid body dynamics; moment of inertia tensor; noninertial frames and pseudo forces; variational principle; Lagrange's and Hamilton's formalisms; equation of motion, cyclic coordinates, Poisson bracket; periodic motion, small oscillations, normal modes; wave equation and wave propagation; special theory of relativity - Lorentz transformations, relativistic kinematics, mass-energy equivalence.

Electromagnetic Theory: Laplace and Poisson equations; conductors and dielectrics; boundary value problems; Ampere's and Biot-Savart's laws; Faraday's law; Maxwell's equations; scalar and vector potentials; Coulomb and Lorentz gauges; boundary conditions at interfaces; electromagnetic waves; interference, diffraction and polarization; radiation from moving charges.

Quantum Mechanics: Physical basis of quantum mechanics; uncertainty principle; Schrodinger equation; one and three dimensional potential problems; Particle in a box, harmonic oscillator, hydrogen atom; linear vectors and operators in Hilbert space; angular momentum and spin; addition of angular momentum; time independent perturbation theory; elementary scattering theory.

Atomic and Molecular Physics: Spectra of one-and many-electron atoms; LS and jj coupling; hyperfine structure; Zeeman and Stark effects; electric dipole transitions and selection rules; X-ray spectra; rotational and vibrational spectra of diatomic molecules; electronic transition in diatomic molecules, Franck-Condon principle; Raman effect; NMR and ESR; lasers.

Thermodynamics and Statistical Physics: Laws of thermodynamics; macrostates, phase space; probability ensembles; partition function, free energy, calculation of thermodynamic quantities; classical and quantum statistics; degenerate Fermi gas; black body radiation and Planck's distribution law; Bose-Einstein condensation; first and second order phase transitions, critical point.

Solid State Physics: Elements of crystallography; diffraction methods for structure determination; bonding in solids; elastic properties of solids; defects in crystals; lattice vibrations and thermal properties of solids; free electron theory; band theory of solids; metals, semiconductors and insulators; transport properties; optical, dielectric and magnetic properties of solids; elements of superconductivity.

Nuclear and Particle Physics: Rutheford scattering; basic properties of nuclei; radioactive decay; nuclear forces; two nucleon problem; nuclear reactions; conservation laws; fission and fusion; nuclear models; particle accelerators, detectors; elementary particles; photons, baryons, mesons and leptons; Quark model.

Electronics: Network analysis; semiconductor devices; bipolar transistors; FETs; power supplies, amplifier, oscillators; operational amplifiers; elements of digital electronics; logic circuits.

PI - PRODUCTION AND INDUSTRIAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

GENERAL ENGINEERING:

Engineering Materials: Structure and properties of engineering materials and their applications; effect of strain, strain rate and temperature on mechanical properties of metals and alloys; heat treatment of metals and alloys.

Applied Mechanics: Engineering mechanics - equivalent force systems, free body concepts, equations of equilibrium, virtual work and minimum potential energy; strength of materials-stress, strain and their relationship, Mohr's circle, deflection of beams, bending and shear stress, Euler's theory of columns.

Theory of Machines and Design: Analysis of planar mechanisms, plane cams and followers; governers and fly wheels; design of elements-failure theories; design of bolted, riveted and welded joints; design of shafts, keys, belt drives, brakes and clutches.

Thermal Engineering: Fluid machines - fluid statics, Bernoulli's equation, flow through pipes, equations of continuity and momentum; Thermodynamics - zeroth, First and Second laws of thermodynamics, thermodynamic system and processes, calculation of work and heat for systems and control volumes; Heat transfer - fundamentals of conduction, convection and radiation.

PRODUCTION ENGINEERING

Metal Casting: Casting processes; patterns-materials; allowances; moulds and cores - materials, making and testing; melting and founding of cast iron, steels and nonferrous metals and alloys; solidification; design of casting, gating and risering; casting defects and inspection.

Metal working: Stress-strain in elastic and plastic deformation; deformation mechanisms; hot and cold working-forging, rolling, extrusion, wire and tube drawing; sheet metal working; analysis of rolling, forging, extrusion and wire /rod drawing; metal working defects, high energy rate forming processes-explosive, magnetic, electro and electrohydraulic.

Metal Joining Processes: Welding processes - gas shielded metal arc, TIG, MIG, submerged arc, electroslag, thermit, resistance, pressure and forge welding; thermal cutting; other joining processes - soldering, brazing, braze welding; welding codes, welding symbols, design of welded joints, defects and inspection; introduction to modern welding processes - friction, ultrasonic, explosive, electron beam, laser and plasma.

Machining and Machine Tool Operations: Machining processes-turning, drilling, boring, milling, shaping, planing, sawing, gear cutting, thread production, broaching, grinding, lapping, honing super finishing; mechanics of cutting- Merchant's analysis, geometry of cutting tools, cutting forces, power requirements; selection of process parameters; tool materials, tool wear and tool life, cutting fluids, machinability; nontraditional machining processes and hybrid processes- EDM, CHM, ECM, USM, LBM, EBM, AJM, PAM AND WJM; economics of machining.

Metrology and Inspection: Limits and fits, linear and angular measurements by mechanical and optical methods, comparators; design of limit gauges; interferometry; measurement of straightness, flatness, roundness, squareness and symmetry; surface finish measurement; inspection of screw threads and gears; alignment testing.

Powder Metallurgy and Processing of Plastics: Production of powders, compaction, sintering; Polymers and composites; injection, compression and blow molding, extrusion, calendaring and thermoforming; molding of composites.

Tool Engineering: Work-holding-location and clamping; principles and methods; design of jigs and fixtures; design of press working tools, forging dies.

Manufacturing Analysis: Sources of errors in manufacturing; process capability; part-print analysis; tolerance analysis in manufacturing and assembly; process planning; parameter selection and comparison of production alternatives; time and cost analysis; Issues in choosing manufacturing technologies and strategies.

Computer Integrated Manufacturing: Basic concepts of CAD, CAM, CAPP, group technology, NC, CNC, DNC, FMS, Robotics and CIM.

INDUSTRIAL ENGINEERING

Product Design and Development: Principles of good product design, component and tolerance design; efficiency, quality and cost considerations; product life cycle; standardization, simplification, diversification, value analysis, concurrent engineering.

Engineering Economy and Costing: Financial statements; elementary cost accounting, methods of depreciation; break-even analysis, techniques for evaluation of capital investments.

Work System Design: Taylor's scientific management, Gilbreths's contributions; productivity concepts and measurements; method study, micro-motion study, principles of motion economy; human factors engineering, ergonomics; work measurement - time study, PMTS, work sampling; job evaluation, merit rating, wage administration, incentive systems; business process reengineering.

Logistics and Facility Design: Facility location factors, evaluation of alternatives, types of plant layout, evaluation; computer aided layout; assembly line balancing; material handling systems; supply chain management.

Production Planning and Inventory Control: Inventory Function costs, classifications - deterministic and probabilistic models; quantity discount; safety stock; inventory control system; Forecasting techniques - causal and time series models, moving average, exponential smoothing; trend and seasonality; aggregate production planning; master scheduling; bill of materials and material requirement planning; order control and flow control, routing, scheduling and priority dispatching; JIT; Kanban PULL systems; bottleneck scheduling and theory of constraints.

Operation Research: Linear programming - problem formulation, simplex method, duality and sensitivity analysis; transportation; assignment; network flow models, constrained optimization and Lagrange multipliers; simple queuing models; dynamic programming; simulation; PERT and CPM, time-cost trade-off, resource leveling.

Quality Control: Taguchi method; design of experiments; quality costs, statistical quality assurance, process control charts, acceptance sampling, zero defects; quality circles, total quality management.

Reliability and Maintenance: Reliability, availability and maintainability; probabilistic failure and repair times; system reliability; preventive maintenance and replacement, TPM.

Management Information System: Value of information; information storage and retrieval system - database and data structures; interactive systems; knowledge based systems.

Intellectual Property System: Definition of intellectual property, importance of IPR; TRIPS, and its implications, WIPO and Global IP structure, and IPS in India; patent, copyright, industrial design and trademark; meanings, rules and procedures, terms, infringements and remedies.

PY - PHARMACEUTICAL SCIENCES

Natural Products: Pharmacognosy & Phytochemistry - Chemistry, tests, isolation, characterization and estimation of phytopharmaceuticals belonging to the group of Alkaloids, Glycosides, Terpenoids, Steroids, Bioflavanoids, Purines, Guggul lipids. Pharmacognosy of crude drugs which contain the above constituents. Standardisation of raw materials and herbal products. WHO guide lines. Quantitative microscopy including modern techniques used for evaluation. Biotechnological principles and techniques for plant development Tissue culture.

Pharmacology: General pharmacological principles including Toxicology. Drug interaction. Pharmacology of drugs acting on Central nervous system, Cardiovascular system, Autonomic nervous system, Gastro intestinal system and Respiratory system. Pharmacology of Autocoids, Hormones, Chemotherapeutic agents including anticancer drugs. Bioassays. Immuno Pharmacology.

Medicinal Chemistry: Structure, nomenclature, classification, synthesis, SAR and metabolism of the following category of drugs which are official in Indian Pharmacopoeia and British Pharmacopoeia Hypnotics and Sedatives, Analgesics, NSAIDS, Neuroleptics, Antidepressants, Anxiolytics, Anticonvulsants, Antihistaminics, Local anaesthetics, Cardio Vascular drugs - Antianginal agents Vasodilators, Adrenergic & cholinergic drugs, Cardiotonic agents, Diuretics, Antihypertensive drugs, Hypoglycemic agents, Antilipedmic agents, Coagulants, Anticoagulants, Antiplatelet agents. Chemotherapeutic agents - Antibiotics, Antibacterials, Sulphadrugs. Antiproliozoal drugs, Antiviral, Antitubercular, Antimalarial, Anticancer, Antiamoebic drugs. Diagnostic agents. Preparation and storage and uses of official Radiopharmaceuticals. Vitamins and Hormones.

Pharmaceutics: Development, manufacturing standards, labeling, packing as per the pharmacopoeal requirements, Storage of different dosage forms and new drug delivery systems. Biopharmaceutics and Pharmacokinetics and their importance in formulation. Formulation and preparation of cosmetics - lipstick, shampoo, creams, nail preparations and dentifrices. Pharmaceutical calculations.

Pharmaceutical Jurisprudence: Legal aspects of manufacture, storage, sale of drugs. D and C act and rules. Pharmacy act.

Pharmaceutical Analysis: Principles, instrumentation and applications of the following. Absorption spectroscopy (UV, visible & IR), Fluorimetry, Flame photometry, Potentiometry, Conductometry and Plarography. Pharmacopoeial assays. Principles of NMR, ESR, Mass spectroscopy, X-ray diffraction analysis and different chromatographic methods.

Biochemistry and Clinical Pharmacy: Biochemical role of hormones, Vitamins, Enzymes, Nucleic acids. Bioenergetics. General principles of immunology. Immunological techniques. Adverse drug interaction.

Microbiology: Principles and methods of microbiological assays of the Pharmacopoeia. Methods of preparation of official sera and vaccines. Serological and diagnostic tests. Applications of microorganisms in Bio Conversions and in Pharmaceutical industry.

TF - TEXTILE ENGINEERING AND FIBRE SCIENCE

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

TEXTILE ENGINEERING & FIBRE SCIENCE

Textile Fibres: Classification of textile fibres according to their nature and origin; general characteristics of textile fibres-their chemical and physical structures and their properties; essential characteristics of fibre forming polymers; uses of natural and man-made fibres; physical and chemical methods of fibre and blend identification and blend analysis.

Melt Spinning processes with special reference to polyamide and polyester fibres; wet and dry spinning of viscose and acrylic fibres; post spinning operations-drawing, heat setting, texturing- false twist and air-jet, tow-to-top conversion. Methods of investigating fibre structure e.g. X-ray diffraction, birefringence, optical and electron microscopy, I.R. absorption, thermal methods; structure and morphology and principal natural and man-made fibres, mechanical properties of fibres, moisture sorption in fibres; fibre structure and property correlation.

Textile Testing: Sampling techniques, sample size and sampling errors; measurement of fibre length, fineness, crimp, strength and reflectance; measurement of cotton fibre maturity ad trash content; HVI and AFIS for fibre testing. Measurement of yarn count, twist and hairiness; tensile testing of fibres, yarn and fabrics; evenness testing of slivers, rovings and yarns; testing equipment for measurement test methods of fabric properties like thickness, compressibility, air permeability, drape, crease recovery, tear strength bursting strength and abrasion resistance. Correlation analysis, significance tests and analysis of variance; frequency distributions and control charts.

Yarn Manufacture and Yarn Structure: Modern methods of opening, cleaning and blending of fibrous materials; the technology of carding with particular reference to modern developments; causes of irregularity introduced by drafting, the development of modern drafting systems; principles and techniques of preparing material for combing; recent development in combers; functions and synchronization of various mechanisms concerned with roving production; forces acting on yarn and traveller, ring and traveller designs; causes of end breakages; properties of doubles yarns; new methods of yarn production such as rotor spinning, air jet spinning and friction spinning.

Yarn diameter; specific volume, packing coefficient; twist-strength relationship; fibre orientation in yarn; fibre migration.

Fabric Manufacture and Fabric Structure: Principles of cheese and cone winding processes and machines; random and precision winding; package faults and their remedies; yarn clearers and tensioners; different systems of yarn splicing; features of modern cone winding machines; different types of warping creels; features of modern beam and sectional warping machines; different sizing systems, sizing of spun and filament yarns, modern sizing machines; principles of pirn winding processes and machines; primary and secondary motions of loom, effect of their settings and timings on fabric formation, fabric appearance and weaving performance; dobby and jacquard shedding; mechanics of weft insertion with shuttle; warp and weft stop motions, warp protection, weft replenishment; functional principles of weft insertion systems of shuttleless weaving machines, principles of multiphase and circular looms. Principles of weft and warp knitting; basic weft and warp knitted structures; classification, production and areas of application of nonwoven fabrics.

Basic woven fabric constructions and their derivatives; crepe, cord, terry, gauze, lino and double cloth constructions.

Peirce's equations for fabric geometry; thickness, cover and maximum sett of woven fabrics

Textile Chemical Processing: Preparatory processes for natural-and and their blends; mercerization of cotton; machines for yarn and fabric mercerization.

Dyeing and printing of natural- and synthetic- fibre fabrics and their blends with different dye classes; dyeing and printing machines; styles of printing; fastness properties of dyed and printed textile materials.

Finishing of textile materials, wash and wear, durable press, soil release, water repellent, flame retardant and antistatic finishes; shrink-resistance finish for wool; heat setting of synthetic-fibre fabrics, finishing machines; energy efficient processes; pollution control.

XE - ENGINERING SCIENCES

The syllabi of the sections of this paper are as follows:

SECTION A. ENGINEERING MATHEMATICS (Compulsory)

Linear Algebra : Determinates, algebra of matrices, rank, inverse, system of linear equations, symmetric, skew-symmetric and orthogonal matrices. Hermitian, skew-hermitian and unitary matrices. eigenvalues and eigenvectors, diagonalisation of matrices, Cayley-Hamiltonian, quadratic forms.

Calculus : Functions of single variables, limit, continuity and differentiability, Mean value theorems, Intermediate forms and L'Hospital rule, Maxima and minima, Taylor's series, Fundamental and mean value-theorems of integral calculus. Evaluation of definite and improper integrals, Beta and Gamma functions, Functions of two variables, limit, continuity, partial derivatives, Euler's theorem for homogeneous functions, total derivatives, maxima and minima, Lagrange method of multipliers, double and triple integrals and their applications, sequence and series, tests for convergence, power series, Fourier Series, Fourier integrals.

Complex variable: Analytic functions, Cauchy's integral theorem and integral formula without proof. Taylor's and Laurent' series, Residue theorem (without proof) with application to the evaluation of real integarls.

Vector Calculus: Gradient, divergence and curl, vector identities, directional derivatives, line, surface and volume integrals, Stokes, Gauss and Green's theorems (without proofs) with applications.

Ordinary Differential Equations: First order equation (linear and nonlinear), higher order linear differential equations with constant coefficients, method of variation of paramaters, Cauchy's and Euler's equations, initial and boundary value problems, power series solutions, Legendre polynomials and Bessel's functions of the first kind.

Partial Differential Equations: Variables separable method, solutions of one dimensional heat, wave and Laplace equations.

Probability and Statistics: Definitions of probability and simple theorems, conditional probability, mean, mode and standard deviation, random variables, discrete and continuous distributions, Poisson, normal and Binomial distribution, correlation and regression

Numerical Methods: L-U decomposition for systems of linear equations,Newton-Raphson method, numerical integration(trapezoidal and Simpson's rule), numerical methods for first order differential equation (Euler method)

SECTION B. COMPUTATIONAL SCIENCE

Numerical Methods: Truncation errors, round off errors and their propagation; Interpolation; Lagrange, Newton's forward, backward and divided difference formulas, least square curve fitting, solution of non-linear equations of one variables using bisection, false position, secant and Newton Raphson methods; Rate of convergence of these methods, general iterative methods. Simple and multiple roots of polynomials. Solutions of system of linear algebraic equations using Gauss elimination methods, Jacobi and Gauss-Seidel iterative methods and their rate of convergence; ill conditioned and well conditioned system. eigen values and eigen vectors using power methods. Numerical integration using trapezoidal, Simpson's rule and other quadrature formulas. Numerical Differentiation. Solution of boundary value problems. Solution of initial value problems of ordinary differential equations using Euler's method, predictor corrector and Runge Kutta method.

Programming : Elementary concepts and terminology of a computer system and system software, Fortran77 and C programming.

Fortran : Program organization, arithmetic statements, transfer of control, Do loops, subscripted variables, functions and subroutines.

C language : Basic data types and declarations, flow of control- iterative statement, conditional statement, unconditional branching, arrays, functions and procedures.

SECTION C. ELECTRICAL SCIENCES

Electric Circuits: Ideal voltage and current sources; RLC circuits, steady state and transient analysis of DC circuits, network theorems; alternating currents and voltages, single-phase AC circuits, resonance; three-phase circuits.

Magnetic circuits: Mmf and flux, and their relationship with voltage and current; transformer, equivalent circuit of a practical transformer, three-phase transformer connections.

Electrical machines: Principle of operation, characteristics, efficiency and regulation of DC and synchronous machines; equivalent circuit and performance of three-phase and single-phase induction motors.

Electronic Circuits: Characteristics of p-n junction diodes, zener diodes, bipolar junction transistors (BJT) and junction field effect transistors (JFET); MOSFET's structure, characteristics, and operations; rectifiers, filters, and regulated power supplies; biasing circuits, different configurations of transistor amplifiers, class A, B and C of power amplifiers; linear applications of operational amplifiers; oscillators; tuned and phase shift types.

Digital circuits: Number systems, Boolean algebra; logic gates, combinational circuits, flip-flops (RS, JK, D and T) counters.

Measuring instruments: Moving coil, moving iron, and dynamometer type instruments; shunts, instrument transformers, cathode ray oscilloscopes; D/A and A/D converters.

SECTION D. FLUID MECHANICS

Fluid Properties: Relation between stress and strain rate for Newtonian fluids

Hydrostatics, buoyancy, manometry

Concept of local and convective accelerations; control volume analysis for mass, momentum and energy conservation.

Differential equations of continuity and momentum (Euler's equation of motion); concept of fluid rotation, stream function, potential function; Bernoulli's equation and its applications.

Qualitative ideas of boundary layers and its separation; streamlined and bluff bodies; drag and lift forces.

Fully-developed pipe flow; laminar and turbulent flows; friction factor; Darcy Weisbach relation; Moody's friction chart; losses in pipe fittings; flow measurements using venturimeter and orifice plates.

Dimensional analysis; similitude and concept of dynamic similarity; importance of dimensionless numbers in model studies.

SECTION E. MATERIALS SCIENCE

Atomic structure and bonding in materials: metals, ceramics and polymers.

Structure of materials: Crystal systems, unit cells and space lattice; determination of structures of simple crystals by X-ray diffraction; Miller indices for planes and directions. Packing geometry in metallic, ionic and covalent solids.

Concept of amorphous, single and polycrystalline structures and their effects on properties of materials.

Imperfections in crystalline solids and their role in influencing various properties.

Fick´s laws of diffusion and applications of diffusion in sintering, doping of semiconductors and surface hardening of metals.

Alloys: solid solution and solubility limit. Binary phase diagram, intermediate phases and intermetallic compounds; iron-iron carbide phase diagram. Phase transformation in steels. Cold and hot working of metals, recovery, recrystallization and grain growth.

Properties and applications of ferrous and nonferrous alloys.

Structure, properties, processing and applications of traditional and advanced ceramics.

Polymers: classification, polymerization, structure and properties, additives for polymer products, processing and application.

Composites: properties and application of various composites.

Corrosion and environmental degradation of materials (metals, ceramics and polymers).

Mechanical properties of materials: Stress-strain diagrams of metallic, ceramic and polymeric materials, modulus of elasticity, yield strength, plastic deformation and toughness, tensile strength and elongation at break; viscoelasticity, hardness, impact strength. ductile and brittle fracture. creep and fatigue properties of materials.

Heat capacity, thermal conductivity, thermal expansion of materials.

Concept of energy band diagram for materials; conductors, semiconductors and insulators in terms of energy bands. Electrical conductivity, effect of temperature on conductivity in materials, intrinsic and extrinsic semiconductors, dielectric properties of materials.

Refraction, reflection, absorption and transmission of electromagnetic radiation in solids.

Origin of magnetism in metallic and ceramic materials, paramagnetism, diamagnetism, antiferromagnetism, ferromagnetism, ferrimagnetism in materials and magnetic hysteresis.

Advanced materials: Smart materials exhibiting ferroelectric, piezoelectric, optoelectronic, semiconducting behaviour; lasers and optical fibers; photoconductivity and superconductivity in materials.

SECTION F. SOLID MECHANICS

Equivalent force systems; free-body diagrams; equilibrium equations; analysis of determinate and indeterminate trusses and frames; friction.

Simple relative motion of particles; force as function of position, time and speed; force acting on a body in motion; laws of motion; law of conservation of energy; law of conservation of momentum

Stresses and strains; principal stresses and strains; Mohr's circle; generalized Hooke's Law; equilibrium equations; compatibility conditions; yield criteria.

Axial, shear and bending moment diagrams; axial, shear and bending stresses; deflection (for symmetric bending); torsion in circular shafts; thin cylinders; energy methods (Castigliano's Theorems); Euler buckling.

SECTION G. THERMODYNAMICS

Basic Concepts: Continuum, macroscopic approach, thermodynamic system (closed and open or control volume); thermodynamic properties and equilibrium; state of a system, state diagram, path and process; different modes of work; Zeroth law of thermodynamics; concept of temperature; heat.

First Law of Thermodynamics: Energy, enthalpy, specific heats, first law applied to systems and control volumes, steady and unsteady flow analysis.

Second Law of Thermodynamics: Kelvin-Planck and Clausius statements, reversible and irreversible processes, Carnot theorems, thermodynamic temperature scale, Clausius inequality and concept of entropy, principle of increase of entropy; availability and irreversibility.

Properties of Pure Substances: Thermodynamic properties of pure substances in solid, liquid and vapour phases, P-V-T behaviour of simple compressible substances, phase rule, thermodynamic property tables and charts, ideal and real gases, equations of state, compressibility chart.

Thermodynamic Relations: T-ds relations, Maxwell equations, Joule-Thomson coefficient, coefficient of volume expansion, adiabatic and isothermal compressibilities, Clapeyron equation.

Ideal Gas Mixtures: Dalton's and Amagat's laws, calculations of properties, air-water vapour mixtures.

XL - LIFE SCIENCES

The syllabi of the Sections of this paper are as follows:

SECTION H. CHEMISTRY (Compulsory)

Atomic structure and periodicity: Quantum chemistry; Planck's quantum theory, wave particle duality, uncertainty principle, quantum mechanical model of hydrogen atom; electronic configuration of atoms; periodic table and periodic properties; ionization energy, election affinity, electronegativity, atomic size.

Structure and bonding: Ionic and covalent bonding M.O. and V.B. approaches for diatomic molecules, VSEPR theory and shape of molecules, hybridisation, resonance, dipole moment, structure parameters such as bond length, bond angle and bond energy, hydrogen bonding, van der Waals interactions. Ionic solids; ionic radii, lattice energy (Born-Haber Cycle).

s.p. and d Block Elements: Oxides, halides and hydrides of alkali and alkaline earth metals, B, Al, S, N, P and S, silicones, general characteristics of 3d elements, coordination complexes: valence bond and crystal field theory, color, geometry and magnetic properties.

Chemical Equilibria: Colligative properties of solutions, ionic equilibria in solution, solubility product, common ion effect, hydrolysis of salts, pH, buffer and their applications in chemical analysis.

Electrochemistry: Conductance, Kohlrausch law, Half Cell potentials, emf, Nernst equation, galvanic cells, thermodynamic aspects and their applications.

Reaction Kinetics: Rate constant, order of reaction, molecularity, activation energy, zero, first and second order kinetics, equilibrium constants (Kc, Kp and Kx) for homogeneous reactions, catalysis and elementary enzyme reactions.

Thermodynamics: First law, reversible and irreversible processes, internal energy, enthalpy, Kirchoff's equation, heat of reaction, Hess law, heat of formation, Second law, entropy, free energy, and work function. Gibbs-Helmholtz equation, Clausius-Clapeyron equation, free energy change and equilibrium constant, Troutons rule, Third law of thermodynamics.

Mechanistic Basis of Organic Reactions: Elementary treatment of SN1, SN2, E1 and E2 reactions, Hoffmann and Saytzeff rules, Addition reactions, Markonikoff rule and Kharash effect, Diels-Alder reaction, aromatic electrophilic substitution, orientation effect as exemplified by various functional groups.

Structure-Reactivity Correlations: Acids and bases, electronic and steric effects, optical and geometrical isomerism, tautomerism, concept of aromaticity

SECTION I. BIOCHEMISTRY

Organization of life. Importance of water. Cell structure and organelles. Structure and function of biomolecules: Carbohydrates, Lipids, Proteins and Nucleic acids. Biochemical separation techniques. Spectroscopic methods; UV-visible and fluorescence. Protein structure, folding and function: Myoglobin, Hemoglobin, Lysozyme, ribonuclease A, Carboxypeptidase and Chymotrypsin. Enzyme kinetics and regulation, Coenzymes.

Metabolism and bioenergitics. Generation and utilization of ATP. Photosynthesis. Major metabolic pathways and their regulation. Biological membranes. Transport across membranes. Signal transduction; hormones and neurotransmitters.

DNA replication, transcription and translation. Biochemical regulation of gene expression. Recombinant DNA technology and applications. Genomics and Proteomics.

The immune system. Active and passive immunity. Complement system. Antobody structure, function and diversity. Cells of the immune system: T, B and macrophages. T and B cell activation. Major histocompatibilty complex. T cell receptor. Immunological techniques: Immunodiffusion, immunoelectrophoresis, RIA and ELISA.

SECTION J. BIOTECHNOLOGY

Recombinant DNA technology for the production of therapeutic proteins. Micro array technology. Heterologous protein expression systems in bacteria, yeast etc.

Architecture of plant genome; plant tissue culture techniques; methods of gene transfer into plant cells; manipulation of phenotypic traits in plants; plant cell fermentations and production of secondary metabolites using suspension/ immobilized cell culture; methods for plant micro propagation; crop improvement and development of transgenic plants. Expression of animal proteins in plants.

Animal cell metabolism and regulation; cell cycle; primary cell culture; nutritional requirements for animal cell culture; techniques for the mass culture of animal cell lines; production of vaccines; growth hormones and interferons using animal cell culture; cytokines-production and therapeutic uses; hybridoma technology; vectors for gene transfer and expression in animal cells. Transgenic animals and molecular pharming.

Microbial production of industrial enzymes; methods for immobilization of enzymes; kinetics of soluble and immobilized enzymes; application of soluble and immobilized enzymes; enzyme-based sensors.

Microbial growth kinetics; batch, fed batch and continuous culture of microbial cells; media for industrial fermentations; sterilization of air and media; design features and operation of stirred tank, air-lift and fluidized bed reactors; aeration and agitation in aerobic fermentations; recovery and purification of fermentation products- filtration, centrifugation, cell disintegration, solvent extraction and chromatographic separations; industrial fermentations for the production of ethanol, citric acid, lysine, penicillin and other biomolecules; simple calculations based on material and energy balance of fermentation processes; application of microbes in the management of domestic and industrial wastes.

SECTION K. BOTANY

Anatomy: Roots, stem and leaves of land plants, meristems, vascular system, their ontogeny, structure and functions. Plant cell structure, organisation, organelles, cytoskeleton, cell wall and membranes.

Development: Cell cycle, cell division, senescence, hormonal regulation of growth; life cycle of an angiosperm, pollination, fertilization, embryogenesis, seed formation, seed storage proteins, seed dormancy and germination. Concept of cellular totipotency, organogenesis and somatic embryogenesis, somaclonal variation, embryo culture, in vitro fertilization.

Physiology and Biochemistry: Plant water relations, transport of minerals and solutes, N2 metabolism, proteins and nucleic acid, respiration, photophysiology, photosynthesis, photorespiration; biosynthesis, mechanism of action and physiological effects of plant growth regulators.

Genetics: Principles of Mendelian inheritance, linkage, recombination and genetic mapping; extrachromosomal inheritance; eukaryotic genome organization (chromatin structure) and regulation of gene expression, gene mutation, chromosome aberrations (numerical and structural), transposons.

Plant Breeding: Principles, methods - selection, hybridization, heterosis; male sterility, self and inter-specific incompatibility; haploidy; somatic cell hybridization; molecular marker-assisted selection; gene transfer methods viz. direct and vector-mediated, transgenic plants and their applications in agriculture.

Economic Botany: Economically important plants - cereals, pulses, plants yielding fiber, timber, sugar, beverages, oils, rubber, dyes, gums, drugs and narcotics - a general account.

Systematics: Systems of classification (non-phylogenetic vs. phylogenetic - outline), plant groups, molecular systematics.

Plant Pathology: Nature and classification of plant diseases, diseases of important crops caused by fungi, bacteria and viruses, and their control measures, mechanism(s) of pathogenesis and resistance, molecular detection of pathogens; plant-microbe beneficial interactions.

Ecology and Plant Geography: Ecosystems - types, dynamics, degradation, ecological succession; food chains; vegetation types of the world; pollution and global warming; speciation and extinction, conservation strategies, cryopreservation.

SECTION L. MICROBIOLOGY

Historical perspective - Discovery of the microbial world; Controversy over spontaneous generation; Role of microorganisms in transformation of organic matter and in the causation of diseases.

Methods in microbiology - Pure culture techniques; Theory and practice of sterilization; Principles of microbial nutrition; Construction of culture media; Enrichment culture techniques for isolation of chemoautotrophs, chemoheterotrophs and photosynthetic microorganisms.

Microbial evolution, systematics and taxonomy - Evolution of earth and earliest life forms; Primitive organisms and their metabolic strategies; New approaches to bacterial taxonomic classification including ribotyping; Nomenclature.

Microbial diversity - Bacteria, archea and their broad classification; Eukaryotic microbes, yeast, fungi, slime mold and protozoa; Viruses and their classification.

Microbial growth -The definition of growth, mathematical expression of growth, growth curve, measurement of growth and growth yields; Synchronous growth; Continuous culture.

Nutrition and metabolism - Overview of metabolism; Microbial nutrition; Energy classes of microorganisms; Culture media; Energetics, modes of ATP generation; ATP generation by heterotrophs; Fermentation; Glycolysis; Respiration; The citric acid cycle; Electron transport systems; Alternate modes of energy generation; Pathways (anabolism) in the biosynthesis of amino acids, purines, pyrimidines and fatty acids.

Metabolic diversity among microorganisms - Photosynthesis in microorganisms; Role of chlorophylls, carotenoids and phycobilins; Calvin cycle; Chemolithotrophy; Hydrogen- iron-nitrite-oxidizing bacteria; Nitrate and sulfate reduction; Methanogenesis and acetogenesis.

Prokaryotic cells: structure-function - Cells walls of eubacteria (peptidoglycan) and related molecules; Outer-membrane of gram-negative bacteria; Cell wall and cell membrane synthesis; Flagella and motility; Cell inclusions like endospores, gas vesicles.

Microbial diseases and host parasite relationships - Normal microflora of skin; Oral cavity; Gastrointestinal tract; Entry of pathogens into the host; Infectious disease transmission; Respiratory infections caused by bacteria and viruses; Tuberculosis; Sexually transmitted diseases including AIDS; Diseases transmitted by animals (Rabies, plague), insects and ticks (rikettsias, Lyme disease, malaria); Food and water borne diseases; Public health and water quality; Pahtogenic fungi; Emerging and resurgent infectious diseases.

Chemotherapy/Antibiotics - Antimicrobial agents; Sulfa drugs; Antibiotics; Pencillins and cephalosporins; Broad-spectrum antibiotics; Antibiotics from prokaryotes; Antifungal antibiotics; Mode of action; Resistance to antibiotics.

Microbial genetics - Genes, mutation and mutagenesis - UV and chemical mutagnes; Types of mutations; Ames test for mutagenesis; Methods of genetic analysis. Bacterial genetic system - Transformation; Conjugation; Transduction; Recombination; Plasmids and Transposons; Bacterial genetic map with reference to E. coli. Viruses and their genetic system - Phage ? and its life cycle; RNA phages; RNA viruses; Retroviruses; Genetic systems of yeast and Neurospora; Extrachromosomal inheritance and mitochondrial genetics; Basic concept of genomics.

SECTION M. ZOOLOGY

Animal world: Animal diversity, distribution, systematic and classification of animals, the phylogenetic relationship.

Evolution: Origin of life, history of life on earth, evolutionary theories, natural selection, adaptation, speciation.

Genetics: Principles of inheritance, molecular basis of heredity, the genetic material, transmission of genetic material, mutations, cytoplasmic inheritance.

Biochemistry and Molecular Biology: Nucleic acids, proteins and other biological macromolecules. Replication, transcription and translation, regulation of gene expression, organization of genome, Kreb's cycle, glycolysis, enzyme catalysis, hormones and their action.

Cell Biology: Structure of cell, cellular organelles and their structure and function, cell cycle, cell division, cellular differentiation, chromosome and chromatin structure. Eukaryotic gene organisation and expression.

Animal Anatomy and Physiology: Comparative physiology, the respiratory system, circulatory system, digestive system, the nervous system, the excretory system, the endocrine system, the reproductive system, the skeletal system, osmoregulation.

Parasitology and Immunology: Nature of parasite, host-parasite relation, protozoan and helminthic parasites, the immune response, cellular and humoral immune response, evolution of the immune system.

Development Biology: Embryonic development, cellular differentiation, organogenesis, metamorphosis, genetic basis of development.

Ecology: The ecosystem, habitats the food chain, population dynamics, species diversity, zoogeography, biogeochemical cycles, conservation biology.

Animal Behaviour: Types of behaviours, courtship, mating and territoriality, instinct, learning and memory, social behaviour across the animal taxa, communication, pheromones, evolution of animal behaviour.

IT - INFORMATION TECHNOLOGY

ENGINEERING MATHEMATICS

Mathematical Logic: Propositional Logic; First Order Logic.

Probability: Conditional Probability; Mean, Median, Mode and Standard Deviation; Random Variables; Distributions; uniform, normal, exponential, Poisson, Binomial.

Set Theory & Algebra: Sets; Relations; Functions; Groups; Partial Orders; Lattice; Boolean Algebra.

Combinatorics: Permutations; Combinations; Counting; Summation; generating functions; recurrence relations; asymptotics.

Graph Theory: Connectivity; spanning trees; Cut vertices & edges; covering; matching; independent sets; Colouring; Planarity; Isomorphism.

Linear Algebra: Algebra of matrices, determinants, systems of linear equations, Eigen values and Eigen vectors.

Numerical Methods: LU decomposition for systems of linear equations; numerical solutions of non linear algebraic equations by Secant, Bisection and Newton-Raphson Methods; Numerical integration by trapezoidal and Simpson's rules.

Calculus: Limit, Continuity & differentiability, Mean value Theorems, Theorems of integral calculus, evaluation of definite & improper integrals, Partial derivatives, Total derivatives, maxima & minima.

FORMAL LANGUAGES AND AUTOMATA

Regular Languages: finite automata, regular expressions, regular grammar.

Context free languages: push down automata, context free grammars

COMPUTER HARDWARE

Digital Logic: Logic functions, minimization, design and synthesis of combinatorial and sequential circuits, number representation and computer arithmetic (fixed and floating point)

Computer organization: Machine instructions and addressing modes, ALU and data path, hardwired and microprogrammed control, memory interface, I/O interface (interrupt and DMA mode), serial communication interface, instruction pipelining, cache, main and secondary storage

SOFTWARE SYSTEMS

Data structures and Algorithms: the notion of abstract data types, stack, queue, list, set, string, tree, binary search tree, heap, graph, tree and graph traversals, connected components, spanning trees, shortest paths, hashing, sorting, searching, design techniques (greedy, dynamic, divide and conquer), asymptotic analysis (best, worst, average cases) of time and space, upper and lower bounds, intractability

Programming Methodology: C programming, program control (iteration, recursion, functions), scope, binding, parameter passing, elementary concepts of object oriented programming

Operating Systems (in the context of Unix): classical concepts (concurrency, synchronization, deadlock), processes, threads and interprocess communication, CPU scheduling, memory management, file systems, I/O systems, protection and security

Information Systems and Software Engineering: information gathering, requirement and feasibility analysis, data flow diagrams, process specifications, input/output design, process life cycle, planning and managing the project, design, coding, testing, implementation, maintenance.

Databases: relational model, database design, integrity constraints, normal forms, query languages (SQL), file structures (sequential, indexed), b-trees, transaction and concurrency control

Data Communication: data encoding and transmission, data link control, multiplexing, packet switching, LAN architecture, LAN systems (Ethernet, token ring), Network devices: switches, gateways, routers

Networks: ISO/OSI stack, sliding window protocols, routing protocols, TCP/UDP, application layer protocols & systems (http, smtp, dns, ftp), network security

Web technologies: three tier web based architecture; JSP, ASP, J2EE, .NET systems; html, XML

AG - AGRICULTURAL ENGINEERING

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

FARM MACHINERY AND POWER:

Sources of power on the farm-human, animal, mechanical, electrical, wind, solar and biomass; design and selection of machine elements - gears, pulleys, chains and sprockets and belts; overload safety devices used in farm machinery; measurement of force, torque, speed, displacement and acceleration on machine elements.

Soil tillage; forces acting on a tillage tool; hitch systems and hitching of tillage implements; functional requirements, principles of working, construction and operation of manual, animal and power operated equipment for tillage. sowing, planting, fertilizer application, inter-cultivation, spraying, mowing, chaff cutting, harvesting, threshing and transport; testing of agricultural machinery and equipment; calculation of performance parameters -field capacity, efficiency, application rate and losses; cost analysis of implements and tractors.

Thermodynamic principles of I.C. engines; I.C. engine cycles; engine components; fuels and combustion; lubricants and their properties; I.C. engine systems - fuel, cooling, lubrication, ignition, electrical, intake and exhaust; selection, operation, maintenance and repair of I.C.

engines; power efficiencies and measurement; calculation of power, torque, fuel consumption, heat load and power losses.

Tractors and power tillers - type, selection, maintenance and repair; tractor clutches and brakes; power transmission systems - gear trains, differential, final drives and power take-off; mechanics of tractor chassis; traction theory; three point hitches- free link and restrained link operations; mechanical steering and hydraulic control systems used in tractors; human engineering and safety in tractor design; tractor tests and performance.

SOIL AND WATER CONSERVATION ENGINEERING:

Ideal and real fluids, properties of fluids; hydrostatic pressure and its measurement; hydrostatic forces on plane and curved surface; continuity equation; Bernoulli's theorem; laminar and turbulent flow in pipes, Darcy-Weisbach and Hazen-Williams equations, Moody's diagram; flow through orifices and notches; flow in open channels.

Engineering properties of soils, fundamental definitions and relationships; index properties of soils; permeability and seepage analysis; shear strength, Mohr's circle of stresses; active and passive earth pressures; stability of slopes.

Hydrological cycle; precipitation measurement, analysis of precipitation data; abstraction from precipitation; runoff; hydrograph analysis, unit hydrograph theory and application; stream flow measurement; flood routing, hydrological reservoir and channel routing.

Mechanics of soil erosion, factors affecting erosion; soil loss estimation; biological and engineering measures to control erosion, terraces and bunds; vegetative waterways; gully control structures, drop, drop inlet and chute spillways; farm ponds; earthen dams; principles of watershed management.

Water requirement of crops; consumptive use and evapo-transpiration; irrigation scheduling; irrigation efficiencies; design of prismatic and silt loaded channels; methods of irrigation water application; design and evaluation of irrigation methods; drainage coefficient; surface and subsurface drainage systems; leaching requirement and salinity control; irrigation and drainage water quality; classification of pumps; pump characteristics; pump selection; types of aquifer; evaluation of aquifer properties; well hydraulics; ground water recharge.

AGRICULTURAL PROCESSING AND FOOD ENGINEERING:

Steady state heat transfer in conduction, convection and radiation; transient heat transfer in simple geometry; condensation and boiling heat transfer; working principles of heat exchangers; diffusive and convective mass transfer; simultaneous heat and mass transfer in agricultural processing operations.

Material and energy balances in food processing systems; water activity, sorption and desorption isotherms; centrifugal separation of solids, liquids and gases; kinetics of microbial death - pasteurisation and sterilization of liquid foods; preservation of food by cooling and freezing; psychrometry - properties of air-vapour mixture; concentration and dehydration of liquid foods - evaporators, tray, drum and spray dryers.

Mechanics and energy requirement in size reduction of granular solids; particle size analysis for comminuted solids; size separation by screening; fluidisation of granular solids; cleaning and grading efficiency and effectiveness of grain cleaners; conditioning and hydrothermal treatments for grains; dehydration of food grains; processes and machines for processing of cereals, pulses and oilseeds; design considerations for grain silos.

AR - ARCHITECTURE AND PLANNING

City planning: Historical development of cities; principles of city planning; new towns; survey methods, site planning, planning regulations and building bye-laws.

Housing: Concept of shelter; housing policies and design; community planning; role of government agencies; finance and management.

Landscape Design: Principles of landscape design and site planning; history and landscape styles; landscape elements and materials; planting design.

Computer Aided Design: Application of computers in architecture and planning; understanding elements of hardware and software; computer graphics; programming languages - C and Visual Basic and usage of packages such as AutoCAD.

Environmental and Building Science: Elements of environmental science; ecological principles concerning environment; role of micro-climate in design; climatic control through design elements; thermal comfort; elements of solar architecture; principles of lighting and illumination; basic principles of architectural acoustics; air pollution, noise pollution and their control.

Visual and Urban Design: Principles of visual composition; proportion, scale, rhythm, symmetry, harmony, balance, form and colour; sense of place and space, division of space; focal point, vista, imageability, visual survey.

History of Architecture: Indian - Indus valley, Vedic, Buddhist, Indo-Aryan, Dravidian and Mughal periods; European - Egyptian, Greek, Roman, medieval and renaissance periods.

Development of Contemporary Architecture: Architectural developments and impacts on society since industrial revolution; influence of modern art on architecture; works of national and international architects; post modernism in architecture.

Building Services: Water supply, Sewerage and Drainage systems; Sanitary fittings and fixtures; principles of electrification of buildings; elevators, their standards and uses; air-conditioning systems; fire fighting systems.

Building Construction and Management: Building construction techniques, methods and details; building systems and prefabrication of building elements; principles of modular coordination; estimation, specification, valuation, professional practice; project management, PERT, CPM.

Materials and Structural Systems: Behavioural characteristics of all types of building materials e.g. mud, timber, bamboo, brick, concrete, steel, glass, FRP; principles of strength of materials; design of structural elements in wood, steel and RCC; elastic and limit state design; complex structural systems; principles of pre-stressing.

Planning Theory: Planning process; multilevel planning; comprehensive planning; central place theory; settlement pattern; land use and land utilization.

Techniques of Planning: Planning surveys; Preparation of urban and regional structure plans, development plans, action plans; site planning principles and design; statistical methods; application of remote sensing techniques in urban and regional planning.

Traffic and Transportation Planning: Principles of traffic engineering and transportation planning; methods of conducting surveys; design of roads, intersections and parking areas; hierarchy of roads and levels of services; traffic and transport management in urban areas; traffic safety and traffic laws; public transportation planning; modes of transportation.

Services and Amenities: Principles and design of water supply systems, sewerage systems, solid waste disposal systems, power supply and communication systems; Health, education, recreation and demography related standards at various levels of the settlements.

Development Administration and Management: Planning laws; development control and zoning regulations; laws relating to land acquisition; development enforcements, land ceiling; regional and urban plan preparations; planning and municipal administration; taxation, revenue resources and fiscal management; public participation and role of NGO.

CE - CIVIL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

STRUCTURAL ENGINEERING

Mechanics: Bending moments and shear forces in statically determinate beams; simple stress and strain: relationship; stress and strain in two dimensions, principal stresses, stress transformation, Mohr's circle; simple bending theory; flexural shear stress; thin-walled pressure vessels; uniform torsion.

Structural Analysis: Analysis of statically determinate trusses, arches and frames; displacements in statically determinate structures and analysis of statically indeterminate structures by force/energy methods; analysis by displacement methods (slope-deflection and moment-distribution methods); influence lines for determinate and indeterminate structures; basic concepts of matrix methods of structural analysis.

Concrete Structures: Basic working stress and limit states design concepts; analysis of ultimate load capacity and design of members subject to flexure, shear, compression and torsion (beams, columns and isolated footings); basic elements of prestressed concrete: analysis of beam sections at transfer and service loads.

Steel Structures: Analysis and design of tension and compression members, beams and beam-columns, column bases; connections - simple and eccentric, beam-column connections, plate girders and trusses; plastic analysis of beams and frames.

GEOTECHNICAL ENGINEERING

Soil Mechanics: Origin of soils; soil classification; three-phase system, fundamental definitions, relationship and inter-relationships; permeability and seepage; effective stress principle: consolidation, compaction; shear strength.

Foundation Engineering: Sub-surface investigation - scope, drilling bore holes, sampling, penetrometer tests, plate load test; earth pressure theories, effect of water table, layered soils; stability of slopes - infinite slopes, finite slopes; foundation types - foundation design requirements; shallow foundations; bearing capacity, effect of shape, water table and other factors, stress distribution, settlement analysis in sands and clays; deep foundations - pile types, dynamic and static formulae, load capacity of piles in sands and clays.

WATER RESOURCES ENGINEERING

Fluid Mechanics and Hydraulics: Hydrostatics, applications of Bernoulli equation, laminar and turbulent flow in pipes, pipe networks; concept of boundary layer and its growth; uniform flow, critical flow and gradually varied flow in channels, specific energy concept, hydraulic jump; forces on immersed bodies; flow measurement in channels; tanks and pipes; dimensional analysis and hydraulic modeling. Applications of momentum equation, potential flow, kinematics of flow; velocity triangles and specific speed of pumps and turbines.

Hydrology: Hydrologic cycle; rainfall; evaporation infiltration, unit hydrographs, flood estimation, reservoir design, reservoir and channel routing, well hydraulics.

Irrigation: Duty, delta, estimation of evapo-transpiration; crop water requirements; design of lined and unlined canals; waterways; head works, gravity dams and Ogee spillways. Designs of weirs on permeable foundation, irrigation methods.

ENVIRONMENTAL ENGINEERING

Water requirements; quality and standards, basic unit processes and operations for water treatment, distribution of water. Sewage and sewerage treatment: quantity and characteristic of waste water sewerage; primary and secondary treatment of waste water; sludge disposal; effluent discharge standards.

TRANSPORTATION ENGINEERING

Highway planning; geometric design of highways; testing and specifications of paving materials; design of flexible and rigid pavements.

CH - CHEMICAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

CHEMICAL ENGINEERING

Process Calculations and Thermodynamics: Laws of conservation of mass and energy; use of tie components; recycle, bypass and purge calculations; degree of freedom analysis.

First and Second laws of thermodynamics and their applications; equations of state and thermodynamic properties of real systems; phase equilibria; fugacity, excess properties and correlations of activity coefficients; chemical reaction equilibria.

Fluid Mechanics and Mechanical Operations: Fluid statics, Newtonian and non-Newtonian fluids, Bernoulli equation, Macroscopic friction factors, energy balance, dimensional analysis, shell balances, flow through pipeline systems, flow meters, pumps and compressors, packed and fluidized beds, elementary boundary layer theory, size reduction and size separation; free and hindered settling; centrifuge and cyclones; thickening and classification, filtration, mixing and agitation; conveying of solids.

Heat Transfer: Conduction, convection and radiation, heat transfer coefficients, steady and unsteady heat conduction, boiling, condensation and evaporation; types of heat exchangers and evaporators and their design.

Mass Transfer: Fick's law, molecular diffusion in fluids, mass transfer coefficients, film, penetration and surface renewal theories; momentum, heat and mass transfer analogies; stagewise and continuous contacting and stage efficiencies; HTU & NTU concepts design and operation of equipment for distillation, absorption, leaching, liquid-liquid extraction, crystallization, drying, humidification, dehumidification and adsorption.

Chemical Reaction Engineering: Theories of reaction rates; kinetics of homogeneous reactions, interpretation of kinetic data, single and multiple reactions in ideal reactors, non-ideal reactors; residence time; non-isothermal reactors; kinetics of heterogeneous catalytic reactions; diffusion effects in catalysis.

Instrumentation and Process Control: Measurement of process variables; sensors, transducers and their dynamics, dynamics of simple systems, dynamics such as CSTRs, transfer functions and responses of simple systems, process reaction curve, controller modes (P, PI, and PID); control valves; analysis of closed loop systems including stability, frequency response (including Bode plots) and controller tuning, cascade, feed forward control.

Plant Design and Economics: Design and sizing of chemical engineering equipment such as compressors, heat exchangers, multistage contactors; principles of process economics and cost estimation including total annualized cost, cost indexes, rate of return, payback period, discounted cash flow, optimization in Design.

Chemical Technology: Inorganic chemical industries; sulfuric acid, NaOH, fertilizers (Ammonia, Urea, SSP and TSP); natural products industries (Pulp and Paper, Sugar, Oil, and Fats); petroleum refining and petrochemicals; polymerization industries; polyethylene, polypropylene, PVC and polyester synthetic fibers.

CS - COMPUTER SCIENCE AND ENGINEERING

ENGINEERING MATHEMATICS

Mathematical Logic: Propositional Logic; First Order Logic.

Probability: Conditional Probability; Mean, Median, Mode and Standard Deviation; Random Variables; Distributions; uniform, normal, exponential, Poisson, Binomial.

Set Theory & Algebra: Sets; Relations; Functions; Groups; Partial Orders; Lattice; Boolean Algebra.

Combinatorics: Permutations; Combinations; Counting; Summation; generating functions; recurrence relations; asymptotics.

Graph Theory: Connectivity; spanning trees; Cut vertices & edges; covering; matching; independent sets; Colouring; Planarity; Isomorphism.

Linear Algebra: Algebra of matrices, determinants, systems of linear equations, Eigen values and Eigen vectors.

Numerical Methods: LU decomposition for systems of linear equations; numerical solutions of non linear algebraic equations by Secant, Bisection and Newton-Raphson Methods; Numerical integration by trapezoidal and Simpson's rules.

Calculus: Limit, Continuity & differentiability, Mean value Theorems, Theorems of integral calculus, evaluation of definite & improper integrals, Partial derivatives, Total derivatives, maxima & minima.

THEORY OF COMPUTATION

Formal Languages and Automata Theory: Regular languages and finite automata, Context free languages and Push-down automata, Recursively enumerable sets and Turing machines, Undecidability;

Analysis of Algorithms and Computational Complexity: Asymptotic analysis (best, worst, average case) of time and space, Upper and lower bounds on the complexity of specific problems, NP-completeness.

COMPUTER HARDWARE

Digital Logic: Logic functions, Minimization, Design and synthesis of Combinational and Sequential circuits; Number representation and Computer Arithmetic (fixed and floating point);

Computer Organization: Machine instructions and addressing modes, ALU and Data-path, hardwired and micro-programmed control, Memory interface, I/O interface (Interrupt and DMA mode), Serial communication interface, Instruction pipelining, Cache, main and secondary storage.

SOFTWARE SYSTEMS

Data structures: Notion of abstract data types, Stack, Queue, List, Set, String, Tree, Binary search tree, Heap, Graph;

Programming Methodology: C programming, Program control (iteration, recursion, Functions), Scope, Binding, Parameter passing, Elementary concepts of Object oriented, Functional and Logic Programming;

Algorithms for problem solving: Tree and graph traversals, Connected components, Spanning trees, Shortest paths; Hashing, Sorting, Searching; Design techniques (Greedy, Dynamic Programming, Divide-and-conquer);

Compiler Design: Lexical analysis, Parsing, Syntax directed translation, Runtime environment, Code generation, Linking (static and dynamic); Operating Systems: Classical concepts (concurrency, synchronization, deadlock), Processes, threads and Inter-process communication, CPU scheduling, Memory management, File systems, I/O systems, Protection and security.

Databases: Relational model (ER-model, relational algebra, tuple calculus), Database design (integrity constraints, normal forms), Query languages (SQL), File structures (sequential files, indexing, B+ trees), Transactions and concurrency control;

Computer Networks: ISO/OSI stack, sliding window protocol, LAN Technologies (Ethernet, Token ring), TCP/UDP, IP, Basic concepts of switches, gateways, and routers.

CH - CHEMISTRY

PHYSICAL CHEMISTRY

Structure: Quantum theory - principles and techniques; applications to particle in a box, harmonic oscillator, rigid rotor and hydrogen atom; valence bond and molecular orbital theories and Huckel approximation, approximate techniques: variation and perturbation; symmetry, point groups; rotational, vibrational, electronic, NMR and ESR spectroscopy.

Equilibrium: First law of thermodynamics, heat, energy and work; second law of thermodynamics and entropy; third law and absolute entropy; free energy; partial molar quantities; ideal and non-ideal solutions; phase transformation: phase rule and phase diagrams- one, two, and three component systems; activity, activity coefficient, fugacity and fugacity coefficient ; chemical equilibrium, response of chemical equilibrium to temperature and pressure; colligative properties; kinetic theory of gases; thermodynamics of electrochemical cells; standard electrode potentials: applications - corrosion and energy conversion; molecular partition function (translational, rotational, vibrational and electronic).

Kinetics: Rates of chemical reactions, theories of reaction rates, collision and transition state theory; temperature dependence of chemical reactions; elementary reactions, consecutive elementary reactions; steady state approximation, kinetics of photochemical reactions and free radical polymerization, homogenous and heterogeneous catalysis.

INORGANIC CHEMISTRY

Non-Transition Elements: General characteristics, structure and reactions of simple and industrially important compounds, boranes, carboranes, silicates, silicones, diamond and graphite; hydrides, oxides and oxoacids of N, P, S and halogens; boron nitride, borazines and phosphazenes; xenon compounds. Shapes of molecules, hard-soft acid base concept.

Transition Elements: General characteristics of d and f block elements; coordination chemistry: structure and isomerism, stability, theories of metal-ligand bonding (CFT and LFT), electronic spectra and magnetic properties of transition metal complexes and lanthanides; metal carbonyls, metal-metal bonds and metal atom clusters, metallocenes; transition metal complexes with bonds to hydrogen, alkyls, alkenes, and arenes; metal carbenes; use of organometallic compounds as catalysts in organic synthesis; mechanisms of substitution and electron transfer reactions of coordination complexes. Role of metals with special reference to Na, K, Mg, Ca, Fe, Co, Zn, and Mo in biological systems.

Solids: Crystal systems and lattices, Miller planes, crystal packing, crystal defects; Bragg's Law; ionic crystals, band theory, metals and semiconductors. Spinels.

Instrumental methods of analysis: atomic absorption, UV-visible spectrometry, chromatographic and electro-analytical methods.

ORGANIC CHEMISTRY

Synthesis, reactions and mechanisms involving the following: Alkenes, alkynes, arenes, alcohols, phenols, aldehydes, ketones, carboxylic acids and their derivatives; halides, nitro compounds and amines; stereochemical and conformational effects on reactivity and specificity; reactions with diborane and peracids. Michael reaction, Robinson annulation, reactivity umpolung, acyl anion equivalents; molecular rearrangements involving electron deficient atoms.

Photochemistry: Basic principles, photochemistry of olefins, carbonyl compounds, arenes, photo oxidation and reduction.

Pericyclic reactions: Cycloadditions, electrocyclic reactions, sigmatropic reactions; Woodward-Hoffmann rules.

Heterocycles: Structural properties and reactions of furan, pyrrole, thiophene, pyridine, indole.

Biomolecules: Structure, properties and reactions of mono- and di-saccharides, physico-chemical properties of amino acids, structural features of proteins and nucleic acids.

Spectroscopy: Principles and applications of IR, UV-visible, NMR and mass spectrometry in the determination of structures of organic compounds.

EC - ELECTRONICS AND COMMUNICATION ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix Algebra, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Mean value theorems, Theorems of integral calculus, Evaluation of definite and improper integrals, Partial Derivatives, Maxima and minima, Multiple integrals, Fourier series. Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equation (linear and nonlinear), Higher order linear differential equations with constant coefficients, Method of variation of parameters, Cauchy's and Euler's equations, Initial and boundary value problems, Partial Differential Equations and variable separable method.

Complex variables: Analytic functions, Cauchy's integral theorem and integral formula, Taylor's and Laurent' series, Residue theorem, solution integrals.

Probability and Statistics: Sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Discrete and continuous distributions, Poisson, Normal and Binomial distribution, Correlation and regression analysis.

Numerical Methods: Solutions of non-linear algebraic equations, single and multi-step methods for differential equations.

Transform Theory: Fourier transform, Laplace transform, Z-transform.

ELECTRONICS & COMMUNICATION ENGINEERING

Networks: Network graphs: matrices associated with graphs; incidence, fundamental cut set and fundamental circuit matrices. Solution methods: nodal and mesh analysis. Network theorems: superposition, Thevenin and Norton's maximum power transfer, Wye-Delta transformation. Steady state sinusoidal analysis using phasors. Linear constant coefficient differential equations; time domain analysis of simple RLC circuits, Solution of network equations using Laplace transform: frequency domain analysis of RLC circuits. 2-port network parameters: driving point and transfer functions. State equations for networks.

Electronic Devices: Energy bands in silicon, intrinsic and extrinsic silicon. Carrier transport in silicon: diffusion current, drift current, mobility, resistivity. Generation and recombination of carriers. p-n junction diode, Zener diode, tunnel diode, BJT, JFET, MOS capacitor, MOSFET, LED, p-I-n and avalanche photo diode, LASERs. Device technology: integrated circuits fabrication process, oxidation, diffusion, ion implantation, photolithography, n-tub, p-tub and twin-tub CMOS process.

Analog Circuits: Equivalent circuits (large and small-signal) of diodes, BJTs, JFETs, and MOSFETs. Simple diode circuits, clipping, clamping, rectifier. Biasing and bias stability of transistor and FET amplifiers. Amplifiers: single-and multi-stage, differential, operational, feedback and power. Analysis of amplifiers; frequency response of amplifiers. Simple op-amp circuits. Filters. Sinusoidal oscillators; criterion for oscillation; single-transistor and op-amp configurations. Function generators and wave-shaping circuits. Power supplies.

Digital circuits: Boolean algebra, minimization of Boolean functions; logic gates digital IC families (DTL, TTL, ECL, MOS, CMOS). Combinational circuits: arithmetic circuits, code converters, multiplexers and decoders. Sequential circuits: latches and flip-flops, counters and shift-registers. Sample and hold circuits, ADCs, DACs. Semiconductor memories. Microprocessor(8085): architecture, programming, memory and I/O interfacing.

Signals and Systems: Definitions and properties of Laplace transform, continuous-time and discrete-time Fourier series, continuous-time and discrete-time Fourier Transform, z-transform. Sampling theorems. Linear Time-Invariant (LTI) Systems: definitions and properties; casuality, stability, impulse response, convolution, poles and zeros frequency response, group delay, phase delay. Signal transmission through LTI systems. Random signals and noise: probability, random variables, probability density function, autocorrelation, power spectral density.

Controls Systems: Basic control system components; block diagrammatic description, reduction of block diagrams. Open loop and closed loop (feedback) systems and stability analysis of these systems. Signal flow graphs and their use in determining transfer functions of systems; transient and steady state analysis of LTI control systems and frequency response. Tools and techniques for LTI control system analysis: root loci, Routh-Hurwitz criterion, Bode and Nyquist plots. Control system compensators: elements of lead and lag compensation, elements of Proportional-Integral-Derivative(PID) control. State variable representation and solution of state equation of LTI control systems.

Communications: Analog communication systems: amplitude and angle modulation and demodulation systems, spectral analysis of these operations, superheterodyne receivers; elements of hardware, realizations of analog communication systems; signal-to-noise ratio (SNR) calculations for amplitude modulation (AM) and frequency modulation (FM) for low noise conditions. Digital communication systems: pulse code modulation (PCM), differential pulse code modulation (DPCM), delta modulation (DM); digital modulation schemes-amplitude, phase and frequency shift keying schemes (ASK, PSK, FSK), matched filter receivers, bandwith consideration and probability of error calculations for these schemes.

Electromagnetics: Elements of vector calculus: divergence and curl; Gauss' and Stokes' theorems, Maxwell's equations: differential and integral forms. Wave equation, Poynting vector. Plane waves: propagation through various media; reflection and refraction; phase and group velocity; skin depth. Transmission lines: characteristic impedance; impedance transformation; Smith chart; impedance matching; pulse excitation. Waveguides: modes in rectangular waveguides; boundary conditions; cut-off frequencies; dispersion relations. Antennas: Dipole antennas; antenna arrays; radiation pattern; reciprocity theorem, antenna gain.

EE - ELECTRICAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix Algebra, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Mean value theorems, Theorems of integral calculus, Evaluation of definite and improper integrals, Partial Derivatives, Maxima and minima, Multiple integrals, Fourier series. Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equation (linear and nonlinear), Higher order linear differential equations with constant coefficients, Method of variation of parameters, Cauchy's and Euler's equations, Initial and boundary value problems, Partial Differential Equations and variable separable method.

Complex variables: Analytic functions, Cauchy's integral theorem and integral formula, Taylor's and Laurent' series, Residue theorem, solution integrals.

Probability and Statistics: Sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Discrete and continuous distributions, Poisson, Normal and Binomial distribution, Correlation and regression analysis.

Numerical Methods: Solutions of non-linear algebraic equations, single and multi-step methods for differential equations.

Transform Theory: Fourier transform, Laplace transform, Z-transform.

ELECTRICAL ENGINEERING

Electrical Circuits and Fields: Network graph, KCL, KVL, node/ cut set, mesh/ tie set analysis, transient response of d.c. and a.c. networks; sinusoidal steady-state analysis; resonance in electrical circuits; concepts of ideal voltage and current sources, network theorems, driving point, immittance and transfer functions of two port networks, elementary concepts of filters; three phase circuits; Fourier series and its application; Gauss theorem, electric field intensity and potential due to point, line, plane and spherical charge distribution, dielectrics, capacitance calculations for simple configurations; Ampere's and Biot-Savart's law, inductance calculations for simple configurations.

Electrical Machines: Single phase transformer - equivalent circuit, phasor diagram, tests, regulation and efficiency; three phase transformers - connections, parallel operation; auto transformer and three-winding transformer; principles of energy conversion, windings of rotating machines: D. C. generators and motors - characteristics, starting and speed control, armature reaction and commutation; three phase induction motors-performance characteristics, starting and speed control; single-phase induction motors; synchronous generators-performance, regulation, parallel operation; synchronous motors - starting, characteristics, applications, synchronous condensers; fractional horse power motors; permanent magnet and stepper motors.

Power Systems: Electric power generation - thermal, hydro, nuclear; transmission line parameters; steady-state performance of overhead transmission lines and cables and surge propagation; distribution systems, insulators, bundle conductors, corona and radio interference effects; per-unit quantities; bus admittance and impedance matrices; load flow; voltage control and power factor correction; economic operation; symmetrical components, analysis of symmetrical and unsymmetrical faults; principles of over current, differential and distance protections; concept of solid state relays and digital protection; circuit breakers; concept of system stability-swing curves and equal area criterion; basic concepts of HVDC transmission.

Control Systems: Principles of feedback; transfer function; block diagrams: steady-state errors; stability-Routh and Nyquist criteria; Bode plots; compensation; root loci; elementary state variable formulation; state transition matrix and response for Linear Time Invariant systems.

Electrical and Electronic Measurements: Bridges and potentiometers, PMMC, moving iron, dynamometer and induction type instruments; measurement of voltage, current, power, energy and power factor; instrument transformers; digital voltmeters and multimeters; phase, time and frequency measurement; Q-meter, oscilloscopes, potentiometric recorders, error analysis.

Analog and Digital Electronics: Characteristics of diodes, BJT, FET, SCR; amplifiers-biasing, equivalent circuit and frequency response; oscillators and feedback amplifiers, operational amplifiers- characteristics and applications; simple active filters; VCOs and timers; combinational and sequential logic circuits, multiplexer, Schmitt trigger, multivibrators, sample and hold circuits, A/D and D/A converters; microprocessors and their applications.

Power Electronics and Electric Drives: Semiconductor power devices-diodes, transistors, thyristors, triacs, GTOs, MOSFETs and IGBTs - static characteristics and principles of operation; triggering circuits; phase control rectifiers; bridge converters-fully controlled and half controlled; principles of choppers and inverters, basic concepts of adjustable speed dc and ac drives.

GG - GEOLOGY AND GEOPHYSICS

PART - I

Earth and planetary system; size, shape, internal structure and composition of the earth; atmosphere and greenhouse effect; isostasy; elements of seismology; continents and continental processes; physical oceanography; palaeomagnetism, continental drift plate tectonics, geothermal energy.

Weathering; soil formation; action of river, wind and glacier; oceans and oceanic features; earthquakes, volcanoes, orogeny and mountain building; elements of structural geology; crystallography; classification, composition and properties of minerals and rocks; engineering properties of rocks and soils, role of geology in the construction of engineering structures.

Processes of ore formation, occurrence and distribution of ores on land and on ocean floor; coal and petroleum resources in India; ground water geology including well hydraulics, geological time scale and geochronology; stratigraphic principles and stratigraphy of India; basics concepts of gravity, magnetic and electrical prospecting for ores and ground water.

PART - IIA: GEOLOGY

Crystal symmetry, forms, twinning; crystal chemistry; optical mineralogy, classification of minerals, diagnostic properties of rock minerals.

Mineralogy, structure, texture and classification of igneous, sedimentary and metamorphic rock, their origin and evolution; application of thermodynamics; structure and petrology of sedimentary rocks; sedimentary processes and environments, sedimentary facies, basin studies; basement cover relationship;

Primary and secondary structures; geometry and genesis of folds, faults, joints, unconformities, cleavage, schistosity and lineation; methods of projection. Tectonites and their significance; shear zone; superposed folding.

Morphology, classification and geological significance of important invertebrates, vertebrates, microfossils and palaeoflora; stratigraphic principles and Indian stratigraphy; geomorphic processes and agents; development and evolution of landforms; slope and drainage; processes on deep oceanic and near-shore regions; quantitative and applied geomorphology; air photo interpretation and remote sensing; chemical and optical properties of ore minerals; formation and localization of ore deposits; prospecting and exploration of economic minerals; coal and petroleum geology; origin and distribution of mineral and fuel deposits in India; ore dressing and mineral economics.

Cosmic abundance; meteorites; geochemical evolution of the earth; geochemical cycles;

distribution of major, minor and trace elements; isotope geochemistry; geochemistry of waters including solution equilibria and water rock interaction.

Engineering properties of rocks and soils; rocks as construction material; geology of dams, tunnels and excavation sites; natural hazards; the fly ash problem; ground water geology and exploration; water quality; impact of human activity; Remote sensing techniques for the interpretation of landforms and resource management.

PART - II B: GEOPHYSICS

The earth as a planet; different motions of the earth; gravity filed of the earth and its shape; geochronology; isostasy, seismology and interior of the earth; variation of density, velocity, pressure, temperature, electrical and magnetic properties inside the earth; earthquakes-causes and measurements; zonation and seismic hazards; geomagnetic field, palaeomagnetism; oceanic and continental lithosphere; plate tectonics; heat flow; upper and lower atmospheric phenomena.

Theories of scalar and vector potential fields; Laplace, Maxwell and Helmholtz equations for solution of different types of boundary value problems for Cartesian, cylindrical and spherical polar coordinates; Green's theorem; Image theory; integral equations and conformal transformations in potential theory; Eikonal equation and ray theory.

'G' and 'g' units of measurement, density of rocks, gravimeters, preparation, analysis and interpretation of gravity maps; derivative maps, analytical continuation; gravity anomaly type curves; calculation of mass.

Earth's magnetic field, units of measurement, magnetic susceptibility of rocks, magnetometers, corrections, preparation of magnetic maps, magnetic anomaly type curve, analytical continuation, interpretation and application; magnetic well logging.

Conduction of electricity through rocks, electrical conductivities of metals, metallic, non-metallic and rock forming minerals, D.C. resistivity units and methods of measurement, electrode configuration for sounding and profiling, application of filter theory, interpretation of resistivity field data, application; self potential origin, classification, field measurement, interpretation of induced polarization time frequency, phase domain; IP units and methods of measurement, interpretation and application; ground-water exploration.

Origin of electromagnetic field elliptic polarization, methods of measurement for different source-receiver configuration components in EM measurements, interpretation and applications; earth's natural electromagnetic field, tellurics, magneto-tellurics; geomagnetic depth sounding principles, methods of measurement, processing of data and interpretation.

Seismic methods of prospecting: Reflection, refraction and CDP surveys; land and marine seismic sources, generation and propagation of elastic waves, velocity increasing with depth, geophones, hydrophones, recording instruments (DFS), digital formats, field layouts, seismic noises and noise profile analysis, optimum geophone grouping, noise cancellation by shot and geophone arrays, 2D and 3D seismic data acquisition and processing, CDP stacking charts, binning, filtering, dip-moveout, static and dynamic corrections, deconvolution, migration, signal processing, Fourier and Hilbert transforms, attribute analysis, bright and dim spots, seismic stratigraphy, high resolution seismics, VSP.

Principles and techniques of geophysical well-logging, SP, resistivity, induction, micro gamma ray, neutron, density, sonic, temperature, dip meter, caliper, nuclear magnetic, cement bond logging. Quantitative evaluation of formations from well logs; well hydraulics and application of geophysical methods for groundwater study; application of bore hole geophysics in ground water, mineral and oil exploration. Remote sensing techniques and application of remote sensing methods in geophysics.

IN - INSTRUMENTATION ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix Algebra, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Mean value theorems, Theorems of integral calculus, Evaluation of definite and improper integrals, Partial Derivatives, Maxima and minima, Multiple integrals, Fourier series. Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equation (linear and nonlinear), Higher order linear differential equations with constant coefficients, Method of variation of parameters, Cauchy's and Euler's equations, Initial and boundary value problems, Partial Differential Equations and variable separable method.

Complex variables: Analytic functions, Cauchy's integral theorem and integral formula, Taylor's and Laurent' series, Residue theorem, solution integrals.

Probability and Statistics: Sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Discrete and continuous distributions, Poisson, Normal and Binomial distribution, Correlation and regression analysis.

Numerical Methods: Solutions of non-linear algebraic equations, single and multi-step methods for differential equations.

Transform Theory: Fourier transform, Laplace transform, Z-transform.

INSTRUMENTATION ENGINEERING

Measurement Basics and Metrology: Static and dynamic characteristics of measurement systems. Standards and calibration. Error and uncertainty analysis, statistical analysis of data, and curve fitting. Linear and angular measurements; Measurement of straightness, flatness, roundness and roughness.

Transducers, Mechanical Measurements and Industrial Instrumentation: Transducers - elastic, resistive, inductive, capacitive, thermo-electric, piezoelectric, photoelectric, electro-mechanical, electro-chemical, and ultrasonic. Measurement of displacement, velocity (linear and rotational), acceleration, shock, vibration, force, torque, power, strain, stress, pressure, flow, temperature, humidity, viscosity, and density. energy storing elements, suspension systems and dampers.

Analog Electronics: Characteristics of diodes, BJTs, JFETs and MOSFETs; Diode circuits; Amplifiers: single and multi-stage, feedback; Frequency response; Operational amplifiers - design, characteristic, linear and non-linear applications: difference amplifiers; instrumentation amplifiers; precision rectifiers, I-to-V converters, active filters, oscillators, comparators, signal generators, wave shaping circuits.

Digital Electronics: Combinational logic circuits, minimization of Boolean functions; IC families (TTL, MOS, CMOS), arithmetic circuits, multiplexer and decoders. Sequential circuits: flip-flops, counters, shift registers. Schmitt trigger, timers, and multivibrators. Analog switches, multiplexers, S/H circuits. Analog-to-digital and digital-to-analog converters. Basics of computer organization and architecture. 8-bit microprocessor (8085), applications, memory, I/O interfacing, and microcontrollers.

Signals and Systems: Vectors and matrices; Fourier series; Fourier transforms; Ordinary differential equations. Impulse and frequency responses of first and second order systems. Laplace transform and transfer function, convolution and correlation. Amplitude and frequency modulations and demodulations. Discrete time systems, difference equations, impulse and frequency responses; Z-transforms and transfer functions; IIR and FIR filters.

Electrical and Electronic Measurements: Measurement of R, L and C; bridges and potentiometers. Measurement of voltage, current, power, power factor, and energy; Instrument transformers; Q meter, waveform analyzers. Digital volt-meters and multi-meters. Time, phase and frequency measurements; Oscilloscope. Noise and interference in instrumentation.

Control Systems & Process Control: Principles of feedback; transfer function, signal flow graphs. Stability criteria, Bode plots, root-loci, Routh and Nyquist criteria. Compensation techniques; State space analysis. System components: mechanical, hydraulic, pneumatic, electrical and electronic; Servos and synchros; Stepper motors. On-off, cascade, P, PI, PID and feed-forward controls. Controller tuning and general frequency response.

Analytical, Optical and Biomedical Instrumentation: Principles of spectrometry, UV, visible, IR mass spectrometry, X-ray methods; nuclear radiation measurements, gas, solid and semi conductor lasers and their characteristics, interferometers, basics of fibre optics, transducers in biomedical applications, cardiovascular system measurements, instrumentation for clinical laboratory.

MA - MATHEMATICS

Linear Algebra: Finite dimensional vector spaces. Linear transformations and their matrix representations, rank; systems of linear equations, eigenvalues and eigenvectors, minimal polynomial, Cayley-Hamilton theorem, diagonalisation, Hermitian, Skew-Hermitian and unitary matrices. Finite dimensional inner product spaces, self-adjoint and Normal linear operators, spectral theorem, Quadratic forms.

Complex Analysis: Analytic functions, conformal mappings, bilinear transformations, complex integration: Cauchy's integral theorem and formula, Liouville's theorem, maximum modulus principle, Taylor and Laurent's series, residue theorem and applications for evaluating real integrals.

Real Analysis: Sequences and series of functions, uniform convergence, power series, Fourier series, functions of several variables, maxima, minima, multiple integrals, line, surface and volume integrals, theorems of Green, Stokes and Gauss; metric spaces, completeness, Weierstrass approximation theorem, compactness. Lebesgue measure, measurable functions; Lebesgue integral, Fatou's lemma, dominated convergence theorem.

Ordinary Differential Equations: First order ordinary differential equations, existence and uniqueness theorems, systems of linear first order ordinary differential equations, linear ordinary differential equations of higher order with constant coefficients; linear second order ordinary differential equations with variable coefficients, method of Laplace transforms for solving ordinary differential equations, series solutions; Legendre and Bessel functions and their orthogonality, Sturm Liouville system, Greeen's functions.

Algebra: Normal subgroups and homomorphisms theorems, automorphisms. Group actions, sylow's theorems and their applications groups of order less than or equal to 20, Finite p-groups. Euclidean domains, Principal ideal domains and unique factorizations domains. Prime ideals and maximal ideals in commutative rings.

Functional Analysis: Banach spaces, Hahn-Banach theorems, open mapping and closed graph theorems, principle of uniform boundedness; Hilbert spaces, orthonormal sets, Riesz representation theorem, self-adjoint, unitary and normal linear operators on Hilbert Spaces.

Numerical Analysis: Numerical solution of algebraic and transcendental equations; bisection, secant method, Newton-Raphson method, fixed point iteration, interpolation: existence and error of polynomial interpolation, Lagrange, Newton, Hermite(osculatory)interpolations; numerical differentiation and integration, Trapezoidal and Simpson rules; Gaussian quadrature; (Gauss-Legendre and Gauss-Chebyshev), method of undetermined parameters, least square and orthonormal polynomial approximation; numerical solution of systems of linear equations: direct and iterative methods, (Jacobi Gauss-Seidel and SOR) with convergence; matrix eigenvalue problems: Jacobi and Given's methods, numerical solution of ordinary differential equations: initial value problems, Taylor series method, Runge-Kutta methods, predictor-corrector methods; convergence and stability.

Partial Differential Equations: Linear and quasilinear first order partial differential equations, method of characteristics; second order linear equations in two variables and their classification; Cauchy, Dirichlet and Neumann problems, Green's functions; solutions of Laplace, wave and diffusion equations in two variables Fourier series and transform methods of solutions of the above equations and applications to physical problems.

Mechanics: Forces in three dimensions, Poinsot central axis, virtual work, Lagrange's equations for holonomic systems, theory of small oscillations, Hamiltonian equations;

Topology: Basic concepts of topology, product topology, connectedness, compactness, countability and separation axioms, Urysohn's Lemma, Tietze extension theorem, metrization theorems, Tychonoff theorem on compactness of product spaces.

Probability and Statistics: Probability space, conditional probability, Bayes' theorem, independence, Random variables, joint and conditional distributions, standard probability distributions and their properties, expectation, conditional expectation, moments. Weak and strong law of large numbers, central limit theorem. Sampling distributions, UMVU estimators, sufficiency and consistency, maximum likelihood estimators. Testing of hypotheses, Neyman-Pearson tests, monotone likelihood ratio, likelihood ratio tests, standard parametric tests based on normal, X2 ,t, F-distributions. Linear regression and test for linearity of regression. Interval estimation.

Linear Programming: Linear programming problem and its formulation, convex sets their properties, graphical method, basic feasible solution, simplex method, big-M and two phase methods, infeasible and unbounded LPP's, alternate optima. Dual problem and duality theorems, dual simplex method and its application in post optimality analysis, interpretation of dual variables. Balanced and unbalanced transportation problems, unimodular property and u-v method for solving transportation problems. Hungarian method for solving assignment problems.

Calculus of Variations and Integral Equations: Variational problems with fixed boundaries; sufficient conditions for extremum, Linear integral equations of Fredholm and Volterra type, their iterative solutions. Fredholm alternative.

ME - MECHANICAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

APPLIED MECHANICS AND DESIGN

Engineering Mechanics: Equivalent force systems, free-body concepts, equations of equilibrium, trusses and frames, virtual work and minimum potential energy. Kinematics and dynamics of particles and rigid bodies, impulse and momentum (linear and angular), energy methods, central force motion.

Strength of Materials: Stress and strain, stress-strain relationship and elastic constants, Mohr's circle for plane stress and plane strain, shear force and bending moment diagrams, bending and shear stresses, deflection of beams, torsion of circular shafts, thin and thick cylinders, Euler's theory of columns, strain energy methods, thermal stresses.

Theory of Machines: Displacement, velocity and acceleration, analysis of plane mechanisms, dynamic analysis of slider-crank mechanism, planar cams and followers, gear tooth profiles, kinematics of gears, governors and flywheels, balancing of reciprocating and rotating masses.

Vibrations: Free and forced vibration of single degree freedom systems, effect of damping, vibration isolation, resonance, critical speed of rotors.

Design of Machine Elements: Design for static and dynamic loading, failure theories, fatigue strength; design of bolted, riveted and welded joints; design of shafts and keys; design of spur gears, rolling and sliding contact bearings; brakes and clutches; belt, rope and chain drives.

FLUID MECHANICS AND THERMAL SCIENCES

Fluid Mechanics: Fluid properties, fluid statics, manometry, buoyancy; control-volume analysis of mass, momentum and energy; fluid acceleration; differential equations of continuity and momentum; Bernoulli's equation; viscous flow of incompressible fluids; boundary layer; elementary turbulent flow; flow through pipes, head losses in pipes, bends etc.

Heat-Transfer: Modes of heat transfer; one dimensional heat conduction, resistance concept, electrical analogy, unsteady heat conduction, fins; dimensionless parameters in free and forced convective heat transfer, various correlations for heat transfer in flow over flat plates and through pipes; thermal boundary layer; effect of turbulence; radiative heat transfer, black and grey surfaces, shape factors, network analysis; heat exchanger performance, LMTD and NTU methods.

Thermodynamics: Zeroth, First and Second laws of thermodynamics; thermodynamic system and processes; irreversibility and availability; behaviour of ideal and real gases, properties of pure substances, calculation of work and heat in ideal processes; analysis of thermodynamic cycles related to energy conversion; Carnot, Rankine, Otto, Diesel, Brayton and vapour compression cycles.

Power Plant Engineering: Steam generators; steam power cycles; steam turbines; impulse and reaction principles, velocity diagrams, pressure and velocity compounding; reheating and reheat factor; condensers and feed heaters.

I.C. Engines: Requirements and suitability of fuels in IC engines, fuel ratings, fuel-air mixture requirements; normal combustion in SI and CI engines; engine performance calculations.

Refrigeration and air-conditioning: Refrigerant compressors, expansion devices, condensers and evaporators; properties of moist air, psychrometric chart, basic psychometric processes.

Turbomachinery: Components of gas turbines; compression processes, centrifugal and axial flow compressors; axial flow turbines, elementary theory; hydraulic turbines; Euler-turbine equation; specific speed, Pelton-wheel, Francis and Kaplan turbines; centrifugal pumps.

MANUFACTURING AND INDUSTRIAL ENGINEERING

Engineering Materials: Structure and properties of engineering materials and their applications, heat treatment.

Metal Casting: Casting processes (expendable and non-expendable) -pattern, moulds and cores, heating and pouring, solidification and cooling, gating design, design considerations, defects.

Forming Processes: Stress-strain diagrams for ductile and brittle material, Plastic deformation and yield criteria, fundamentals of hot and cold working processes, Bulk metal forming processes (forging, rolling, extrusion, drawing), sheet metal working processes (punching, blanking, bending, deep drawing, coining, spinning, load estimation using homogeneous deformation methods, defects). processing of powder metals- atomization, compaction, sintering, secondary and finishing operations. forming and shaping of plastics- extrusion, injection moulding.

Joining Processes: Physics of welding, fusion and non-fusion welding processes, brazing and soldering, adhesive bonding, design considerations in welding, weld quality defects.

Machining and Machine Tool Operations: Mechanics of machining, single and multi-point cutting tools, tool geometry and materials, tool life and wear, cutting fluids, machinability, economics of machining, non-traditional machining processes.

Metrology and Inspection: Limits, fits and tolerances, linear and angular measurements, comparators, gauge design, interferometry, form and finish measurement, measurement of screw threads, alignment and testing methods.

Tool Engineering: Principles of work holding, design of jigs and fixtures.

Computer Integrated Manufacturing: Basic concepts of CAD, CAM and their integration tools.

Manufacturing Analysis: Part-print analysis, tolerance analysis in manufacturing and assembly, time and cost analysis.

Work-Study: Method study, work measurement, time study, work sampling, job evaluation, merit rating.

Production Planning and Control: Forecasting models, aggregate production planning, master scheduling, materials requirements planning.

Inventory Control: Deterministic and probabilistic models, safety stock inventory control systems.

Operations Research: Linear programming, simplex and duplex method, transportation, assignment, network flow models, simple queuing models, PERT and CPM

MN - MINING ENGINEERING

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

MINING ENGINEERING

Mechanics: Equivalent force systems, equations of equilibrium, two dimensional frames and trusses, free body diagrams, friction forces, particle kinematics and dynamics.

Mine Development, Geomechanics and Strata Control: Drivages for underground mine development, drilling methods and machines, explosives, blasting devices and practices, shaft sinking. Physico-mechanical properties of rocks, rock mass classification, ground control instrumentation and stress measurement techniques, theories of rock failure, ground vibrations, stress distribution around mine openings, subsidence, design of supports in roadways and workings, stability of open pits, slopes.

Mining Methods and Machinery: Surface mining - layout, development, loading, transportation and mechanization, continuous surface mining systems. Underground coal mining - bord and pillar system, longwall mining, thick seam mining methods. Underground metal mining: different stoping methods, stope mechanization, ore handling systems, mine filling. Generation and transmission of mechanical, hydraulic, and pneumatic power. Materials handling - haulages, conveyors, ropeways, face and development machinery, hoisting systems, and pumps.

Ventilation, Underground Hazards and Surface Environment: Underground atmosphere, heat load sources and thermal environment, air cooling, mechanics of air flow distribution, natural and mechanical ventilation, mine fans and their usage, auxiliary ventilation. Subsurface hazards from fires, explosions, gases, dust, and inundation, rescue apparatus and practices, safety in mines, accident analysis, noise, mine lighting. Air and water pollution: causes, dispersion, quality standards, and control.

Surveying, Mine Planning and Systems Engineering: Fundamentals of engineering surveying, Levels and levelling, Theodolite, tacheometry, triangulation, contouring, errors and adjustments, correlation, underground surveying, curves, photogrammetry, field astronomy, GPS fundamentals. Principles of planning - Sampling methods and practices, reserve estimation techniques, basics of geostatistics, optimization of facility location, cash flow concepts and mine valuation, open pit design. Work study, concepts of reliability, reliability of series and parallel systems. Linear programming, transportation and assignment problems, queueing, network analysis, inventory control.

MT - METALLURGICAL ENGINEERING

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

METALLURGICAL ENGINEERING

Thermodynamics and Rate Processes: Laws of thermodynamics, activity, equilibrium constant, applications to metallurgical systems, solutions, phase equilibria, basic kinetic laws, order of reactions, rate constants and rate limiting steps principles of electro chemistry, aqueous, corrosion and protection of metals, oxidation and high temperature corrosion - characterization and control; momentum transfer - concepts of viscosity, shell balances, Bernoulli's equation; heat transfer - conduction, convection and heat transfer coefficient relations, radiation, mass transfer - diffusion and Fick's laws.

Extractive Metallurgy: Flotation, gravity and other methods of mineral processing; agglomeration, pyro-hydro-and electro-metallurgical processes; material and energy balances; principles and processes for the extraction of non-ferrous metals - aluminium, copper, zinc, lead, magnesium, nickel, titanium and other rare metals; iron and steel making - principles, blast furnace, direct reduction processes, primary and secondary steel making, deoxidation and inclusion in steel; ingot and continuous casting; stainless steel making, design of furnaces; fuels and refractories.

Physical Metallurgy: Crystal structure and bonding characteristics of metals, alloys, ceramics and polymers; solid solutions; solidification; phase transformation and binary phase diagrams; principles of heat treatment of steels, aluminum alloys and cast irons; recovery, recrystallization and grain growth; industrially important ferrous and non-ferrous alloys; elements of X-ray and electron diffraction; principles of scanning and transmission electron microscopy; elements of ceramics, composites and electronic materials; electronic basis of thermal, optical, electrical and magnetic properties of materials.

Mechanical Metallurgy: Elements of elasticity and plasticity; defects in crystals; elements of dislocation theory - types of dislocations, slip and twinning, stress fields of dislocations, dislocation interactions and reactions, methods of seeing dislocations; strengthening mechanisms; tensile, fatigue and creep behaviour; superplasticity; fracture - Griffith theory, ductile to brittle transition, fracture toughness; failure analysis; mechanical testing - tension, compression, torsion, hardness, impact, creep, fatigue, fracture toughness and formability tests.

Manufacturing Processes: Metal casting - patterns, moulds, melting, gating, feeding and casting processes, defects and castings, hot and cold working of metals; Metal forming - fundamentals of metal forming, rolling wire drawing, extrusion, forming, sheet metal forming processes, defects in forming; Metal joining - soldering, brazing and welding, common welding processes, welding metallurgy, problems associated with welding of steels and aluminium alloys, defects in welding, powder metallurgy; NDT methods - ultrasonic, radiography, eddy current, acoustic emission and magnetic.

PH - PHYSICS

Mathematical Physics: Linear vector space, matrices; vector calculus; linear differential equations; elements of complex analysis; Laplace transforms, Fourier analysis, elementary ideas about tensors.

Classical Mechanics: Conservation laws; central forces; collisions and scattering in laboratory and centre of mass reference frames; mechanics of system of particles; rigid body dynamics; moment of inertia tensor; noninertial frames and pseudo forces; variational principle; Lagrange's and Hamilton's formalisms; equation of motion, cyclic coordinates, Poisson bracket; periodic motion, small oscillations, normal modes; wave equation and wave propagation; special theory of relativity - Lorentz transformations, relativistic kinematics, mass-energy equivalence.

Electromagnetic Theory: Laplace and Poisson equations; conductors and dielectrics; boundary value problems; Ampere's and Biot-Savart's laws; Faraday's law; Maxwell's equations; scalar and vector potentials; Coulomb and Lorentz gauges; boundary conditions at interfaces; electromagnetic waves; interference, diffraction and polarization; radiation from moving charges.

Quantum Mechanics: Physical basis of quantum mechanics; uncertainty principle; Schrodinger equation; one and three dimensional potential problems; Particle in a box, harmonic oscillator, hydrogen atom; linear vectors and operators in Hilbert space; angular momentum and spin; addition of angular momentum; time independent perturbation theory; elementary scattering theory.

Atomic and Molecular Physics: Spectra of one-and many-electron atoms; LS and jj coupling; hyperfine structure; Zeeman and Stark effects; electric dipole transitions and selection rules; X-ray spectra; rotational and vibrational spectra of diatomic molecules; electronic transition in diatomic molecules, Franck-Condon principle; Raman effect; NMR and ESR; lasers.

Thermodynamics and Statistical Physics: Laws of thermodynamics; macrostates, phase space; probability ensembles; partition function, free energy, calculation of thermodynamic quantities; classical and quantum statistics; degenerate Fermi gas; black body radiation and Planck's distribution law; Bose-Einstein condensation; first and second order phase transitions, critical point.

Solid State Physics: Elements of crystallography; diffraction methods for structure determination; bonding in solids; elastic properties of solids; defects in crystals; lattice vibrations and thermal properties of solids; free electron theory; band theory of solids; metals, semiconductors and insulators; transport properties; optical, dielectric and magnetic properties of solids; elements of superconductivity.

Nuclear and Particle Physics: Rutheford scattering; basic properties of nuclei; radioactive decay; nuclear forces; two nucleon problem; nuclear reactions; conservation laws; fission and fusion; nuclear models; particle accelerators, detectors; elementary particles; photons, baryons, mesons and leptons; Quark model.

Electronics: Network analysis; semiconductor devices; bipolar transistors; FETs; power supplies, amplifier, oscillators; operational amplifiers; elements of digital electronics; logic circuits.

PI - PRODUCTION AND INDUSTRIAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

GENERAL ENGINEERING:

Engineering Materials: Structure and properties of engineering materials and their applications; effect of strain, strain rate and temperature on mechanical properties of metals and alloys; heat treatment of metals and alloys.

Applied Mechanics: Engineering mechanics - equivalent force systems, free body concepts, equations of equilibrium, virtual work and minimum potential energy; strength of materials-stress, strain and their relationship, Mohr's circle, deflection of beams, bending and shear stress, Euler's theory of columns.

Theory of Machines and Design: Analysis of planar mechanisms, plane cams and followers; governers and fly wheels; design of elements-failure theories; design of bolted, riveted and welded joints; design of shafts, keys, belt drives, brakes and clutches.

Thermal Engineering: Fluid machines - fluid statics, Bernoulli's equation, flow through pipes, equations of continuity and momentum; Thermodynamics - zeroth, First and Second laws of thermodynamics, thermodynamic system and processes, calculation of work and heat for systems and control volumes; Heat transfer - fundamentals of conduction, convection and radiation.

PRODUCTION ENGINEERING

Metal Casting: Casting processes; patterns-materials; allowances; moulds and cores - materials, making and testing; melting and founding of cast iron, steels and nonferrous metals and alloys; solidification; design of casting, gating and risering; casting defects and inspection.

Metal working: Stress-strain in elastic and plastic deformation; deformation mechanisms; hot and cold working-forging, rolling, extrusion, wire and tube drawing; sheet metal working; analysis of rolling, forging, extrusion and wire /rod drawing; metal working defects, high energy rate forming processes-explosive, magnetic, electro and electrohydraulic.

Metal Joining Processes: Welding processes - gas shielded metal arc, TIG, MIG, submerged arc, electroslag, thermit, resistance, pressure and forge welding; thermal cutting; other joining processes - soldering, brazing, braze welding; welding codes, welding symbols, design of welded joints, defects and inspection; introduction to modern welding processes - friction, ultrasonic, explosive, electron beam, laser and plasma.

Machining and Machine Tool Operations: Machining processes-turning, drilling, boring, milling, shaping, planing, sawing, gear cutting, thread production, broaching, grinding, lapping, honing super finishing; mechanics of cutting- Merchant's analysis, geometry of cutting tools, cutting forces, power requirements; selection of process parameters; tool materials, tool wear and tool life, cutting fluids, machinability; nontraditional machining processes and hybrid processes- EDM, CHM, ECM, USM, LBM, EBM, AJM, PAM AND WJM; economics of machining.

Metrology and Inspection: Limits and fits, linear and angular measurements by mechanical and optical methods, comparators; design of limit gauges; interferometry; measurement of straightness, flatness, roundness, squareness and symmetry; surface finish measurement; inspection of screw threads and gears; alignment testing.

Powder Metallurgy and Processing of Plastics: Production of powders, compaction, sintering; Polymers and composites; injection, compression and blow molding, extrusion, calendaring and thermoforming; molding of composites.

Tool Engineering: Work-holding-location and clamping; principles and methods; design of jigs and fixtures; design of press working tools, forging dies.

Manufacturing Analysis: Sources of errors in manufacturing; process capability; part-print analysis; tolerance analysis in manufacturing and assembly; process planning; parameter selection and comparison of production alternatives; time and cost analysis; Issues in choosing manufacturing technologies and strategies.

Computer Integrated Manufacturing: Basic concepts of CAD, CAM, CAPP, group technology, NC, CNC, DNC, FMS, Robotics and CIM.

INDUSTRIAL ENGINEERING

Product Design and Development: Principles of good product design, component and tolerance design; efficiency, quality and cost considerations; product life cycle; standardization, simplification, diversification, value analysis, concurrent engineering.

Engineering Economy and Costing: Financial statements; elementary cost accounting, methods of depreciation; break-even analysis, techniques for evaluation of capital investments.

Work System Design: Taylor's scientific management, Gilbreths's contributions; productivity concepts and measurements; method study, micro-motion study, principles of motion economy; human factors engineering, ergonomics; work measurement - time study, PMTS, work sampling; job evaluation, merit rating, wage administration, incentive systems; business process reengineering.

Logistics and Facility Design: Facility location factors, evaluation of alternatives, types of plant layout, evaluation; computer aided layout; assembly line balancing; material handling systems; supply chain management.

Production Planning and Inventory Control: Inventory Function costs, classifications - deterministic and probabilistic models; quantity discount; safety stock; inventory control system; Forecasting techniques - causal and time series models, moving average, exponential smoothing; trend and seasonality; aggregate production planning; master scheduling; bill of materials and material requirement planning; order control and flow control, routing, scheduling and priority dispatching; JIT; Kanban PULL systems; bottleneck scheduling and theory of constraints.

Operation Research: Linear programming - problem formulation, simplex method, duality and sensitivity analysis; transportation; assignment; network flow models, constrained optimization and Lagrange multipliers; simple queuing models; dynamic programming; simulation; PERT and CPM, time-cost trade-off, resource leveling.

Quality Control: Taguchi method; design of experiments; quality costs, statistical quality assurance, process control charts, acceptance sampling, zero defects; quality circles, total quality management.

Reliability and Maintenance: Reliability, availability and maintainability; probabilistic failure and repair times; system reliability; preventive maintenance and replacement, TPM.

Management Information System: Value of information; information storage and retrieval system - database and data structures; interactive systems; knowledge based systems.

Intellectual Property System: Definition of intellectual property, importance of IPR; TRIPS, and its implications, WIPO and Global IP structure, and IPS in India; patent, copyright, industrial design and trademark; meanings, rules and procedures, terms, infringements and remedies.

PY - PHARMACEUTICAL SCIENCES

Natural Products: Pharmacognosy & Phytochemistry - Chemistry, tests, isolation, characterization and estimation of phytopharmaceuticals belonging to the group of Alkaloids, Glycosides, Terpenoids, Steroids, Bioflavanoids, Purines, Guggul lipids. Pharmacognosy of crude drugs which contain the above constituents. Standardisation of raw materials and herbal products. WHO guide lines. Quantitative microscopy including modern techniques used for evaluation. Biotechnological principles and techniques for plant development Tissue culture.

Pharmacology: General pharmacological principles including Toxicology. Drug interaction. Pharmacology of drugs acting on Central nervous system, Cardiovascular system, Autonomic nervous system, Gastro intestinal system and Respiratory system. Pharmacology of Autocoids, Hormones, Chemotherapeutic agents including anticancer drugs. Bioassays. Immuno Pharmacology.

Medicinal Chemistry: Structure, nomenclature, classification, synthesis, SAR and metabolism of the following category of drugs which are official in Indian Pharmacopoeia and British Pharmacopoeia Hypnotics and Sedatives, Analgesics, NSAIDS, Neuroleptics, Antidepressants, Anxiolytics, Anticonvulsants, Antihistaminics, Local anaesthetics, Cardio Vascular drugs - Antianginal agents Vasodilators, Adrenergic & cholinergic drugs, Cardiotonic agents, Diuretics, Antihypertensive drugs, Hypoglycemic agents, Antilipedmic agents, Coagulants, Anticoagulants, Antiplatelet agents. Chemotherapeutic agents - Antibiotics, Antibacterials, Sulphadrugs. Antiproliozoal drugs, Antiviral, Antitubercular, Antimalarial, Anticancer, Antiamoebic drugs. Diagnostic agents. Preparation and storage and uses of official Radiopharmaceuticals. Vitamins and Hormones.

Pharmaceutics: Development, manufacturing standards, labeling, packing as per the pharmacopoeal requirements, Storage of different dosage forms and new drug delivery systems. Biopharmaceutics and Pharmacokinetics and their importance in formulation. Formulation and preparation of cosmetics - lipstick, shampoo, creams, nail preparations and dentifrices. Pharmaceutical calculations.

Pharmaceutical Jurisprudence: Legal aspects of manufacture, storage, sale of drugs. D and C act and rules. Pharmacy act.

Pharmaceutical Analysis: Principles, instrumentation and applications of the following. Absorption spectroscopy (UV, visible & IR), Fluorimetry, Flame photometry, Potentiometry, Conductometry and Plarography. Pharmacopoeial assays. Principles of NMR, ESR, Mass spectroscopy, X-ray diffraction analysis and different chromatographic methods.

Biochemistry and Clinical Pharmacy: Biochemical role of hormones, Vitamins, Enzymes, Nucleic acids. Bioenergetics. General principles of immunology. Immunological techniques. Adverse drug interaction.

Microbiology: Principles and methods of microbiological assays of the Pharmacopoeia. Methods of preparation of official sera and vaccines. Serological and diagnostic tests. Applications of microorganisms in Bio Conversions and in Pharmaceutical industry.

TF - TEXTILE ENGINEERING AND FIBRE SCIENCE

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

TEXTILE ENGINEERING & FIBRE SCIENCE

Textile Fibres: Classification of textile fibres according to their nature and origin; general characteristics of textile fibres-their chemical and physical structures and their properties; essential characteristics of fibre forming polymers; uses of natural and man-made fibres; physical and chemical methods of fibre and blend identification and blend analysis.

Melt Spinning processes with special reference to polyamide and polyester fibres; wet and dry spinning of viscose and acrylic fibres; post spinning operations-drawing, heat setting, texturing- false twist and air-jet, tow-to-top conversion. Methods of investigating fibre structure e.g. X-ray diffraction, birefringence, optical and electron microscopy, I.R. absorption, thermal methods; structure and morphology and principal natural and man-made fibres, mechanical properties of fibres, moisture sorption in fibres; fibre structure and property correlation.

Textile Testing: Sampling techniques, sample size and sampling errors; measurement of fibre length, fineness, crimp, strength and reflectance; measurement of cotton fibre maturity ad trash content; HVI and AFIS for fibre testing. Measurement of yarn count, twist and hairiness; tensile testing of fibres, yarn and fabrics; evenness testing of slivers, rovings and yarns; testing equipment for measurement test methods of fabric properties like thickness, compressibility, air permeability, drape, crease recovery, tear strength bursting strength and abrasion resistance. Correlation analysis, significance tests and analysis of variance; frequency distributions and control charts.

Yarn Manufacture and Yarn Structure: Modern methods of opening, cleaning and blending of fibrous materials; the technology of carding with particular reference to modern developments; causes of irregularity introduced by drafting, the development of modern drafting systems; principles and techniques of preparing material for combing; recent development in combers; functions and synchronization of various mechanisms concerned with roving production; forces acting on yarn and traveller, ring and traveller designs; causes of end breakages; properties of doubles yarns; new methods of yarn production such as rotor spinning, air jet spinning and friction spinning.

Yarn diameter; specific volume, packing coefficient; twist-strength relationship; fibre orientation in yarn; fibre migration.

Fabric Manufacture and Fabric Structure: Principles of cheese and cone winding processes and machines; random and precision winding; package faults and their remedies; yarn clearers and tensioners; different systems of yarn splicing; features of modern cone winding machines; different types of warping creels; features of modern beam and sectional warping machines; different sizing systems, sizing of spun and filament yarns, modern sizing machines; principles of pirn winding processes and machines; primary and secondary motions of loom, effect of their settings and timings on fabric formation, fabric appearance and weaving performance; dobby and jacquard shedding; mechanics of weft insertion with shuttle; warp and weft stop motions, warp protection, weft replenishment; functional principles of weft insertion systems of shuttleless weaving machines, principles of multiphase and circular looms. Principles of weft and warp knitting; basic weft and warp knitted structures; classification, production and areas of application of nonwoven fabrics.

Basic woven fabric constructions and their derivatives; crepe, cord, terry, gauze, lino and double cloth constructions.

Peirce's equations for fabric geometry; thickness, cover and maximum sett of woven fabrics

Textile Chemical Processing: Preparatory processes for natural-and and their blends; mercerization of cotton; machines for yarn and fabric mercerization.

Dyeing and printing of natural- and synthetic- fibre fabrics and their blends with different dye classes; dyeing and printing machines; styles of printing; fastness properties of dyed and printed textile materials.

Finishing of textile materials, wash and wear, durable press, soil release, water repellent, flame retardant and antistatic finishes; shrink-resistance finish for wool; heat setting of synthetic-fibre fabrics, finishing machines; energy efficient processes; pollution control.

XE - ENGINERING SCIENCES

The syllabi of the sections of this paper are as follows:

SECTION A. ENGINEERING MATHEMATICS (Compulsory)

Linear Algebra : Determinates, algebra of matrices, rank, inverse, system of linear equations, symmetric, skew-symmetric and orthogonal matrices. Hermitian, skew-hermitian and unitary matrices. eigenvalues and eigenvectors, diagonalisation of matrices, Cayley-Hamiltonian, quadratic forms.

Calculus : Functions of single variables, limit, continuity and differentiability, Mean value theorems, Intermediate forms and L'Hospital rule, Maxima and minima, Taylor's series, Fundamental and mean value-theorems of integral calculus. Evaluation of definite and improper integrals, Beta and Gamma functions, Functions of two variables, limit, continuity, partial derivatives, Euler's theorem for homogeneous functions, total derivatives, maxima and minima, Lagrange method of multipliers, double and triple integrals and their applications, sequence and series, tests for convergence, power series, Fourier Series, Fourier integrals.

Complex variable: Analytic functions, Cauchy's integral theorem and integral formula without proof. Taylor's and Laurent' series, Residue theorem (without proof) with application to the evaluation of real integarls.

Vector Calculus: Gradient, divergence and curl, vector identities, directional derivatives, line, surface and volume integrals, Stokes, Gauss and Green's theorems (without proofs) with applications.

Ordinary Differential Equations: First order equation (linear and nonlinear), higher order linear differential equations with constant coefficients, method of variation of paramaters, Cauchy's and Euler's equations, initial and boundary value problems, power series solutions, Legendre polynomials and Bessel's functions of the first kind.

Partial Differential Equations: Variables separable method, solutions of one dimensional heat, wave and Laplace equations.

Probability and Statistics: Definitions of probability and simple theorems, conditional probability, mean, mode and standard deviation, random variables, discrete and continuous distributions, Poisson, normal and Binomial distribution, correlation and regression

Numerical Methods: L-U decomposition for systems of linear equations,Newton-Raphson method, numerical integration(trapezoidal and Simpson's rule), numerical methods for first order differential equation (Euler method)

SECTION B. COMPUTATIONAL SCIENCE

Numerical Methods: Truncation errors, round off errors and their propagation; Interpolation; Lagrange, Newton's forward, backward and divided difference formulas, least square curve fitting, solution of non-linear equations of one variables using bisection, false position, secant and Newton Raphson methods; Rate of convergence of these methods, general iterative methods. Simple and multiple roots of polynomials. Solutions of system of linear algebraic equations using Gauss elimination methods, Jacobi and Gauss-Seidel iterative methods and their rate of convergence; ill conditioned and well conditioned system. eigen values and eigen vectors using power methods. Numerical integration using trapezoidal, Simpson's rule and other quadrature formulas. Numerical Differentiation. Solution of boundary value problems. Solution of initial value problems of ordinary differential equations using Euler's method, predictor corrector and Runge Kutta method.

Programming : Elementary concepts and terminology of a computer system and system software, Fortran77 and C programming.

Fortran : Program organization, arithmetic statements, transfer of control, Do loops, subscripted variables, functions and subroutines.

C language : Basic data types and declarations, flow of control- iterative statement, conditional statement, unconditional branching, arrays, functions and procedures.

SECTION C. ELECTRICAL SCIENCES

Electric Circuits: Ideal voltage and current sources; RLC circuits, steady state and transient analysis of DC circuits, network theorems; alternating currents and voltages, single-phase AC circuits, resonance; three-phase circuits.

Magnetic circuits: Mmf and flux, and their relationship with voltage and current; transformer, equivalent circuit of a practical transformer, three-phase transformer connections.

Electrical machines: Principle of operation, characteristics, efficiency and regulation of DC and synchronous machines; equivalent circuit and performance of three-phase and single-phase induction motors.

Electronic Circuits: Characteristics of p-n junction diodes, zener diodes, bipolar junction transistors (BJT) and junction field effect transistors (JFET); MOSFET's structure, characteristics, and operations; rectifiers, filters, and regulated power supplies; biasing circuits, different configurations of transistor amplifiers, class A, B and C of power amplifiers; linear applications of operational amplifiers; oscillators; tuned and phase shift types.

Digital circuits: Number systems, Boolean algebra; logic gates, combinational circuits, flip-flops (RS, JK, D and T) counters.

Measuring instruments: Moving coil, moving iron, and dynamometer type instruments; shunts, instrument transformers, cathode ray oscilloscopes; D/A and A/D converters.

SECTION D. FLUID MECHANICS

Fluid Properties: Relation between stress and strain rate for Newtonian fluids

Hydrostatics, buoyancy, manometry

Concept of local and convective accelerations; control volume analysis for mass, momentum and energy conservation.

Differential equations of continuity and momentum (Euler's equation of motion); concept of fluid rotation, stream function, potential function; Bernoulli's equation and its applications.

Qualitative ideas of boundary layers and its separation; streamlined and bluff bodies; drag and lift forces.

Fully-developed pipe flow; laminar and turbulent flows; friction factor; Darcy Weisbach relation; Moody's friction chart; losses in pipe fittings; flow measurements using venturimeter and orifice plates.

Dimensional analysis; similitude and concept of dynamic similarity; importance of dimensionless numbers in model studies.

SECTION E. MATERIALS SCIENCE

Atomic structure and bonding in materials: metals, ceramics and polymers.

Structure of materials: Crystal systems, unit cells and space lattice; determination of structures of simple crystals by X-ray diffraction; Miller indices for planes and directions. Packing geometry in metallic, ionic and covalent solids.

Concept of amorphous, single and polycrystalline structures and their effects on properties of materials.

Imperfections in crystalline solids and their role in influencing various properties.

Fick´s laws of diffusion and applications of diffusion in sintering, doping of semiconductors and surface hardening of metals.

Alloys: solid solution and solubility limit. Binary phase diagram, intermediate phases and intermetallic compounds; iron-iron carbide phase diagram. Phase transformation in steels. Cold and hot working of metals, recovery, recrystallization and grain growth.

Properties and applications of ferrous and nonferrous alloys.

Structure, properties, processing and applications of traditional and advanced ceramics.

Polymers: classification, polymerization, structure and properties, additives for polymer products, processing and application.

Composites: properties and application of various composites.

Corrosion and environmental degradation of materials (metals, ceramics and polymers).

Mechanical properties of materials: Stress-strain diagrams of metallic, ceramic and polymeric materials, modulus of elasticity, yield strength, plastic deformation and toughness, tensile strength and elongation at break; viscoelasticity, hardness, impact strength. ductile and brittle fracture. creep and fatigue properties of materials.

Heat capacity, thermal conductivity, thermal expansion of materials.

Concept of energy band diagram for materials; conductors, semiconductors and insulators in terms of energy bands. Electrical conductivity, effect of temperature on conductivity in materials, intrinsic and extrinsic semiconductors, dielectric properties of materials.

Refraction, reflection, absorption and transmission of electromagnetic radiation in solids.

Origin of magnetism in metallic and ceramic materials, paramagnetism, diamagnetism, antiferromagnetism, ferromagnetism, ferrimagnetism in materials and magnetic hysteresis.

Advanced materials: Smart materials exhibiting ferroelectric, piezoelectric, optoelectronic, semiconducting behaviour; lasers and optical fibers; photoconductivity and superconductivity in materials.

SECTION F. SOLID MECHANICS

Equivalent force systems; free-body diagrams; equilibrium equations; analysis of determinate and indeterminate trusses and frames; friction.

Simple relative motion of particles; force as function of position, time and speed; force acting on a body in motion; laws of motion; law of conservation of energy; law of conservation of momentum

Stresses and strains; principal stresses and strains; Mohr's circle; generalized Hooke's Law; equilibrium equations; compatibility conditions; yield criteria.

Axial, shear and bending moment diagrams; axial, shear and bending stresses; deflection (for symmetric bending); torsion in circular shafts; thin cylinders; energy methods (Castigliano's Theorems); Euler buckling.

SECTION G. THERMODYNAMICS

Basic Concepts: Continuum, macroscopic approach, thermodynamic system (closed and open or control volume); thermodynamic properties and equilibrium; state of a system, state diagram, path and process; different modes of work; Zeroth law of thermodynamics; concept of temperature; heat.

First Law of Thermodynamics: Energy, enthalpy, specific heats, first law applied to systems and control volumes, steady and unsteady flow analysis.

Second Law of Thermodynamics: Kelvin-Planck and Clausius statements, reversible and irreversible processes, Carnot theorems, thermodynamic temperature scale, Clausius inequality and concept of entropy, principle of increase of entropy; availability and irreversibility.

Properties of Pure Substances: Thermodynamic properties of pure substances in solid, liquid and vapour phases, P-V-T behaviour of simple compressible substances, phase rule, thermodynamic property tables and charts, ideal and real gases, equations of state, compressibility chart.

Thermodynamic Relations: T-ds relations, Maxwell equations, Joule-Thomson coefficient, coefficient of volume expansion, adiabatic and isothermal compressibilities, Clapeyron equation.

Ideal Gas Mixtures: Dalton's and Amagat's laws, calculations of properties, air-water vapour mixtures.

XL - LIFE SCIENCES

The syllabi of the Sections of this paper are as follows:

SECTION H. CHEMISTRY (Compulsory)

Atomic structure and periodicity: Quantum chemistry; Planck's quantum theory, wave particle duality, uncertainty principle, quantum mechanical model of hydrogen atom; electronic configuration of atoms; periodic table and periodic properties; ionization energy, election affinity, electronegativity, atomic size.

Structure and bonding: Ionic and covalent bonding M.O. and V.B. approaches for diatomic molecules, VSEPR theory and shape of molecules, hybridisation, resonance, dipole moment, structure parameters such as bond length, bond angle and bond energy, hydrogen bonding, van der Waals interactions. Ionic solids; ionic radii, lattice energy (Born-Haber Cycle).

s.p. and d Block Elements: Oxides, halides and hydrides of alkali and alkaline earth metals, B, Al, S, N, P and S, silicones, general characteristics of 3d elements, coordination complexes: valence bond and crystal field theory, color, geometry and magnetic properties.

Chemical Equilibria: Colligative properties of solutions, ionic equilibria in solution, solubility product, common ion effect, hydrolysis of salts, pH, buffer and their applications in chemical analysis.

Electrochemistry: Conductance, Kohlrausch law, Half Cell potentials, emf, Nernst equation, galvanic cells, thermodynamic aspects and their applications.

Reaction Kinetics: Rate constant, order of reaction, molecularity, activation energy, zero, first and second order kinetics, equilibrium constants (Kc, Kp and Kx) for homogeneous reactions, catalysis and elementary enzyme reactions.

Thermodynamics: First law, reversible and irreversible processes, internal energy, enthalpy, Kirchoff's equation, heat of reaction, Hess law, heat of formation, Second law, entropy, free energy, and work function. Gibbs-Helmholtz equation, Clausius-Clapeyron equation, free energy change and equilibrium constant, Troutons rule, Third law of thermodynamics.

Mechanistic Basis of Organic Reactions: Elementary treatment of SN1, SN2, E1 and E2 reactions, Hoffmann and Saytzeff rules, Addition reactions, Markonikoff rule and Kharash effect, Diels-Alder reaction, aromatic electrophilic substitution, orientation effect as exemplified by various functional groups.

Structure-Reactivity Correlations: Acids and bases, electronic and steric effects, optical and geometrical isomerism, tautomerism, concept of aromaticity

SECTION I. BIOCHEMISTRY

Organization of life. Importance of water. Cell structure and organelles. Structure and function of biomolecules: Carbohydrates, Lipids, Proteins and Nucleic acids. Biochemical separation techniques. Spectroscopic methods; UV-visible and fluorescence. Protein structure, folding and function: Myoglobin, Hemoglobin, Lysozyme, ribonuclease A, Carboxypeptidase and Chymotrypsin. Enzyme kinetics and regulation, Coenzymes.

Metabolism and bioenergitics. Generation and utilization of ATP. Photosynthesis. Major metabolic pathways and their regulation. Biological membranes. Transport across membranes. Signal transduction; hormones and neurotransmitters.

DNA replication, transcription and translation. Biochemical regulation of gene expression. Recombinant DNA technology and applications. Genomics and Proteomics.

The immune system. Active and passive immunity. Complement system. Antobody structure, function and diversity. Cells of the immune system: T, B and macrophages. T and B cell activation. Major histocompatibilty complex. T cell receptor. Immunological techniques: Immunodiffusion, immunoelectrophoresis, RIA and ELISA.

SECTION J. BIOTECHNOLOGY

Recombinant DNA technology for the production of therapeutic proteins. Micro array technology. Heterologous protein expression systems in bacteria, yeast etc.

Architecture of plant genome; plant tissue culture techniques; methods of gene transfer into plant cells; manipulation of phenotypic traits in plants; plant cell fermentations and production of secondary metabolites using suspension/ immobilized cell culture; methods for plant micro propagation; crop improvement and development of transgenic plants. Expression of animal proteins in plants.

Animal cell metabolism and regulation; cell cycle; primary cell culture; nutritional requirements for animal cell culture; techniques for the mass culture of animal cell lines; production of vaccines; growth hormones and interferons using animal cell culture; cytokines-production and therapeutic uses; hybridoma technology; vectors for gene transfer and expression in animal cells. Transgenic animals and molecular pharming.

Microbial production of industrial enzymes; methods for immobilization of enzymes; kinetics of soluble and immobilized enzymes; application of soluble and immobilized enzymes; enzyme-based sensors.

Microbial growth kinetics; batch, fed batch and continuous culture of microbial cells; media for industrial fermentations; sterilization of air and media; design features and operation of stirred tank, air-lift and fluidized bed reactors; aeration and agitation in aerobic fermentations; recovery and purification of fermentation products- filtration, centrifugation, cell disintegration, solvent extraction and chromatographic separations; industrial fermentations for the production of ethanol, citric acid, lysine, penicillin and other biomolecules; simple calculations based on material and energy balance of fermentation processes; application of microbes in the management of domestic and industrial wastes.

SECTION K. BOTANY

Anatomy: Roots, stem and leaves of land plants, meristems, vascular system, their ontogeny, structure and functions. Plant cell structure, organisation, organelles, cytoskeleton, cell wall and membranes.

Development: Cell cycle, cell division, senescence, hormonal regulation of growth; life cycle of an angiosperm, pollination, fertilization, embryogenesis, seed formation, seed storage proteins, seed dormancy and germination. Concept of cellular totipotency, organogenesis and somatic embryogenesis, somaclonal variation, embryo culture, in vitro fertilization.

Physiology and Biochemistry: Plant water relations, transport of minerals and solutes, N2 metabolism, proteins and nucleic acid, respiration, photophysiology, photosynthesis, photorespiration; biosynthesis, mechanism of action and physiological effects of plant growth regulators.

Genetics: Principles of Mendelian inheritance, linkage, recombination and genetic mapping; extrachromosomal inheritance; eukaryotic genome organization (chromatin structure) and regulation of gene expression, gene mutation, chromosome aberrations (numerical and structural), transposons.

Plant Breeding: Principles, methods - selection, hybridization, heterosis; male sterility, self and inter-specific incompatibility; haploidy; somatic cell hybridization; molecular marker-assisted selection; gene transfer methods viz. direct and vector-mediated, transgenic plants and their applications in agriculture.

Economic Botany: Economically important plants - cereals, pulses, plants yielding fiber, timber, sugar, beverages, oils, rubber, dyes, gums, drugs and narcotics - a general account.

Systematics: Systems of classification (non-phylogenetic vs. phylogenetic - outline), plant groups, molecular systematics.

Plant Pathology: Nature and classification of plant diseases, diseases of important crops caused by fungi, bacteria and viruses, and their control measures, mechanism(s) of pathogenesis and resistance, molecular detection of pathogens; plant-microbe beneficial interactions.

Ecology and Plant Geography: Ecosystems - types, dynamics, degradation, ecological succession; food chains; vegetation types of the world; pollution and global warming; speciation and extinction, conservation strategies, cryopreservation.

SECTION L. MICROBIOLOGY

Historical perspective - Discovery of the microbial world; Controversy over spontaneous generation; Role of microorganisms in transformation of organic matter and in the causation of diseases.

Methods in microbiology - Pure culture techniques; Theory and practice of sterilization; Principles of microbial nutrition; Construction of culture media; Enrichment culture techniques for isolation of chemoautotrophs, chemoheterotrophs and photosynthetic microorganisms.

Microbial evolution, systematics and taxonomy - Evolution of earth and earliest life forms; Primitive organisms and their metabolic strategies; New approaches to bacterial taxonomic classification including ribotyping; Nomenclature.

Microbial diversity - Bacteria, archea and their broad classification; Eukaryotic microbes, yeast, fungi, slime mold and protozoa; Viruses and their classification.

Microbial growth -The definition of growth, mathematical expression of growth, growth curve, measurement of growth and growth yields; Synchronous growth; Continuous culture.

Nutrition and metabolism - Overview of metabolism; Microbial nutrition; Energy classes of microorganisms; Culture media; Energetics, modes of ATP generation; ATP generation by heterotrophs; Fermentation; Glycolysis; Respiration; The citric acid cycle; Electron transport systems; Alternate modes of energy generation; Pathways (anabolism) in the biosynthesis of amino acids, purines, pyrimidines and fatty acids.

Metabolic diversity among microorganisms - Photosynthesis in microorganisms; Role of chlorophylls, carotenoids and phycobilins; Calvin cycle; Chemolithotrophy; Hydrogen- iron-nitrite-oxidizing bacteria; Nitrate and sulfate reduction; Methanogenesis and acetogenesis.

Prokaryotic cells: structure-function - Cells walls of eubacteria (peptidoglycan) and related molecules; Outer-membrane of gram-negative bacteria; Cell wall and cell membrane synthesis; Flagella and motility; Cell inclusions like endospores, gas vesicles.

Microbial diseases and host parasite relationships - Normal microflora of skin; Oral cavity; Gastrointestinal tract; Entry of pathogens into the host; Infectious disease transmission; Respiratory infections caused by bacteria and viruses; Tuberculosis; Sexually transmitted diseases including AIDS; Diseases transmitted by animals (Rabies, plague), insects and ticks (rikettsias, Lyme disease, malaria); Food and water borne diseases; Public health and water quality; Pahtogenic fungi; Emerging and resurgent infectious diseases.

Chemotherapy/Antibiotics - Antimicrobial agents; Sulfa drugs; Antibiotics; Pencillins and cephalosporins; Broad-spectrum antibiotics; Antibiotics from prokaryotes; Antifungal antibiotics; Mode of action; Resistance to antibiotics.

Microbial genetics - Genes, mutation and mutagenesis - UV and chemical mutagnes; Types of mutations; Ames test for mutagenesis; Methods of genetic analysis. Bacterial genetic system - Transformation; Conjugation; Transduction; Recombination; Plasmids and Transposons; Bacterial genetic map with reference to E. coli. Viruses and their genetic system - Phage ? and its life cycle; RNA phages; RNA viruses; Retroviruses; Genetic systems of yeast and Neurospora; Extrachromosomal inheritance and mitochondrial genetics; Basic concept of genomics.

SECTION M. ZOOLOGY

Animal world: Animal diversity, distribution, systematic and classification of animals, the phylogenetic relationship.

Evolution: Origin of life, history of life on earth, evolutionary theories, natural selection, adaptation, speciation.

Genetics: Principles of inheritance, molecular basis of heredity, the genetic material, transmission of genetic material, mutations, cytoplasmic inheritance.

Biochemistry and Molecular Biology: Nucleic acids, proteins and other biological macromolecules. Replication, transcription and translation, regulation of gene expression, organization of genome, Kreb's cycle, glycolysis, enzyme catalysis, hormones and their action.

Cell Biology: Structure of cell, cellular organelles and their structure and function, cell cycle, cell division, cellular differentiation, chromosome and chromatin structure. Eukaryotic gene organisation and expression.

Animal Anatomy and Physiology: Comparative physiology, the respiratory system, circulatory system, digestive system, the nervous system, the excretory system, the endocrine system, the reproductive system, the skeletal system, osmoregulation.

Parasitology and Immunology: Nature of parasite, host-parasite relation, protozoan and helminthic parasites, the immune response, cellular and humoral immune response, evolution of the immune system.

Development Biology: Embryonic development, cellular differentiation, organogenesis, metamorphosis, genetic basis of development.

Ecology: The ecosystem, habitats the food chain, population dynamics, species diversity, zoogeography, biogeochemical cycles, conservation biology.

Animal Behaviour: Types of behaviours, courtship, mating and territoriality, instinct, learning and memory, social behaviour across the animal taxa, communication, pheromones, evolution of animal behaviour.

IT - INFORMATION TECHNOLOGY

ENGINEERING MATHEMATICS

Mathematical Logic: Propositional Logic; First Order Logic.

Probability: Conditional Probability; Mean, Median, Mode and Standard Deviation; Random

Variables; Distributions; uniform, normal, exponential, Poisson, Binomial.

Set Theory & Algebra: Sets; Relations; Functions; Groups; Partial Orders; Lattice; Boolean Algebra.

Combinatorics: Permutations; Combinations; Counting; Summation; generating functions; recurrence relations; asymptotics.

Graph Theory: Connectivity; spanning trees; Cut vertices & edges; covering; matching; independent sets; Colouring; Planarity; Isomorphism.

Linear Algebra: Algebra of matrices, determinants, systems of linear equations, Eigen values and Eigen vectors.

Numerical Methods: LU decomposition for systems of linear equations; numerical solutions of non linear algebraic equations by Secant, Bisection and Newton-Raphson Methods; Numerical integration by trapezoidal and Simpson's rules.

Calculus: Limit, Continuity & differentiability, Mean value Theorems, Theorems of integral calculus, evaluation of definite & improper integrals, Partial derivatives, Total derivatives, maxima & minima.

FORMAL LANGUAGES AND AUTOMATA

Regular Languages: finite automata, regular expressions, regular grammar.

Context free languages: push down automata, context free grammars

COMPUTER HARDWARE

Digital Logic: Logic functions, minimization, design and synthesis of combinatorial and sequential circuits, number representation and computer arithmetic (fixed and floating point)

Computer organization: Machine instructions and addressing modes, ALU and data path, hardwired and microprogrammed control, memory interface, I/O interface (interrupt and DMA mode), serial communication interface, instruction pipelining, cache, main and secondary storage

SOFTWARE SYSTEMS

Data structures and Algorithms: the notion of abstract data types, stack, queue, list, set, string, tree, binary search tree, heap, graph, tree and graph traversals, connected components, spanning trees, shortest paths, hashing, sorting, searching, design techniques (greedy, dynamic, divide and conquer), asymptotic analysis (best, worst, average cases) of time and space, upper and lower bounds, intractability

Programming Methodology: C programming, program control (iteration, recursion, functions), scope, binding, parameter passing, elementary concepts of object oriented programming

Operating Systems (in the context of Unix): classical concepts (concurrency, synchronization, deadlock), processes, threads and interprocess communication, CPU scheduling, memory management, file systems, I/O systems, protection and security

Information Systems and Software Engineering: information gathering, requirement and feasibility analysis, data flow diagrams, process specifications, input/output design, process life cycle, planning and managing the project, design, coding, testing, implementation, maintenance.

Databases: relational model, database design, integrity constraints, normal forms, query languages (SQL), file structures (sequential, indexed), b-trees, transaction and concurrency control

Data Communication: data encoding and transmission, data link control, multiplexing, packet switching, LAN architecture, LAN systems (Ethernet, token ring), Network devices: switches, gateways, routers

Networks: ISO/OSI stack, sliding window protocols, routing protocols, TCP/UDP, application layer protocols & systems (http, smtp, dns, ftp), network security

Web technologies: three tier web based architecture; JSP, ASP, J2EE, .NET systems; html, XML

AG - AGRICULTURAL ENGINEERING

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

FARM MACHINERY AND POWER:

Sources of power on the farm-human, animal, mechanical, electrical, wind, solar and biomass; design and selection of machine elements - gears, pulleys, chains and sprockets and belts; overload safety devices used in farm machinery; measurement of force, torque, speed, displacement and acceleration on machine elements.

Soil tillage; forces acting on a tillage tool; hitch systems and hitching of tillage implements; functional requirements, principles of working, construction and operation of manual, animal and power operated equipment for tillage. sowing, planting, fertilizer application, inter-cultivation, spraying, mowing, chaff cutting, harvesting, threshing and transport; testing of agricultural machinery and equipment; calculation of performance parameters -field capacity, efficiency, application rate and losses; cost analysis of implements and tractors.

Thermodynamic principles of I.C. engines; I.C. engine cycles; engine components; fuels and combustion; lubricants and their properties; I.C. engine systems - fuel, cooling, lubrication, ignition, electrical, intake and exhaust; selection, operation, maintenance and repair of I.C. engines; power efficiencies and measurement; calculation of power, torque, fuel consumption, heat load and power losses.

Tractors and power tillers - type, selection, maintenance and repair; tractor clutches and brakes; power transmission systems - gear trains, differential, final drives and power take-off; mechanics of tractor chassis; traction theory; three point hitches- free link and restrained link operations; mechanical steering and hydraulic control systems used in tractors; human engineering and safety in tractor design; tractor tests and performance.

SOIL AND WATER CONSERVATION ENGINEERING:

Ideal and real fluids, properties of fluids; hydrostatic pressure and its measurement; hydrostatic forces on plane and curved surface; continuity equation; Bernoulli's theorem; laminar and turbulent flow in pipes, Darcy-Weisbach and Hazen-Williams equations, Moody's diagram; flow through orifices and notches; flow in open channels.

Engineering properties of soils, fundamental definitions and relationships; index properties of soils; permeability and seepage analysis; shear strength, Mohr's circle of stresses; active and passive earth pressures; stability of slopes.

Hydrological cycle; precipitation measurement, analysis of precipitation data; abstraction from precipitation; runoff; hydrograph analysis, unit hydrograph theory and application; stream flow measurement; flood routing, hydrological reservoir and channel routing.

Mechanics of soil erosion, factors affecting erosion; soil loss estimation; biological and engineering measures to control erosion, terraces and bunds; vegetative waterways; gully control structures, drop, drop inlet and chute spillways; farm ponds; earthen dams; principles of watershed management.

Water requirement of crops; consumptive use and evapo-transpiration; irrigation scheduling; irrigation efficiencies; design of prismatic and silt loaded channels; methods of irrigation water application; design and evaluation of irrigation methods; drainage coefficient; surface and subsurface drainage systems; leaching requirement and salinity control; irrigation and drainage water quality; classification of pumps; pump characteristics; pump selection; types of aquifer; evaluation of aquifer properties; well hydraulics; ground water recharge.

AGRICULTURAL PROCESSING AND FOOD ENGINEERING:

Steady state heat transfer in conduction, convection and radiation; transient heat transfer in simple geometry; condensation and boiling heat transfer; working principles of heat exchangers; diffusive and convective mass transfer; simultaneous heat and mass transfer in agricultural processing operations.

Material and energy balances in food processing systems; water activity, sorption and desorption isotherms; centrifugal separation of solids, liquids and gases; kinetics of microbial death - pasteurisation and sterilization of liquid foods; preservation of food by cooling and freezing; psychrometry - properties of air-vapour mixture; concentration and dehydration of liquid foods - evaporators, tray, drum and spray dryers.

Mechanics and energy requirement in size reduction of granular solids; particle size analysis for comminuted solids; size separation by screening; fluidisation of granular solids; cleaning and grading efficiency and effectiveness of grain cleaners; conditioning and hydrothermal treatments for grains; dehydration of food grains; processes and machines for processing of cereals, pulses and oilseeds; design considerations for grain silos.

AR - ARCHITECTURE AND PLANNING

City planning: Historical development of cities; principles of city planning; new towns; survey methods, site planning, planning regulations and building bye-laws.

Housing: Concept of shelter; housing policies and design; community planning; role of government agencies; finance and management.

Landscape Design: Principles of landscape design and site planning; history and landscape styles; landscape elements and materials; planting design.

Computer Aided Design: Application of computers in architecture and planning; understanding elements of hardware and software; computer graphics; programming languages - C and Visual Basic and usage of packages such as AutoCAD.

Environmental and Building Science: Elements of environmental science; ecological principles concerning environment; role of micro-climate in design; climatic control through design elements; thermal comfort; elements of solar architecture; principles of lighting and illumination; basic principles of architectural acoustics; air pollution, noise pollution and their control.

Visual and Urban Design: Principles of visual composition; proportion, scale, rhythm, symmetry, harmony, balance, form and colour; sense of place and space, division of space; focal point, vista, imageability, visual survey.

History of Architecture: Indian - Indus valley, Vedic, Buddhist, Indo-Aryan, Dravidian and Mughal periods; European - Egyptian, Greek, Roman, medieval and renaissance periods.

Development of Contemporary Architecture: Architectural developments and impacts on society since industrial revolution; influence of modern art on architecture; works of national and international architects; post modernism in architecture.

Building Services: Water supply, Sewerage and Drainage systems; Sanitary fittings and fixtures; principles of electrification of buildings; elevators, their standards and uses; air-conditioning systems; fire fighting systems.

Building Construction and Management: Building construction techniques, methods and details; building systems and prefabrication of building elements; principles of modular coordination; estimation, specification, valuation, professional practice; project management, PERT, CPM.

Materials and Structural Systems: Behavioural characteristics of all types of building materials e.g. mud, timber, bamboo, brick, concrete, steel, glass, FRP; principles of strength of materials; design of structural elements in wood, steel and RCC; elastic and limit state design; complex structural systems; principles of pre-stressing.

Planning Theory: Planning process; multilevel planning; comprehensive planning; central place theory; settlement pattern; land use and land utilization.

Techniques of Planning: Planning surveys; Preparation of urban and regional structure plans, development plans, action plans; site planning principles and design; statistical methods; application of remote sensing techniques in urban and regional planning.

Traffic and Transportation Planning: Principles of traffic engineering and transportation planning; methods of conducting surveys; design of roads, intersections and parking areas; hierarchy of roads and levels of services; traffic and transport management in urban areas; traffic safety and traffic laws; public transportation planning; modes of transportation.

Services and Amenities: Principles and design of water supply systems, sewerage systems, solid waste disposal systems, power supply and communication systems; Health, education, recreation and demography related standards at various levels of the settlements.

Development Administration and Management: Planning laws; development control and zoning regulations; laws relating to land acquisition; development enforcements, land ceiling; regional and urban plan preparations; planning and municipal administration; taxation, revenue resources and fiscal management; public participation and role of NGO.

CE - CIVIL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

STRUCTURAL ENGINEERING

Mechanics: Bending moments and shear forces in statically determinate beams; simple stress and strain: relationship; stress and strain in two dimensions, principal stresses, stress transformation, Mohr's circle; simple bending theory; flexural shear stress; thin-walled pressure vessels; uniform torsion.

Structural Analysis: Analysis of statically determinate trusses, arches and frames; displacements in statically determinate structures and analysis of statically indeterminate structures by force/energy methods; analysis by displacement methods (slope-deflection and moment-distribution methods); influence lines for determinate and indeterminate structures; basic concepts of matrix methods of structural analysis.

Concrete Structures: Basic working stress and limit states design concepts; analysis of ultimate load capacity and design of members subject to flexure, shear, compression and torsion (beams, columns and isolated footings); basic elements of prestressed concrete: analysis of beam sections at transfer and service loads.

Steel Structures: Analysis and design of tension and compression members, beams and beam-columns, column bases; connections - simple and eccentric, beam-column connections, plate girders and trusses; plastic analysis of beams and frames.

GEOTECHNICAL ENGINEERING

Soil Mechanics: Origin of soils; soil classification; three-phase system, fundamental definitions, relationship and inter-relationships; permeability and seepage; effective stress principle: consolidation, compaction; shear strength.

Foundation Engineering: Sub-surface investigation - scope, drilling bore holes, sampling, penetrometer tests, plate load test; earth pressure theories, effect of water table, layered soils; stability of slopes - infinite slopes, finite slopes; foundation types - foundation design requirements; shallow foundations; bearing capacity, effect of shape, water table and other factors, stress distribution, settlement analysis in sands and clays; deep foundations - pile types, dynamic and static formulae, load capacity of piles in sands and clays.

WATER RESOURCES ENGINEERING

Fluid Mechanics and Hydraulics: Hydrostatics, applications of Bernoulli equation, laminar and turbulent flow in pipes, pipe networks; concept of boundary layer and its growth; uniform flow, critical flow and gradually varied flow in channels, specific energy concept, hydraulic jump; forces on immersed bodies; flow measurement in channels; tanks and pipes; dimensional analysis and hydraulic modeling. Applications of momentum equation, potential flow, kinematics of flow; velocity triangles and specific speed of pumps and turbines.

Hydrology: Hydrologic cycle; rainfall; evaporation infiltration, unit hydrographs, flood estimation, reservoir design, reservoir and channel routing, well hydraulics.

Irrigation: Duty, delta, estimation of evapo-transpiration; crop water requirements; design of lined and unlined canals; waterways; head works, gravity dams and Ogee spillways. Designs of weirs on permeable foundation, irrigation methods.

ENVIRONMENTAL ENGINEERING

Water requirements; quality and standards, basic unit processes and operations for water treatment, distribution of water. Sewage and sewerage treatment: quantity and characteristic of waste water sewerage; primary and secondary treatment of waste water; sludge disposal; effluent discharge standards.

TRANSPORTATION ENGINEERING

Highway planning; geometric design of highways; testing and specifications of paving materials; design of flexible and rigid pavements.

CH - CHEMICAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

CHEMICAL ENGINEERING

Process Calculations and Thermodynamics: Laws of conservation of mass and energy; use of tie components; recycle, bypass and purge calculations; degree of freedom analysis.

First and Second laws of thermodynamics and their applications; equations of state and thermodynamic properties of real systems; phase equilibria; fugacity, excess properties and correlations of activity coefficients; chemical reaction equilibria.

Fluid Mechanics and Mechanical Operations: Fluid statics, Newtonian and non-Newtonian fluids, Bernoulli equation, Macroscopic friction factors, energy balance, dimensional analysis, shell balances, flow through pipeline systems, flow meters, pumps and compressors, packed and fluidized beds, elementary boundary layer theory, size reduction and size separation; free and hindered settling; centrifuge and cyclones; thickening and classification, filtration, mixing and agitation; conveying of solids.

Heat Transfer: Conduction, convection and radiation, heat transfer coefficients, steady and unsteady heat conduction, boiling, condensation and evaporation; types of heat exchangers and evaporators and their design.

Mass Transfer: Fick's law, molecular diffusion in fluids, mass transfer coefficients, film, penetration and surface renewal theories; momentum, heat and mass transfer analogies; stagewise and continuous contacting and stage efficiencies; HTU & NTU concepts design and operation of equipment for distillation, absorption, leaching, liquid-liquid extraction, crystallization, drying, humidification, dehumidification and adsorption.

Chemical Reaction Engineering: Theories of reaction rates; kinetics of homogeneous reactions, interpretation of kinetic data, single and multiple reactions in ideal reactors, non-ideal reactors; residence time; non-isothermal reactors; kinetics of heterogeneous catalytic reactions; diffusion effects in catalysis.

Instrumentation and Process Control: Measurement of process variables; sensors, transducers and their dynamics, dynamics of simple systems, dynamics such as CSTRs, transfer functions and responses of simple systems, process reaction curve, controller modes (P, PI, and PID); control valves; analysis of closed loop systems including stability, frequency response (including Bode plots) and controller tuning, cascade, feed forward control.

Plant Design and Economics: Design and sizing of chemical engineering equipment such as compressors, heat exchangers, multistage contactors; principles of process economics and cost estimation including total annualized cost, cost indexes, rate of return, payback period, discounted cash flow, optimization in Design.

Chemical Technology: Inorganic chemical industries; sulfuric acid, NaOH, fertilizers (Ammonia, Urea, SSP and TSP); natural products industries (Pulp and Paper, Sugar, Oil, and Fats); petroleum refining and petrochemicals; polymerization industries; polyethylene, polypropylene, PVC and polyester synthetic fibers.

CS - COMPUTER SCIENCE AND ENGINEERING

ENGINEERING MATHEMATICS

Mathematical Logic: Propositional Logic; First Order Logic.

Probability: Conditional Probability; Mean, Median, Mode and Standard Deviation; Random Variables; Distributions; uniform, normal, exponential, Poisson, Binomial.

Set Theory & Algebra: Sets; Relations; Functions; Groups; Partial Orders; Lattice; Boolean Algebra.

Combinatorics: Permutations; Combinations; Counting; Summation; generating functions; recurrence relations; asymptotics.

Graph Theory: Connectivity; spanning trees; Cut vertices & edges; covering; matching; independent sets; Colouring; Planarity; Isomorphism.

Linear Algebra: Algebra of matrices, determinants, systems of linear equations, Eigen values and Eigen vectors.

Numerical Methods: LU decomposition for systems of linear equations; numerical solutions of non linear algebraic equations by Secant, Bisection and Newton-Raphson Methods; Numerical integration by trapezoidal and Simpson's rules.

Calculus: Limit, Continuity & differentiability, Mean value Theorems, Theorems of integral calculus, evaluation of definite & improper integrals, Partial derivatives, Total derivatives, maxima & minima.

THEORY OF COMPUTATION

Formal Languages and Automata Theory: Regular languages and finite automata, Context free languages and Push-down automata, Recursively enumerable sets and Turing machines, Un-decidability;

Analysis of Algorithms and Computational Complexity: Asymptotic analysis (best, worst, average case) of time and space, Upper and lower bounds on the complexity of specific problems, NP-completeness.

COMPUTER HARDWARE

Digital Logic: Logic functions, Minimization, Design and synthesis of Combinational and Sequential circuits; Number representation and Computer Arithmetic (fixed and floating point);

Computer Organization: Machine instructions and addressing modes, ALU and Data-path, hardwired and micro-programmed control, Memory interface, I/O interface (Interrupt and DMA mode), Serial communication interface, Instruction pipelining, Cache, main and secondary storage.

SOFTWARE SYSTEMS

Data structures: Notion of abstract data types, Stack, Queue, List, Set, String, Tree, Binary search tree, Heap, Graph;

Programming Methodology: C programming, Program control (iteration, recursion, Functions), Scope, Binding, Parameter passing, Elementary concepts of Object oriented, Functional and Logic Programming;

Algorithms for problem solving: Tree and graph traversals, Connected components, Spanning trees, Shortest paths; Hashing, Sorting, Searching; Design techniques (Greedy, Dynamic Programming, Divide-and-conquer);

Compiler Design: Lexical analysis, Parsing, Syntax directed translation, Runtime environment, Code generation, Linking (static and dynamic); Operating Systems: Classical concepts (concurrency, synchronization, deadlock), Processes, threads and Inter-process communication, CPU scheduling, Memory management, File systems, I/O systems, Protection and security.

Databases: Relational model (ER-model, relational algebra, tuple calculus), Database design (integrity constraints, normal forms), Query languages (SQL), File structures (sequential files, indexing, B+ trees), Transactions and concurrency control;

Computer Networks: ISO/OSI stack, sliding window protocol, LAN Technologies (Ethernet, Token ring), TCP/UDP, IP, Basic concepts of switches, gateways, and routers.

CH - CHEMISTRY

PHYSICAL CHEMISTRY

Structure: Quantum theory - principles and techniques; applications to particle in a box, harmonic oscillator, rigid rotor and hydrogen atom; valence bond and molecular orbital theories and Huckel approximation, approximate techniques: variation and perturbation; symmetry, point groups; rotational, vibrational, electronic, NMR and ESR spectroscopy.

Equilibrium: First law of thermodynamics, heat, energy and work; second law of thermodynamics and entropy; third law and absolute entropy; free energy; partial molar quantities; ideal and non-ideal solutions; phase transformation: phase rule and phase diagrams- one, two, and three component systems; activity, activity coefficient, fugacity and fugacity coefficient ; chemical equilibrium, response of chemical equilibrium to temperature and pressure; colligative properties; kinetic theory of gases; thermodynamics of electrochemical cells; standard electrode potentials: applications - corrosion and energy conversion; molecular partition function (translational, rotational, vibrational and electronic).

Kinetics: Rates of chemical reactions, theories of reaction rates, collision and transition state theory; temperature dependence of chemical reactions; elementary reactions, consecutive elementary reactions; steady state approximation, kinetics of photochemical reactions and free radical polymerization, homogenous and heterogeneous catalysis.

INORGANIC CHEMISTRY

Non-Transition Elements: General characteristics, structure and reactions of simple and industrially important compounds, boranes, carboranes, silicates, silicones, diamond and graphite; hydrides, oxides and oxoacids of N, P, S and halogens; boron nitride, borazines and phosphazenes; xenon compounds. Shapes of molecules, hard-soft acid base concept.

Transition Elements: General characteristics of d and f block elements; coordination chemistry: structure and isomerism, stability, theories of metal-ligand bonding (CFT and LFT), electronic spectra and magnetic properties of transition metal complexes and lanthanides; metal carbonyls, metal-metal bonds and metal atom clusters, metallocenes; transition metal complexes with bonds to hydrogen, alkyls, alkenes, and arenes; metal carbenes; use of organometallic compounds as catalysts in organic synthesis; mechanisms of substitution and electron transfer reactions of coordination complexes. Role of metals with special reference to Na, K, Mg, Ca, Fe, Co, Zn, and Mo in biological systems.

Solids: Crystal systems and lattices, Miller planes, crystal packing, crystal defects; Bragg's Law; ionic crystals, band theory, metals and semiconductors. Spinels.

Instrumental methods of analysis: atomic absorption, UV-visible spectrometry, chromatographic and electro-analytical methods.

ORGANIC CHEMISTRY

Synthesis, reactions and mechanisms involving the following: Alkenes, alkynes, arenes, alcohols, phenols, aldehydes, ketones, carboxylic acids and their derivatives; halides, nitro compounds and amines; stereochemical and conformational effects on reactivity and specificity; reactions with diborane and peracids. Michael reaction, Robinson annulation, reactivity umpolung, acyl anion equivalents; molecular rearrangements involving electron deficient atoms.

Photochemistry: Basic principles, photochemistry of olefins, carbonyl compounds, arenes, photo oxidation and reduction.

Pericyclic reactions: Cycloadditions, electrocyclic reactions, sigmatropic reactions; Woodward-Hoffmann rules.

Heterocycles: Structural properties and reactions of furan, pyrrole, thiophene, pyridine, indole.

Biomolecules: Structure, properties and reactions of mono- and di-saccharides, physico-chemical properties of amino acids, structural features of proteins and nucleic acids.

Spectroscopy: Principles and applications of IR, UV-visible, NMR and mass spectrometry in the determination of structures of organic compounds.

EC - ELECTRONICS AND COMMUNICATION ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix Algebra, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Mean value theorems, Theorems of integral calculus, Evaluation of definite and improper integrals, Partial Derivatives, Maxima and minima, Multiple integrals, Fourier series. Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equation (linear and nonlinear), Higher order linear differential equations with constant coefficients, Method of variation of parameters, Cauchy's and Euler's equations, Initial and boundary value problems, Partial Differential Equations and variable separable method.

Complex variables: Analytic functions, Cauchy's integral theorem and integral formula, Taylor's and Laurent' series, Residue theorem, solution integrals.

Probability and Statistics: Sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Discrete and continuous distributions, Poisson, Normal and Binomial distribution, Correlation and regression analysis.

Numerical Methods: Solutions of non-linear algebraic equations, single and multi-step methods for differential equations.

Transform Theory: Fourier transform, Laplace transform, Z-transform.

ELECTRONICS & COMMUNICATION ENGINEERING

Networks: Network graphs: matrices associated with graphs; incidence, fundamental cut set and fundamental circuit matrices. Solution methods: nodal and mesh analysis. Network theorems: superposition, Thevenin and Norton's maximum power transfer, Wye-Delta transformation. Steady state sinusoidal analysis using phasors. Linear constant coefficient differential equations; time domain analysis of simple RLC circuits, Solution of network equations using Laplace transform: frequency domain analysis of RLC circuits. 2-port network parameters: driving point and transfer functions. State equations for networks.

Electronic Devices: Energy bands in silicon, intrinsic and extrinsic silicon. Carrier transport in silicon: diffusion current, drift current, mobility, resistivity. Generation and recombination of carriers. p-n junction diode, Zener diode, tunnel diode, BJT, JFET, MOS capacitor, MOSFET, LED, p-I-n and avalanche photo diode, LASERs. Device technology: integrated circuits fabrication process, oxidation, diffusion, ion implantation, photolithography, n-tub, p-tub and twin-tub CMOS process.

Analog Circuits: Equivalent circuits (large and small-signal) of diodes, BJTs, JFETs, and MOSFETs. Simple diode circuits, clipping, clamping, rectifier. Biasing and bias stability of transistor and FET amplifiers. Amplifiers: single-and multi-stage, differential, operational, feedback and power. Analysis of amplifiers; frequency response of amplifiers. Simple op-amp circuits. Filters. Sinusoidal oscillators; criterion for oscillation; single-transistor and op-amp configurations. Function generators and wave-shaping circuits. Power supplies.

Digital circuits: Boolean algebra, minimization of Boolean functions; logic gates digital IC families (DTL, TTL, ECL, MOS, CMOS). Combinational circuits: arithmetic circuits, code converters, multiplexers and decoders. Sequential circuits: latches and flip-flops, counters and shift-registers. Sample and hold circuits, ADCs, DACs. Semiconductor memories. Microprocessor(8085): architecture, programming, memory and I/O interfacing.

Signals and Systems: Definitions and properties of Laplace transform, continuous-time and discrete-time Fourier series, continuous-time and discrete-time Fourier Transform, z-transform. Sampling theorems. Linear Time-Invariant (LTI) Systems: definitions and properties; casuality, stability, impulse response, convolution, poles and zeros frequency response, group delay, phase delay. Signal transmission through LTI systems. Random signals and noise: probability, random variables, probability density function, autocorrelation, power spectral density.

Controls Systems: Basic control system components; block diagrammatic description, reduction of block diagrams. Open loop and closed loop (feedback) systems and stability analysis of these systems. Signal flow graphs and their use in determining transfer functions of systems; transient and steady state analysis of LTI control systems and frequency response. Tools and techniques for LTI control system analysis: root loci, Routh-Hurwitz criterion, Bode and Nyquist plots. Control system compensators: elements of lead and lag compensation, elements of Proportional-Integral-Derivative(PID) control. State variable representation and solution of state equation of LTI control systems.

Communications: Analog communication systems: amplitude and angle modulation and demodulation systems, spectral analysis of these operations, superheterodyne receivers; elements of hardware, realizations of analog communication systems; signal-to-noise ratio (SNR) calculations for amplitude modulation (AM) and frequency modulation (FM) for low noise conditions. Digital communication systems: pulse code modulation (PCM), differential pulse code modulation (DPCM), delta modulation (DM); digital modulation schemes-amplitude, phase and frequency shift keying schemes (ASK, PSK, FSK), matched filter receivers, bandwith consideration and probability of error calculations for these schemes.

Electromagnetics: Elements of vector calculus: divergence and curl; Gauss' and Stokes' theorems, Maxwell's equations: differential and integral forms. Wave equation, Poynting vector. Plane waves: propagation through various media; reflection and refraction; phase and group velocity; skin depth. Transmission lines: characteristic impedance; impedance transformation; Smith chart; impedance matching; pulse excitation. Waveguides: modes in rectangular waveguides; boundary conditions; cut-off frequencies; dispersion relations. Antennas: Dipole antennas; antenna arrays; radiation pattern; reciprocity theorem, antenna gain.

EE - ELECTRICAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix Algebra, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Mean value theorems, Theorems of integral calculus, Evaluation of definite and improper integrals, Partial Derivatives, Maxima and minima, Multiple integrals, Fourier series. Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equation (linear and nonlinear), Higher order linear differential equations with constant coefficients, Method of variation of parameters, Cauchy's and Euler's equations, Initial and boundary value problems, Partial Differential Equations and variable separable method.

Complex variables: Analytic functions, Cauchy's integral theorem and integral formula, Taylor's and Laurent' series, Residue theorem, solution integrals.

Probability and Statistics: Sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Discrete and continuous distributions, Poisson, Normal and Binomial distribution, Correlation and regression analysis.

Numerical Methods: Solutions of non-linear algebraic equations, single and multi-step methods for differential equations.

Transform Theory: Fourier transform, Laplace transform, Z-transform.

ELECTRICAL ENGINEERING

Electrical Circuits and Fields: Network graph, KCL, KVL, node/ cut set, mesh/ tie set analysis, transient response of d.c. and a.c. networks; sinusoidal steady-state analysis; resonance in electrical circuits; concepts of ideal voltage and current sources, network theorems, driving point, immittance and transfer functions of two port networks, elementary concepts of filters; three phase circuits; Fourier series and its application; Gauss theorem, electric field intensity and potential due to point, line, plane and spherical charge distribution, dielectrics, capacitance calculations for simple configurations; Ampere's and Biot-Savart's law, inductance calculations for simple configurations.

Electrical Machines: Single phase transformer - equivalent circuit, phasor diagram, tests, regulation and efficiency; three phase transformers - connections, parallel operation; auto transformer and three-winding transformer; principles of energy conversion, windings of rotating machines: D. C. generators and motors - characteristics, starting and speed control, armature reaction and commutation; three phase induction motors-performance characteristics, starting and speed control; single-phase induction motors; synchronous generators-performance, regulation, parallel operation; synchronous motors - starting, characteristics, applications, synchronous condensers; fractional horse power motors; permanent magnet and stepper motors.

Power Systems: Electric power generation - thermal, hydro, nuclear; transmission line parameters; steady-state performance of overhead transmission lines and cables and surge propagation; distribution systems, insulators, bundle conductors, corona and radio interference effects; per-unit quantities; bus admittance and impedance matrices; load flow; voltage control and power factor correction; economic operation; symmetrical components, analysis of symmetrical and unsymmetrical faults; principles of over current, differential and distance protections; concept of solid state relays and digital protection; circuit breakers; concept of system stability-swing curves and equal area criterion; basic concepts of HVDC transmission.

Control Systems: Principles of feedback; transfer function; block diagrams: steady-state errors; stability-Routh and Nyquist criteria; Bode plots; compensation; root loci; elementary state variable formulation; state transition matrix and response for Linear Time Invariant systems.

Electrical and Electronic Measurements: Bridges and potentiometers, PMMC, moving iron, dynamometer and induction type instruments; measurement of voltage, current, power, energy and power factor; instrument transformers; digital voltmeters and multimeters; phase, time and frequency measurement; Q-meter, oscilloscopes, potentiometric recorders, error analysis.

Analog and Digital Electronics: Characteristics of diodes, BJT, FET, SCR; amplifiers-biasing, equivalent circuit and frequency response; oscillators and feedback amplifiers, operational amplifiers- characteristics and applications; simple active filters; VCOs and timers;

combinational and sequential logic circuits, multiplexer, Schmitt trigger, multivibrators, sample and hold circuits, A/D and D/A converters; microprocessors and their applications.

Power Electronics and Electric Drives: Semiconductor power devices-diodes, transistors, thyristors, triacs, GTOs, MOSFETs and IGBTs - static characteristics and principles of operation; triggering circuits; phase control rectifiers; bridge converters-fully controlled and half controlled; principles of choppers and inverters, basic concepts of adjustable speed dc and ac drives.

GG - GEOLOGY AND GEOPHYSICS

PART - I

Earth and planetary system; size, shape, internal structure and composition of the earth; atmosphere and greenhouse effect; isostasy; elements of seismology; continents and continental processes; physical oceanography; palaeomagnetism, continental drift plate tectonics, geothermal energy.

Weathering; soil formation; action of river, wind and glacier; oceans and oceanic features; earthquakes, volcanoes, orogeny and mountain building; elements of structural geology; crystallography; classification, composition and properties of minerals and rocks; engineering properties of rocks and soils, role of geology in the construction of engineering structures.

Processes of ore formation, occurrence and distribution of ores on land and on ocean floor; coal and petroleum resources in India; ground water geology including well hydraulics, geological time scale and geochronology; stratigraphic principles and stratigraphy of India; basics concepts of gravity, magnetic and electrical prospecting for ores and ground water.

PART - IIA: GEOLOGY

Crystal symmetry, forms, twinning; crystal chemistry; optical mineralogy, classification of minerals, diagnostic properties of rock minerals.

Mineralogy, structure, texture and classification of igneous, sedimentary and metamorphic rock, their origin and evolution; application of thermodynamics; structure and petrology of sedimentary rocks; sedimentary processes and environments, sedimentary facies, basin studies; basement cover relationship;

Primary and secondary structures; geometry and genesis of folds, faults, joints, unconformities, cleavage, schistosity and lineation; methods of projection. Tectonites and their significance; shear zone; superposed folding.

Morphology, classification and geological significance of important invertebrates, vertebrates, microfossils and palaeoflora; stratigraphic principles and Indian stratigraphy; geomorphic processes and agents; development and evolution of landforms; slope and drainage; processes on deep oceanic and near-shore regions; quantitative and applied geomorphology; air photo interpretation and remote sensing; chemical and optical properties of ore minerals; formation and localization of ore deposits; prospecting and exploration of economic minerals; coal and petroleum geology; origin and distribution of mineral and fuel deposits in India; ore dressing and mineral economics.

Cosmic abundance; meteorites; geochemical evolution of the earth; geochemical cycles; distribution of major, minor and trace elements; isotope geochemistry; geochemistry of waters including solution equilibria and water rock interaction.

Engineering properties of rocks and soils; rocks as construction material; geology of dams, tunnels and excavation sites; natural hazards; the fly ash problem; ground water geology and exploration; water quality; impact of human activity; Remote sensing techniques for the interpretation of landforms and resource management.

PART - II B: GEOPHYSICS

The earth as a planet; different motions of the earth; gravity filed of the earth and its shape; geochronology; isostasy, seismology and interior of the earth; variation of density, velocity, pressure, temperature, electrical and magnetic properties inside the earth; earthquakes-causes and measurements; zonation and seismic hazards; geomagnetic field, palaeomagnetism; oceanic and continental lithosphere; plate tectonics; heat flow; upper and lower atmospheric phenomena.

Theories of scalar and vector potential fields; Laplace, Maxwell and Helmholtz equations for solution of different types of boundary value problems for Cartesian, cylindrical and spherical polar coordinates; Green's theorem; Image theory; integral equations and conformal transformations in potential theory; Eikonal equation and ray theory.

'G' and 'g' units of measurement, density of rocks, gravimeters, preparation, analysis and interpretation of gravity maps; derivative maps, analytical continuation; gravity anomaly type curves; calculation of mass.

Earth's magnetic field, units of measurement, magnetic susceptibility of rocks, magnetometers, corrections, preparation of magnetic maps, magnetic anomaly type curve, analytical continuation, interpretation and application; magnetic well logging.

Conduction of electricity through rocks, electrical conductivities of metals, metallic, non-metallic and rock forming minerals, D.C. resistivity units and methods of measurement, electrode configuration for sounding and profiling, application of filter theory, interpretation of resistivity field data, application; self potential origin, classification, field measurement, interpretation of induced polarization time frequency, phase domain; IP units and methods of measurement, interpretation and application; ground-water exploration.

Origin of electromagnetic field elliptic polarization, methods of measurement for different source-receiver configuration components in EM measurements, interpretation and applications; earth's natural electromagnetic field, tellurics, magneto-tellurics; geomagnetic depth sounding principles, methods of measurement, processing of data and interpretation.

Seismic methods of prospecting: Reflection, refraction and CDP surveys; land and marine seismic sources, generation and propagation of elastic waves, velocity increasing with depth, geophones, hydrophones, recording instruments (DFS), digital formats, field layouts, seismic noises and noise profile analysis, optimum geophone grouping, noise cancellation by shot and geophone arrays, 2D and 3D seismic data acquisition and processing, CDP stacking charts, binning, filtering, dip-moveout, static and dynamic corrections, deconvolution, migration, signal processing, Fourier and Hilbert transforms, attribute analysis, bright and dim spots, seismic stratigraphy, high resolution seismics, VSP.

Principles and techniques of geophysical well-logging, SP, resistivity, induction, micro gamma ray, neutron, density, sonic, temperature, dip meter, caliper, nuclear magnetic, cement bond logging. Quantitative evaluation of formations from well logs; well hydraulics and application of geophysical methods for groundwater study; application of bore hole geophysics in ground water, mineral and oil exploration. Remote sensing techniques and application of remote sensing methods in geophysics.

IN - INSTRUMENTATION ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix Algebra, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Mean value theorems, Theorems of integral calculus, Evaluation of definite and improper integrals, Partial Derivatives, Maxima and minima, Multiple integrals, Fourier series.

Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equation (linear and nonlinear), Higher order linear differential equations with constant coefficients, Method of variation of parameters, Cauchy's and Euler's equations, Initial and boundary value problems, Partial Differential Equations and variable separable method.

Complex variables: Analytic functions, Cauchy's integral theorem and integral formula, Taylor's and Laurent' series, Residue theorem, solution integrals.

Probability and Statistics: Sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Discrete and continuous distributions, Poisson, Normal and Binomial distribution, Correlation and regression analysis.

Numerical Methods: Solutions of non-linear algebraic equations, single and multi-step methods for differential equations.

Transform Theory: Fourier transform, Laplace transform, Z-transform.

INSTRUMENTATION ENGINEERING

Measurement Basics and Metrology: Static and dynamic characteristics of measurement systems. Standards and calibration. Error and uncertainty analysis, statistical analysis of data, and curve fitting. Linear and angular measurements; Measurement of straightness, flatness, roundness and roughness.

Transducers, Mechanical Measurements and Industrial Instrumentation: Transducers - elastic, resistive, inductive, capacitive, thermo-electric, piezoelectric, photoelectric, electro-mechanical, electro-chemical, and ultrasonic. Measurement of displacement, velocity (linear and rotational), acceleration, shock, vibration, force, torque, power, strain, stress, pressure, flow, temperature, humidity, viscosity, and density. energy storing elements, suspension systems and dampers.

Analog Electronics: Characteristics of diodes, BJTs, JFETs and MOSFETs; Diode circuits; Amplifiers: single and multi-stage, feedback; Frequency response; Operational amplifiers - design, characteristic, linear and non-linear applications: difference amplifiers; instrumentation amplifiers; precision rectifiers, I-to-V converters, active filters, oscillators, comparators, signal generators, wave shaping circuits.

Digital Electronics: Combinational logic circuits, minimization of Boolean functions; IC families (TTL, MOS, CMOS), arithmetic circuits, multiplexer and decoders. Sequential circuits: flip-flops, counters, shift registers. Schmitt trigger, timers, and multivibrators. Analog switches, multiplexers, S/H circuits. Analog-to-digital and digital-to-analog converters. Basics of computer organization and architecture. 8-bit microprocessor (8085), applications, memory, I/O interfacing, and microcontrollers.

Signals and Systems: Vectors and matrices; Fourier series; Fourier transforms; Ordinary differential equations. Impulse and frequency responses of first and second order systems. Laplace transform and transfer function, convolution and correlation. Amplitude and frequency modulations and demodulations. Discrete time systems, difference equations, impulse and frequency responses; Z-transforms and transfer functions; IIR and FIR filters.

Electrical and Electronic Measurements: Measurement of R, L and C; bridges and potentiometers. Measurement of voltage, current, power, power factor, and energy; Instrument transformers; Q meter, waveform analyzers. Digital volt-meters and multi-meters. Time, phase and frequency measurements; Oscilloscope. Noise and interference in instrumentation.

Control Systems & Process Control: Principles of feedback; transfer function, signal flow graphs. Stability criteria, Bode plots, root-loci, Routh and Nyquist criteria. Compensation techniques; State space analysis. System components: mechanical, hydraulic, pneumatic, electrical and electronic; Servos and synchros; Stepper motors. On-off, cascade, P, PI, PID and feed-forward controls. Controller tuning and general frequency response.

Analytical, Optical and Biomedical Instrumentation: Principles of spectrometry, UV, visible, IR mass spectrometry, X-ray methods; nuclear radiation measurements, gas, solid and semi conductor lasers and their characteristics, interferometers, basics of fibre optics, transducers in biomedical applications, cardiovascular system measurements, instrumentation for clinical laboratory.

MA - MATHEMATICS

Linear Algebra: Finite dimensional vector spaces. Linear transformations and their matrix representations, rank; systems of linear equations, eigenvalues and eigenvectors, minimal polynomial, Cayley-Hamilton theorem, diagonalisation, Hermitian, Skew-Hermitian and unitary matrices. Finite dimensional inner product spaces, self-adjoint and Normal linear operators, spectral theorem, Quadratic forms.

Complex Analysis: Analytic functions, conformal mappings, bilinear transformations, complex integration: Cauchy's integral theorem and formula, Liouville's theorem, maximum modulus principle, Taylor and Laurent's series, residue theorem and applications for evaluating real integrals.

Real Analysis: Sequences and series of functions, uniform convergence, power series, Fourier series, functions of several variables, maxima, minima, multiple integrals, line, surface and volume integrals, theorems of Green, Stokes and Gauss; metric spaces, completeness, Weierstrass approximation theorem, compactness. Lebesgue measure, measurable functions; Lebesgue integral, Fatou's lemma, dominated convergence theorem.

Ordinary Differential Equations: First order ordinary differential equations, existence and uniqueness theorems, systems of linear first order ordinary differential equations, linear ordinary differential equations of higher order with constant coefficients; linear second order ordinary differential equations with variable coefficients, method of Laplace transforms for solving ordinary differential equations, series solutions; Legendre and Bessel functions and their orthogonality, Sturm Liouville system, Greeen's functions.

Algebra: Normal subgroups and homomorphisms theorems, automorphisms. Group actions, sylow's theorems and their applications groups of order less than or equal to 20, Finite p-groups. Euclidean domains, Principal ideal domains and unique factorizations domains. Prime ideals and maximal ideals in commutative rings.

Functional Analysis: Banach spaces, Hahn-Banach theorems, open mapping and closed graph theorems, principle of uniform boundedness; Hilbert spaces, orthonormal sets, Riesz representation theorem, self-adjoint, unitary and normal linear operators on Hilbert Spaces.

Numerical Analysis: Numerical solution of algebraic and transcendental equations; bisection, secant method, Newton-Raphson method, fixed point iteration, interpolation: existence and error of polynomial interpolation, Lagrange, Newton, Hermite(osculatory)interpolations; numerical differentiation and integration, Trapezoidal and Simpson rules; Gaussian quadrature; (Gauss-Legendre and Gauss-Chebyshev), method of undetermined parameters, least square and orthonormal polynomial approximation; numerical solution of systems of linear equations: direct and iterative methods, (Jacobi Gauss-Seidel and SOR) with convergence; matrix eigenvalue problems: Jacobi and Given's methods, numerical solution of ordinary differential equations: initial value problems, Taylor series method, Runge-Kutta methods, predictor-corrector methods; convergence and stability.

Partial Differential Equations: Linear and quasilinear first order partial differential equations, method of characteristics; second order linear equations in two variables and their classification; Cauchy, Dirichlet and Neumann problems, Green's functions; solutions of Laplace, wave and diffusion equations in two variables Fourier series and transform methods of solutions of the above equations and applications to physical problems.

Mechanics: Forces in three dimensions, Poinsot central axis, virtual work, Lagrange's equations for holonomic systems, theory of small oscillations, Hamiltonian equations;

Topology: Basic concepts of topology, product topology, connectedness, compactness, countability and separation axioms, Urysohn's Lemma, Tietze extension theorem, metrization theorems, Tychonoff theorem on compactness of product spaces.

Probability and Statistics: Probability space, conditional probability, Bayes' theorem, independence, Random variables, joint and conditional distributions, standard probability distributions and their properties, expectation, conditional expectation, moments. Weak and strong law of large numbers, central limit theorem. Sampling distributions, UMVU estimators, sufficiency and consistency, maximum likelihood estimators. Testing of hypotheses, Neyman-Pearson tests, monotone likelihood ratio, likelihood ratio tests, standard parametric tests based on normal, X2 ,t, F-distributions. Linear regression and test for linearity of regression. Interval estimation.

Linear Programming: Linear programming problem and its formulation, convex sets their properties, graphical method, basic feasible solution, simplex method, big-M and two phase methods, infeasible and unbounded LPP's, alternate optima. Dual problem and duality theorems, dual simplex method and its application in post optimality analysis, interpretation of dual variables. Balanced and unbalanced transportation problems, unimodular property and u-v method for solving transportation problems. Hungarian method for solving assignment problems.

Calculus of Variations and Integral Equations: Variational problems with fixed boundaries; sufficient conditions for extremum, Linear integral equations of Fredholm and Volterra type, their iterative solutions. Fredholm alternative.

ME - MECHANICAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

APPLIED MECHANICS AND DESIGN

Engineering Mechanics: Equivalent force systems, free-body concepts, equations of equilibrium, trusses and frames, virtual work and minimum potential energy. Kinematics and dynamics of particles and rigid bodies, impulse and momentum (linear and angular), energy methods, central force motion.

Strength of Materials: Stress and strain, stress-strain relationship and elastic constants, Mohr's circle for plane stress and plane strain, shear force and bending moment diagrams, bending and shear stresses, deflection of beams, torsion of circular shafts, thin and thick cylinders, Euler's theory of columns, strain energy methods, thermal stresses.

Theory of Machines: Displacement, velocity and acceleration, analysis of plane mechanisms, dynamic analysis of slider-crank mechanism, planar cams and followers, gear tooth profiles, kinematics of gears, governors and flywheels, balancing of reciprocating and rotating masses.

Vibrations: Free and forced vibration of single degree freedom systems, effect of damping, vibration isolation, resonance, critical speed of rotors.

Design of Machine Elements: Design for static and dynamic loading, failure theories, fatigue strength; design of bolted, riveted and welded joints; design of shafts and keys; design of spur gears, rolling and sliding contact bearings; brakes and clutches; belt, rope and chain drives.

FLUID MECHANICS AND THERMAL SCIENCES

Fluid Mechanics: Fluid properties, fluid statics, manometry, buoyancy; control-volume analysis of mass, momentum and energy; fluid acceleration; differential equations of continuity and momentum; Bernoulli's equation; viscous flow of incompressible fluids; boundary layer; elementary turbulent flow; flow through pipes, head losses in pipes, bends etc.

Heat-Transfer: Modes of heat transfer; one dimensional heat conduction, resistance concept, electrical analogy, unsteady heat conduction, fins; dimensionless parameters in free and forced convective heat transfer, various correlations for heat transfer in flow over flat plates and through pipes; thermal boundary layer; effect of turbulence; radiative heat transfer, black and grey surfaces, shape factors, network analysis; heat exchanger performance, LMTD and NTU methods.

Thermodynamics: Zeroth, First and Second laws of thermodynamics; thermodynamic system and processes; irreversibility and availability; behaviour of ideal and real gases, properties of pure substances, calculation of work and heat in ideal processes; analysis of thermodynamic cycles related to energy conversion; Carnot, Rankine, Otto, Diesel, Brayton and vapour compression cycles.

Power Plant Engineering: Steam generators; steam power cycles; steam turbines; impulse and reaction principles, velocity diagrams, pressure and velocity compounding; reheating and reheat factor; condensers and feed heaters.

I.C. Engines: Requirements and suitability of fuels in IC engines, fuel ratings, fuel-air mixture requirements; normal combustion in SI and CI engines; engine performance calculations.

Refrigeration and air-conditioning: Refrigerant compressors, expansion devices, condensers and evaporators; properties of moist air, psychrometric chart, basic psychometric processes.

Turbomachinery: Components of gas turbines; compression processes, centrifugal and axial flow compressors; axial flow turbines, elementary theory; hydraulic turbines; Euler-turbine equation; specific speed, Pelton-wheel, Francis and Kaplan turbines; centrifugal pumps.

MANUFACTURING AND INDUSTRIAL ENGINEERING

Engineering Materials: Structure and properties of engineering materials and their applications, heat treatment.

Metal Casting: Casting processes (expendable and non-expendable) -pattern, moulds and cores, heating and pouring, solidification and cooling, gating design, design considerations, defects.

Forming Processes: Stress-strain diagrams for ductile and brittle material, Plastic deformation and yield criteria, fundamentals of hot and cold working processes, Bulk metal forming processes (forging, rolling, extrusion, drawing), sheet metal working processes (punching, blanking, bending, deep drawing, coining, spinning, load estimation using homogeneous deformation methods, defects). processing of powder metals- atomization, compaction, sintering, secondary and finishing operations. forming and shaping of plastics- extrusion, injection moulding.

Joining Processes: Physics of welding, fusion and non-fusion welding processes, brazing and soldering, adhesive bonding, design considerations in welding, weld quality defects.

Machining and Machine Tool Operations: Mechanics of machining, single and multi-point cutting tools, tool geometry and materials, tool life and wear, cutting fluids, machinability, economics of machining, non-traditional machining processes.

Metrology and Inspection: Limits, fits and tolerances, linear and angular measurements, comparators, gauge design, interferometry, form and finish measurement, measurement of screw threads, alignment and testing methods.

Tool Engineering: Principles of work holding, design of jigs and fixtures.

Computer Integrated Manufacturing: Basic concepts of CAD, CAM and their integration tools.

Manufacturing Analysis: Part-print analysis, tolerance analysis in manufacturing and assembly, time and cost analysis.

Work-Study: Method study, work measurement, time study, work sampling, job evaluation, merit rating.

Production Planning and Control: Forecasting models, aggregate production planning, master scheduling, materials requirements planning.

Inventory Control: Deterministic and probabilistic models, safety stock inventory control systems.

Operations Research: Linear programming, simplex and duplex method, transportation, assignment, network flow models, simple queuing models, PERT and CPM

MN - MINING ENGINEERING

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes,

Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

MINING ENGINEERING

Mechanics: Equivalent force systems, equations of equilibrium, two dimensional frames and trusses, free body diagrams, friction forces, particle kinematics and dynamics.

Mine Development, Geomechanics and Strata Control: Drivages for underground mine development, drilling methods and machines, explosives, blasting devices and practices, shaft sinking. Physico-mechanical properties of rocks, rock mass classification, ground control instrumentation and stress measurement techniques, theories of rock failure, ground vibrations, stress distribution around mine openings, subsidence, design of supports in roadways and workings, stability of open pits, slopes.

Mining Methods and Machinery: Surface mining - layout, development, loading, transportation and mechanization, continuous surface mining systems. Underground coal mining - bord and pillar system, longwall mining, thick seam mining methods. Underground metal mining: different stoping methods, stope mechanization, ore handling systems, mine filling. Generation and transmission of mechanical, hydraulic, and pneumatic power. Materials handling - haulages, conveyors, ropeways, face and development machinery, hoisting systems, and pumps.

Ventilation, Underground Hazards and Surface Environment: Underground atmosphere, heat load sources and thermal environment, air cooling, mechanics of air flow distribution, natural and mechanical ventilation, mine fans and their usage, auxiliary ventilation. Subsurface hazards from fires, explosions, gases, dust, and inundation, rescue apparatus and practices, safety in mines, accident analysis, noise, mine lighting. Air and water pollution: causes, dispersion, quality standards, and control.

Surveying, Mine Planning and Systems Engineering: Fundamentals of engineering surveying, Levels and levelling, Theodolite, tacheometry, triangulation, contouring, errors and adjustments, correlation, underground surveying, curves, photogrammetry, field astronomy, GPS fundamentals. Principles of planning - Sampling methods and practices, reserve estimation techniques, basics of geostatistics, optimization of facility location, cash flow concepts and mine valuation, open pit design. Work study, concepts of reliability, reliability of series and parallel systems. Linear programming, transportation and assignment problems, queueing, network analysis, inventory control.

MT - METALLURGICAL ENGINEERING

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes,

Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

METALLURGICAL ENGINEERING

Thermodynamics and Rate Processes: Laws of thermodynamics, activity, equilibrium constant, applications to metallurgical systems, solutions, phase equilibria, basic kinetic laws, order of reactions, rate constants and rate limiting steps principles of electro chemistry, aqueous, corrosion and protection of metals, oxidation and high temperature corrosion - characterization and control; momentum transfer - concepts of viscosity, shell balances, Bernoulli's equation; heat transfer - conduction, convection and heat transfer coefficient relations, radiation, mass transfer - diffusion and Fick's laws.

Extractive Metallurgy: Flotation, gravity and other methods of mineral processing; agglomeration, pyro-hydro-and electro-metallurgical processes; material and energy balances; principles and processes for the extraction of non-ferrous metals - aluminium, copper, zinc, lead, magnesium, nickel, titanium and other rare metals; iron and steel making - principles, blast furnace, direct reduction processes, primary and secondary steel making, deoxidation and inclusion in steel; ingot and continuous casting; stainless steel making, design of furnaces; fuels and refractories.

Physical Metallurgy: Crystal structure and bonding characteristics of metals, alloys, ceramics and polymers; solid solutions; solidification; phase transformation and binary phase diagrams; principles of heat treatment of steels, aluminum alloys and cast irons; recovery, recrystallization and grain growth; industrially important ferrous and non-ferrous alloys; elements of X-ray and electron diffraction; principles of scanning and transmission electron microscopy; elements of ceramics, composites and electronic materials; electronic basis of thermal, optical, electrical and magnetic properties of materials.

Mechanical Metallurgy: Elements of elasticity and plasticity; defects in crystals; elements of dislocation theory - types of dislocations, slip and twinning, stress fields of dislocations, dislocation interactions and reactions, methods of seeing dislocations; strengthening mechanisms; tensile, fatigue and creep behaviour; superplasticity; fracture - Griffith theory, ductile to brittle transition, fracture toughness; failure analysis; mechanical testing - tension, compression, torsion, hardness, impact, creep, fatigue, fracture toughness and formability tests.

Manufacturing Processes: Metal casting - patterns, moulds, melting, gating, feeding and casting processes, defects and castings, hot and cold working of metals; Metal forming - fundamentals of metal forming, rolling wire drawing, extrusion, forming, sheet metal forming processes, defects in forming; Metal joining - soldering, brazing and welding, common welding processes, welding metallurgy, problems associated with welding of steels and aluminium alloys, defects in welding, powder metallurgy; NDT methods - ultrasonic, radiography, eddy current, acoustic emission and magnetic.

PH - PHYSICS

Mathematical Physics: Linear vector space, matrices; vector calculus; linear differential equations; elements of complex analysis; Laplace transforms, Fourier analysis, elementary ideas about tensors.

Classical Mechanics: Conservation laws; central forces; collisions and scattering in laboratory and centre of mass reference frames; mechanics of system of particles; rigid body dynamics; moment of inertia tensor; noninertial frames and pseudo forces; variational principle; Lagrange's and Hamilton's formalisms; equation of motion, cyclic coordinates, Poisson bracket; periodic motion, small oscillations, normal modes; wave equation and wave propagation; special theory of relativity - Lorentz transformations, relativistic kinematics, mass-energy equivalence.

Electromagnetic Theory: Laplace and Poisson equations; conductors and dielectrics; boundary value problems; Ampere's and Biot-Savart's laws; Faraday's law; Maxwell's equations; scalar and vector potentials; Coulomb and Lorentz gauges; boundary conditions at interfaces; electromagnetic waves; interference, diffraction and polarization; radiation from moving charges.

Quantum Mechanics: Physical basis of quantum mechanics; uncertainty principle; Schrodinger equation; one and three dimensional potential problems; Particle in a box, harmonic oscillator, hydrogen atom; linear vectors and operators in Hilbert space; angular momentum and spin; addition of angular momentum; time independent perturbation theory; elementary scattering theory.

Atomic and Molecular Physics: Spectra of one-and many-electron atoms; LS and jj coupling; hyperfine structure; Zeeman and Stark effects; electric dipole transitions and selection rules; X-ray spectra; rotational and vibrational spectra of diatomic molecules; electronic transition in diatomic molecules, Franck-Condon principle; Raman effect; NMR and ESR; lasers.

Thermodynamics and Statistical Physics: Laws of thermodynamics; macrostates, phase space; probability ensembles; partition function, free energy, calculation of thermodynamic quantities; classical and quantum statistics; degenerate Fermi gas; black body radiation and Planck's distribution law; Bose-Einstein condensation; first and second order phase transitions, critical point.

Solid State Physics: Elements of crystallography; diffraction methods for structure determination; bonding in solids; elastic properties of solids; defects in crystals; lattice vibrations and thermal properties of solids; free electron theory; band theory of solids; metals, semiconductors and insulators; transport properties; optical, dielectric and magnetic properties of solids; elements of superconductivity.

Nuclear and Particle Physics: Rutheford scattering; basic properties of nuclei; radioactive decay; nuclear forces; two nucleon problem; nuclear reactions; conservation laws; fission and fusion; nuclear models; particle accelerators, detectors; elementary particles; photons, baryons, mesons and leptons; Quark model.

Electronics: Network analysis; semiconductor devices; bipolar transistors; FETs; power supplies, amplifier, oscillators; operational amplifiers; elements of digital electronics; logic circuits.

PI - PRODUCTION AND INDUSTRIAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear

differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

GENERAL ENGINEERING:

Engineering Materials: Structure and properties of engineering materials and their applications; effect of strain, strain rate and temperature on mechanical properties of metals and alloys; heat treatment of metals and alloys.

Applied Mechanics: Engineering mechanics - equivalent force systems, free body concepts, equations of equilibrium, virtual work and minimum potential energy; strength of materials-stress, strain and their relationship, Mohr's circle, deflection of beams, bending and shear stress, Euler's theory of columns.

Theory of Machines and Design: Analysis of planar mechanisms, plane cams and followers; governers and fly wheels; design of elements-failure theories; design of bolted, riveted and welded joints; design of shafts, keys, belt drives, brakes and clutches.

Thermal Engineering: Fluid machines - fluid statics, Bernoulli's equation, flow through pipes, equations of continuity and momentum; Thermodynamics - zeroth, First and Second laws of thermodynamics, thermodynamic system and processes, calculation of work and heat for systems and control volumes; Heat transfer - fundamentals of conduction, convection and radiation.

PRODUCTION ENGINEERING

Metal Casting: Casting processes; patterns-materials; allowances; moulds and cores - materials, making and testing; melting and founding of cast iron, steels and nonferrous metals and alloys; solidification; design of casting, gating and risering; casting defects and inspection.

Metal working: Stress-strain in elastic and plastic deformation; deformation mechanisms; hot and cold working-forging, rolling, extrusion, wire and tube drawing; sheet metal working; analysis of rolling, forging, extrusion and wire /rod drawing; metal working defects, high energy rate forming processes-explosive, magnetic, electro and electrohydraulic.

Metal Joining Processes: Welding processes - gas shielded metal arc, TIG, MIG, submerged arc, electroslag, thermit, resistance, pressure and forge welding; thermal cutting; other joining processes - soldering, brazing, braze welding; welding codes, welding symbols, design of welded joints, defects and inspection; introduction to modern welding processes - friction, ultrasonic, explosive, electron beam, laser and plasma.

Machining and Machine Tool Operations: Machining processes-turning, drilling, boring, milling, shaping, planing, sawing, gear cutting, thread production, broaching, grinding, lapping, honing super finishing; mechanics of cutting- Merchant's analysis, geometry of cutting tools, cutting forces, power requirements; selection of process parameters; tool materials, tool wear and tool life, cutting fluids, machinability; nontraditional machining processes and hybrid processes- EDM, CHM, ECM, USM, LBM, EBM, AJM, PAM AND WJM; economics of machining.

Metrology and Inspection: Limits and fits, linear and angular measurements by mechanical and optical methods, comparators; design of limit gauges; interferometry; measurement of straightness, flatness, roundness, squareness and symmetry; surface finish measurement; inspection of screw threads and gears; alignment testing.

Powder Metallurgy and Processing of Plastics: Production of powders, compaction, sintering; Polymers and composites; injection, compression and blow molding, extrusion, calendaring and thermoforming; molding of composites.

Tool Engineering: Work-holding-location and clamping; principles and methods; design of jigs and fixtures; design of press working tools, forging dies.

Manufacturing Analysis: Sources of errors in manufacturing; process capability; part-print analysis; tolerance analysis in manufacturing and assembly; process planning; parameter selection and comparison of production alternatives; time and cost analysis; Issues in choosing manufacturing technologies and strategies.

Computer Integrated Manufacturing: Basic concepts of CAD, CAM, CAPP, group technology, NC, CNC, DNC, FMS, Robotics and CIM.

INDUSTRIAL ENGINEERING

Product Design and Development: Principles of good product design, component and tolerance design; efficiency, quality and cost considerations; product life cycle; standardization, simplification, diversification, value analysis, concurrent engineering.

Engineering Economy and Costing: Financial statements; elementary cost accounting, methods of depreciation; break-even analysis, techniques for evaluation of capital investments.

Work System Design: Taylor's scientific management, Gilbreths's contributions; productivity concepts and measurements; method study, micro-motion study, principles of motion economy; human factors engineering, ergonomics; work measurement - time study, PMTS, work sampling; job evaluation, merit rating, wage administration, incentive systems; business process reengineering.

Logistics and Facility Design: Facility location factors, evaluation of alternatives, types of plant layout, evaluation; computer aided layout; assembly line balancing; material handling systems; supply chain management.

Production Planning and Inventory Control: Inventory Function costs, classifications - deterministic and probabilistic models; quantity discount; safety stock; inventory control system; Forecasting techniques - causal and time series models, moving average, exponential smoothing; trend and seasonality; aggregate production planning; master scheduling; bill of materials and material requirement planning; order control and flow control, routing, scheduling and priority dispatching; JIT; Kanban PULL systems; bottleneck scheduling and theory of constraints.

Operation Research: Linear programming - problem formulation, simplex method, duality and sensitivity analysis; transportation; assignment; network flow models, constrained optimization and Lagrange multipliers; simple queuing models; dynamic programming; simulation; PERT and CPM, time-cost trade-off, resource leveling.

Quality Control: Taguchi method; design of experiments; quality costs, statistical quality assurance, process control charts, acceptance sampling, zero defects; quality circles, total quality management.

Reliability and Maintenance: Reliability, availability and maintainability; probabilistic failure and repair times; system reliability; preventive maintenance and replacement, TPM.

Management Information System: Value of information; information storage and retrieval system - database and data structures; interactive systems; knowledge based systems.

Intellectual Property System: Definition of intellectual property, importance of IPR; TRIPS, and its implications, WIPO and Global IP structure, and IPS in India; patent, copyright, industrial design and trademark; meanings, rules and procedures, terms, infringements and remedies.

PY - PHARMACEUTICAL SCIENCES

Natural Products: Pharmacognosy & Phytochemistry - Chemistry, tests, isolation, characterization and estimation of phytopharmaceuticals belonging to the group of Alkaloids, Glycosides, Terpenoids, Steroids, Bioflavanoids, Purines, Guggul lipids. Pharmacognosy of crude drugs which contain the above constituents. Standardisation of raw materials and herbal products. WHO guide lines. Quantitative microscopy including modern techniques used for evaluation. Biotechnological principles and techniques for plant development Tissue culture.

Pharmacology: General pharmacological principles including Toxicology. Drug interaction. Pharmacology of drugs acting on Central nervous system, Cardiovascular system, Autonomic nervous system, Gastro intestinal system and Respiratory system. Pharmacology of Autocoids, Hormones, Chemotherapeutic agents including anticancer drugs. Bioassays. Immuno Pharmacology.

Medicinal Chemistry: Structure, nomenclature, classification, synthesis, SAR and metabolism of the following category of drugs which are official in Indian Pharmacopoeia and British Pharmacopoeia Hypnotics and Sedatives, Analgesics, NSAIDS, Neuroleptics, Antidepressants, Anxiolytics, Anticonvulsants, Antihistaminics, Local anaesthetics, Cardio Vascular drugs - Antianginal agents Vasodilators, Adrenergic & cholinergic drugs, Cardiotonic agents, Diuretics, Antihypertensive drugs, Hypoglycemic agents, Antilipedmic agents, Coagulants, Anticoagulants, Antiplatelet agents. Chemotherapeutic agents - Antibiotics, Antibacterials, Sulphadrugs. Antiproliozoal drugs, Antiviral, Antitubercular, Antimalarial, Anticancer, Antiamoebic drugs. Diagnostic agents. Preparation and storage and uses of official Radiopharmaceuticals. Vitamins and Hormones.

Pharmaceutics: Development, manufacturing standards, labeling, packing as per the pharmacopoeal requirements, Storage of different dosage forms and new drug delivery systems. Biopharmaceutics and Pharmacokinetics and their importance in formulation. Formulation and preparation of cosmetics - lipstick, shampoo, creams, nail preparations and dentifrices. Pharmaceutical calculations.

Pharmaceutical Jurisprudence: Legal aspects of manufacture, storage, sale of drugs. D and C act and rules. Pharmacy act.

Pharmaceutical Analysis: Principles, instrumentation and applications of the following. Absorption spectroscopy (UV, visible & IR), Fluorimetry, Flame photometry, Potentiometry, Conductometry and Plarography. Pharmacopoeial assays. Principles of NMR, ESR, Mass spectroscopy, X-ray diffraction analysis and different chromatographic methods.

Biochemistry and Clinical Pharmacy: Biochemical role of hormones, Vitamins, Enzymes, Nucleic acids. Bioenergetics. General principles of immunology. Immunological techniques. Adverse drug interaction.

Microbiology: Principles and methods of microbiological assays of the Pharmacopoeia. Methods of preparation of official sera and vaccines. Serological and diagnostic tests. Applications of microorganisms in Bio Conversions and in Pharmaceutical industry.

TF - TEXTILE ENGINEERING AND FIBRE SCIENCE

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

TEXTILE ENGINEERING & FIBRE SCIENCE

Textile Fibres: Classification of textile fibres according to their nature and origin; general characteristics of textile fibres-their chemical and physical structures and their properties; essential characteristics of fibre forming polymers; uses of natural and man-made fibres; physical and chemical methods of fibre and blend identification and blend analysis.

Melt Spinning processes with special reference to polyamide and polyester fibres; wet and dry spinning of viscose and acrylic fibres; post spinning operations-drawing, heat setting, texturing- false twist and air-jet, tow-to-top conversion. Methods of investigating fibre structure e.g. X-ray diffraction, birefringence, optical and electron microscopy, I.R. absorption, thermal methods; structure and morphology and principal natural and man-made fibres, mechanical properties of fibres, moisture sorption in fibres; fibre structure and property correlation.

Textile Testing: Sampling techniques, sample size and sampling errors; measurement of fibre length, fineness, crimp, strength and reflectance; measurement of cotton fibre maturity ad trash content; HVI and AFIS for fibre testing. Measurement of yarn count, twist and hairiness; tensile testing of fibres, yarn and fabrics; evenness testing of slivers, rovings and yarns; testing equipment for measurement test methods of fabric properties like thickness, compressibility, air permeability, drape, crease recovery, tear strength bursting strength and abrasion resistance. Correlation analysis, significance tests and analysis of variance; frequency distributions and control charts.

Yarn Manufacture and Yarn Structure: Modern methods of opening, cleaning and blending of fibrous materials; the technology of carding with particular reference to modern developments; causes of irregularity introduced by drafting, the development of modern drafting systems; principles and techniques of preparing material for combing; recent development in combers; functions and synchronization of various mechanisms concerned with roving production; forces acting on yarn and traveller, ring and traveller designs; causes of end breakages; properties of doubles yarns; new methods of yarn production such as rotor spinning, air jet spinning and friction spinning.

Yarn diameter; specific volume, packing coefficient; twist-strength relationship; fibre orientation in yarn; fibre migration.

Fabric Manufacture and Fabric Structure: Principles of cheese and cone winding processes and machines; random and precision winding; package faults and their remedies; yarn clearers and tensioners; different systems of yarn splicing; features of modern cone winding machines;

different types of warping creels; features of modern beam and sectional warping machines; different sizing systems, sizing of spun and filament yarns, modern sizing machines; principles of pirn winding processes and machines; primary and secondary motions of loom, effect of their settings and timings on fabric formation, fabric appearance and weaving performance; dobby and jacquard shedding; mechanics of weft insertion with shuttle; warp and weft stop motions, warp protection, weft replenishment; functional principles of weft insertion systems of shuttleless weaving machines, principles of multiphase and circular looms. Principles of weft and warp knitting; basic weft and warp knitted structures; classification, production and areas of application of nonwoven fabrics.

Basic woven fabric constructions and their derivatives; crepe, cord, terry, gauze, lino and double cloth constructions.

Peirce's equations for fabric geometry; thickness, cover and maximum sett of woven fabrics

Textile Chemical Processing: Preparatory processes for natural-and and their blends; mercerization of cotton; machines for yarn and fabric mercerization.

Dyeing and printing of natural- and synthetic- fibre fabrics and their blends with different dye classes; dyeing and printing machines; styles of printing; fastness properties of dyed and printed textile materials.

Finishing of textile materials, wash and wear, durable press, soil release, water repellent, flame retardant and antistatic finishes; shrink-resistance finish for wool; heat setting of synthetic-fibre fabrics, finishing machines; energy efficient processes; pollution control.

XE - ENGINERING SCIENCES

The syllabi of the sections of this paper are as follows:

SECTION A. ENGINEERING MATHEMATICS (Compulsory)

Linear Algebra : Determinates, algebra of matrices, rank, inverse, system of linear equations, symmetric, skew-symmetric and orthogonal matrices. Hermitian, skew-hermitian and unitary matrices. eigenvalues and eigenvectors, diagonalisation of matrices, Cayley-Hamiltonian, quadratic forms.

Calculus : Functions of single variables, limit, continuity and differentiability, Mean value theorems, Intermediate forms and L'Hospital rule, Maxima and minima, Taylor's series, Fundamental and mean value-theorems of integral calculus. Evaluation of definite and improper integrals, Beta and Gamma functions, Functions of two variables, limit, continuity, partial derivatives, Euler's theorem for homogeneous functions, total derivatives, maxima and minima, Lagrange method of multipliers, double and triple integrals and their applications, sequence and series, tests for convergence, power series, Fourier Series, Fourier integrals.

Complex variable: Analytic functions, Cauchy's integral theorem and integral formula without proof. Taylor's and Laurent' series, Residue theorem (without proof) with application to the evaluation of real integarls.

Vector Calculus: Gradient, divergence and curl, vector identities, directional derivatives, line, surface and volume integrals, Stokes, Gauss and Green's theorems (without proofs) with applications.

Ordinary Differential Equations: First order equation (linear and nonlinear), higher order linear differential equations with constant coefficients, method of variation of paramaters, Cauchy's and Euler's equations, initial and boundary value problems, power series solutions, Legendre polynomials and Bessel's functions of the first kind.

Partial Differential Equations: Variables separable method, solutions of one dimensional heat, wave and Laplace equations.

Probability and Statistics: Definitions of probability and simple theorems, conditional probability, mean, mode and standard deviation, random variables, discrete and continuous distributions, Poisson, normal and Binomial distribution, correlation and regression

Numerical Methods: L-U decomposition for systems of linear equations,Newton-Raphson method, numerical integration(trapezoidal and Simpson's rule), numerical methods for first order differential equation (Euler method)

SECTION B. COMPUTATIONAL SCIENCE

Numerical Methods: Truncation errors, round off errors and their propagation; Interpolation; Lagrange, Newton's forward, backward and divided difference formulas, least square curve fitting, solution of non-linear equations of one variables using bisection, false position, secant and Newton Raphson methods; Rate of convergence of these methods, general iterative methods. Simple and multiple roots of polynomials. Solutions of system of linear algebraic equations using Gauss elimination methods, Jacobi and Gauss-Seidel iterative methods and their rate of convergence; ill conditioned and well conditioned system. eigen values and eigen vectors using power methods. Numerical integration using trapezoidal, Simpson's rule and other quadrature formulas. Numerical Differentiation. Solution of boundary value problems. Solution of initial value problems of ordinary differential equations using Euler's method, predictor corrector and Runge Kutta method.

Programming : Elementary concepts and terminology of a computer system and system software, Fortran77 and C programming.

Fortran : Program organization, arithmetic statements, transfer of control, Do loops, subscripted variables, functions and subroutines.

C language : Basic data types and declarations, flow of control- iterative statement, conditional statement, unconditional branching, arrays, functions and procedures.

SECTION C. ELECTRICAL SCIENCES

Electric Circuits: Ideal voltage and current sources; RLC circuits, steady state and transient analysis of DC circuits, network theorems; alternating currents and voltages, single-phase AC circuits, resonance; three-phase circuits.

Magnetic circuits: Mmf and flux, and their relationship with voltage and current; transformer, equivalent circuit of a practical transformer, three-phase transformer connections.

Electrical machines: Principle of operation, characteristics, efficiency and regulation of DC and synchronous machines; equivalent circuit and performance of three-phase and single-phase induction motors.

Electronic Circuits: Characteristics of p-n junction diodes, zener diodes, bipolar junction transistors (BJT) and junction field effect transistors (JFET); MOSFET's structure, characteristics, and operations; rectifiers, filters, and regulated power supplies; biasing circuits, different configurations of transistor amplifiers, class A, B and C of power amplifiers; linear applications of operational amplifiers; oscillators; tuned and phase shift types.

Digital circuits: Number systems, Boolean algebra; logic gates, combinational circuits, flip-flops (RS, JK, D and T) counters.

Measuring instruments: Moving coil, moving iron, and dynamometer type instruments; shunts, instrument transformers, cathode ray oscilloscopes; D/A and A/D converters.

SECTION D. FLUID MECHANICS

Fluid Properties: Relation between stress and strain rate for Newtonian fluids

Hydrostatics, buoyancy, manometry

Concept of local and convective accelerations; control volume analysis for mass, momentum and energy conservation.

Differential equations of continuity and momentum (Euler's equation of motion); concept of fluid rotation, stream function, potential function; Bernoulli's equation and its applications.

Qualitative ideas of boundary layers and its separation; streamlined and bluff bodies; drag and lift forces.

Fully-developed pipe flow; laminar and turbulent flows; friction factor; Darcy Weisbach relation; Moody's friction chart; losses in pipe fittings; flow measurements using venturimeter and orifice plates.

Dimensional analysis; similitude and concept of dynamic similarity; importance of dimensionless numbers in model studies.

SECTION E. MATERIALS SCIENCE

Atomic structure and bonding in materials: metals, ceramics and polymers.

Structure of materials: Crystal systems, unit cells and space lattice; determination of structures of simple crystals by X-ray diffraction; Miller indices for planes and directions. Packing geometry in metallic, ionic and covalent solids.

Concept of amorphous, single and polycrystalline structures and their effects on properties of materials.

Imperfections in crystalline solids and their role in influencing various properties.

Fick´s laws of diffusion and applications of diffusion in sintering, doping of semiconductors and surface hardening of metals.

Alloys: solid solution and solubility limit. Binary phase diagram, intermediate phases and intermetallic compounds; iron-iron carbide phase diagram. Phase transformation in steels. Cold and hot working of metals, recovery, recrystallization and grain growth.

Properties and applications of ferrous and nonferrous alloys.

Structure, properties, processing and applications of traditional and advanced ceramics.

Polymers: classification, polymerization, structure and properties, additives for polymer products, processing and application.

Composites: properties and application of various composites.

Corrosion and environmental degradation of materials (metals, ceramics and polymers).

Mechanical properties of materials: Stress-strain diagrams of metallic, ceramic and polymeric materials, modulus of elasticity, yield strength, plastic deformation and toughness, tensile strength and elongation at break; viscoelasticity, hardness, impact strength. ductile and brittle fracture. creep and fatigue properties of materials.

Heat capacity, thermal conductivity, thermal expansion of materials.

Concept of energy band diagram for materials; conductors, semiconductors and insulators in terms of energy bands. Electrical conductivity, effect of temperature on conductivity in materials, intrinsic and extrinsic semiconductors, dielectric properties of materials.

Refraction, reflection, absorption and transmission of electromagnetic radiation in solids.

Origin of magnetism in metallic and ceramic materials, paramagnetism, diamagnetism, antiferromagnetism, ferromagnetism, ferrimagnetism in materials and magnetic hysteresis.

Advanced materials: Smart materials exhibiting ferroelectric, piezoelectric, optoelectronic, semiconducting behaviour; lasers and optical fibers; photoconductivity and superconductivity in materials.

SECTION F. SOLID MECHANICS

Equivalent force systems; free-body diagrams; equilibrium equations; analysis of determinate and indeterminate trusses and frames; friction.

Simple relative motion of particles; force as function of position, time and speed; force acting on a body in motion; laws of motion; law of conservation of energy; law of conservation of momentum

Stresses and strains; principal stresses and strains; Mohr's circle; generalized Hooke's Law; equilibrium equations; compatibility conditions; yield criteria.

Axial, shear and bending moment diagrams; axial, shear and bending stresses; deflection (for symmetric bending); torsion in circular shafts; thin cylinders; energy methods (Castigliano's Theorems); Euler buckling.

SECTION G. THERMODYNAMICS

Basic Concepts: Continuum, macroscopic approach, thermodynamic system (closed and open or control volume); thermodynamic properties and equilibrium; state of a system, state diagram, path and process; different modes of work; Zeroth law of thermodynamics; concept of temperature; heat.

First Law of Thermodynamics: Energy, enthalpy, specific heats, first law applied to systems and control volumes, steady and unsteady flow analysis.

Second Law of Thermodynamics: Kelvin-Planck and Clausius statements, reversible and irreversible processes, Carnot theorems, thermodynamic temperature scale, Clausius inequality and concept of entropy, principle of increase of entropy; availability and irreversibility.

Properties of Pure Substances: Thermodynamic properties of pure substances in solid, liquid and vapour phases, P-V-T behaviour of simple compressible substances, phase rule, thermodynamic property tables and charts, ideal and real gases, equations of state, compressibility chart.

Thermodynamic Relations: T-ds relations, Maxwell equations, Joule-Thomson coefficient, coefficient of volume expansion, adiabatic and isothermal compressibilities, Clapeyron equation.

Ideal Gas Mixtures: Dalton's and Amagat's laws, calculations of properties, air-water vapour mixtures.

XL - LIFE SCIENCES

The syllabi of the Sections of this paper are as follows:

SECTION H. CHEMISTRY (Compulsory)

Atomic structure and periodicity: Quantum chemistry; Planck's quantum theory, wave particle duality, uncertainty principle, quantum mechanical model of hydrogen atom; electronic configuration of atoms; periodic table and periodic properties; ionization energy, election affinity, electronegativity, atomic size.

Structure and bonding: Ionic and covalent bonding M.O. and V.B. approaches for diatomic molecules, VSEPR theory and shape of molecules, hybridisation, resonance, dipole moment, structure parameters such as bond length, bond angle and bond energy, hydrogen bonding, van der Waals interactions. Ionic solids; ionic radii, lattice energy (Born-Haber Cycle).

s.p. and d Block Elements: Oxides, halides and hydrides of alkali and alkaline earth metals, B, Al, S, N, P and S, silicones, general characteristics of 3d elements, coordination complexes: valence bond and crystal field theory, color, geometry and magnetic properties.

Chemical Equilibria: Colligative properties of solutions, ionic equilibria in solution, solubility product, common ion effect, hydrolysis of salts, pH, buffer and their applications in chemical analysis.

Electrochemistry: Conductance, Kohlrausch law, Half Cell potentials, emf, Nernst equation, galvanic cells, thermodynamic aspects and their applications.

Reaction Kinetics: Rate constant, order of reaction, molecularity, activation energy, zero, first and second order kinetics, equilibrium constants (Kc, Kp and Kx) for homogeneous reactions, catalysis and elementary enzyme reactions.

Thermodynamics: First law, reversible and irreversible processes, internal energy, enthalpy, Kirchoff's equation, heat of reaction, Hess law, heat of formation, Second law, entropy, free energy, and work function. Gibbs-Helmholtz equation, Clausius-Clapeyron equation, free energy change and equilibrium constant, Troutons rule, Third law of thermodynamics.

Mechanistic Basis of Organic Reactions: Elementary treatment of SN1, SN2, E1 and E2 reactions, Hoffmann and Saytzeff rules, Addition reactions, Markonikoff rule and Kharash effect, Diels-Alder reaction, aromatic electrophilic substitution, orientation effect as exemplified by various functional groups.

Structure-Reactivity Correlations: Acids and bases, electronic and steric effects, optical and geometrical isomerism, tautomerism, concept of aromaticity

SECTION I. BIOCHEMISTRY

Organization of life. Importance of water. Cell structure and organelles. Structure and function of biomolecules: Carbohydrates, Lipids, Proteins and Nucleic acids. Biochemical separation techniques. Spectroscopic methods; UV-visible and fluorescence. Protein structure, folding and function: Myoglobin, Hemoglobin, Lysozyme, ribonuclease A, Carboxypeptidase and Chymotrypsin. Enzyme kinetics and regulation, Coenzymes.

Metabolism and bioenergitics. Generation and utilization of ATP. Photosynthesis. Major metabolic pathways and their regulation. Biological membranes. Transport across membranes. Signal transduction; hormones and neurotransmitters.

DNA replication, transcription and translation. Biochemical regulation of gene expression. Recombinant DNA technology and applications. Genomics and Proteomics.

The immune system. Active and passive immunity. Complement system. Antobody structure, function and diversity. Cells of the immune system: T, B and macrophages. T and B cell activation. Major histocompatibilty complex. T cell receptor. Immunological techniques:

Immunodiffusion, immunoelectrophoresis, RIA and ELISA.

SECTION J. BIOTECHNOLOGY

Recombinant DNA technology for the production of therapeutic proteins. Micro array technology. Heterologous protein expression systems in bacteria, yeast etc.

Architecture of plant genome; plant tissue culture techniques; methods of gene transfer into plant cells; manipulation of phenotypic traits in plants; plant cell fermentations and production of secondary metabolites using suspension/ immobilized cell culture; methods for plant micro propagation; crop improvement and development of transgenic plants. Expression of animal proteins in plants.

Animal cell metabolism and regulation; cell cycle; primary cell culture; nutritional requirements for animal cell culture; techniques for the mass culture of animal cell lines; production of vaccines; growth hormones and interferons using animal cell culture; cytokines- production and therapeutic uses; hybridoma technology; vectors for gene transfer and expression in animal cells. Transgenic animals and molecular pharming.

Microbial production of industrial enzymes; methods for immobilization of enzymes; kinetics of soluble and immobilized enzymes; application of soluble and immobilized enzymes; enzyme-based sensors.

Microbial growth kinetics; batch, fed batch and continuous culture of microbial cells; media for industrial fermentations; sterilization of air and media; design features and operation of stirred tank, air-lift and fluidized bed reactors; aeration and agitation in aerobic fermentations; recovery and purification of fermentation products- filtration, centrifugation, cell disintegration, solvent extraction and chromatographic separations; industrial fermentations for the production of ethanol, citric acid, lysine, penicillin and other biomolecules; simple calculations based on material and energy balance of fermentation processes; application of microbes in the management of domestic and industrial wastes.

SECTION K. BOTANY

Anatomy: Roots, stem and leaves of land plants, meristems, vascular system, their ontogeny, structure and functions. Plant cell structure, organisation, organelles, cytoskeleton, cell wall and membranes.

Development: Cell cycle, cell division, senescence, hormonal regulation of growth; life cycle of an angiosperm, pollination, fertilization, embryogenesis, seed formation, seed storage proteins, seed dormancy and germination. Concept of cellular totipotency, organogenesis and somatic embryogenesis, somaclonal variation, embryo culture, in vitro fertilization.

Physiology and Biochemistry: Plant water relations, transport of minerals and solutes, N2 metabolism, proteins and nucleic acid, respiration, photophysiology, photosynthesis, photorespiration; biosynthesis, mechanism of action and physiological effects of plant growth regulators.

Genetics: Principles of Mendelian inheritance, linkage, recombination and genetic mapping; extrachromosomal inheritance; eukaryotic genome organization (chromatin structure) and regulation of gene expression, gene mutation, chromosome aberrations (numerical and structural), transposons.

Plant Breeding: Principles, methods - selection, hybridization, heterosis; male sterility, self and inter-specific incompatibility; haploidy; somatic cell hybridization; molecular marker-assisted selection; gene transfer methods viz. direct and vector-mediated, transgenic plants and their applications in agriculture.

Economic Botany: Economically important plants - cereals, pulses, plants yielding fiber, timber, sugar, beverages, oils, rubber, dyes, gums, drugs and narcotics - a general account.

Systematics: Systems of classification (non-phylogenetic vs. phylogenetic - outline), plant groups, molecular systematics.

Plant Pathology: Nature and classification of plant diseases, diseases of important crops caused by fungi, bacteria and viruses, and their control measures, mechanism(s) of pathogenesis and resistance, molecular detection of pathogens; plant-microbe beneficial interactions.

Ecology and Plant Geography: Ecosystems - types, dynamics, degradation, ecological succession; food chains; vegetation types of the world; pollution and global warming; speciation and extinction, conservation strategies, cryopreservation.

SECTION L. MICROBIOLOGY

Historical perspective - Discovery of the microbial world; Controversy over spontaneous generation; Role of microorganisms in transformation of organic matter and in the causation of diseases.

Methods in microbiology - Pure culture techniques; Theory and practice of sterilization; Principles of microbial nutrition; Construction of culture media; Enrichment culture techniques for isolation of chemoautotrophs, chemoheterotrophs and photosynthetic microorganisms.

Microbial evolution, systematics and taxonomy - Evolution of earth and earliest life forms; Primitive organisms and their metabolic strategies; New approaches to bacterial taxonomic classification including ribotyping; Nomenclature.

Microbial diversity - Bacteria, archea and their broad classification; Eukaryotic microbes, yeast, fungi, slime mold and protozoa; Viruses and their classification.

Microbial growth -The definition of growth, mathematical expression of growth, growth curve, measurement of growth and growth yields; Synchronous growth; Continuous culture.

Nutrition and metabolism - Overview of metabolism; Microbial nutrition; Energy classes of microorganisms; Culture media; Energetics, modes of ATP generation; ATP generation by heterotrophs; Fermentation; Glycolysis; Respiration; The citric acid cycle; Electron transport systems; Alternate modes of energy generation; Pathways (anabolism) in the biosynthesis of amino acids, purines, pyrimidines and fatty acids.

Metabolic diversity among microorganisms - Photosynthesis in microorganisms; Role of chlorophylls, carotenoids and phycobilins; Calvin cycle; Chemolithotrophy; Hydrogen- iron- nitrite-oxidizing bacteria; Nitrate and sulfate reduction; Methanogenesis and acetogenesis.

Prokaryotic cells: structure-function - Cells walls of eubacteria (peptidoglycan) and related molecules; Outer-membrane of gram-negative bacteria; Cell wall and cell membrane synthesis; Flagella and motility; Cell inclusions like endospores, gas vesicles.

Microbial diseases and host parasite relationships - Normal microflora of skin; Oral cavity; Gastrointestinal tract; Entry of pathogens into the host; Infectious disease transmission; Respiratory infections caused by bacteria and viruses; Tuberculosis; Sexually transmitted diseases including AIDS; Diseases transmitted by animals (Rabies, plague), insects and ticks (rikettsias, Lyme disease, malaria); Food and water borne diseases; Public health and water quality; Pahtogenic fungi; Emerging and resurgent infectious diseases.

Chemotherapy/Antibiotics - Antimicrobial agents; Sulfa drugs; Antibiotics; Pencillins and cephalosporins; Broad-spectrum antibiotics; Antibiotics from prokaryotes; Antifungal antibiotics; Mode of action; Resistance to antibiotics.

Microbial genetics - Genes, mutation and mutagenesis - UV and chemical mutagnes; Types of mutations; Ames test for mutagenesis; Methods of genetic analysis. Bacterial genetic system - Transformation; Conjugation; Transduction; Recombination; Plasmids and Transposons; Bacterial genetic map with reference to E. coli. Viruses and their genetic system - Phage ? and its life cycle; RNA phages; RNA viruses; Retroviruses; Genetic systems of yeast and Neurospora; Extrachromosomal inheritance and mitochondrial genetics; Basic concept of genomics.

SECTION M. ZOOLOGY

Animal world: Animal diversity, distribution, systematic and classification of animals, the phylogenetic relationship.

Evolution: Origin of life, history of life on earth, evolutionary theories, natural selection, adaptation, speciation.

Genetics: Principles of inheritance, molecular basis of heredity, the genetic material, transmission of genetic material, mutations, cytoplasmic inheritance.

Biochemistry and Molecular Biology: Nucleic acids, proteins and other biological macromolecules. Replication, transcription and translation, regulation of gene expression, organization of genome, Kreb's cycle, glycolysis, enzyme catalysis, hormones and their action.

Cell Biology: Structure of cell, cellular organelles and their structure and function, cell cycle, cell division, cellular differentiation, chromosome and chromatin structure. Eukaryotic gene organisation and expression.

Animal Anatomy and Physiology: Comparative physiology, the respiratory system, circulatory system, digestive system, the nervous system, the excretory system, the endocrine system, the reproductive system, the skeletal system, osmoregulation.

Parasitology and Immunology: Nature of parasite, host-parasite relation, protozoan and helminthic parasites, the immune response, cellular and humoral immune response, evolution of the immune system.

Development Biology: Embryonic development, cellular differentiation, organogenesis, metamorphosis, genetic basis of development.

Ecology: The ecosystem, habitats the food chain, population dynamics, species diversity, zoogeography, biogeochemical cycles, conservation biology.

Animal Behaviour: Types of behaviours, courtship, mating and territoriality, instinct, learning and memory, social behaviour across the animal taxa, communication, pheromones, evolution of animal behaviour.

IT - INFORMATION TECHNOLOGY

ENGINEERING MATHEMATICS

Mathematical Logic: Propositional Logic; First Order Logic.

Probability: Conditional Probability; Mean, Median, Mode and Standard Deviation; Random Variables; Distributions; uniform, normal, exponential, Poisson, Binomial.

Set Theory & Algebra: Sets; Relations; Functions; Groups; Partial Orders; Lattice; Boolean Algebra.

Combinatorics: Permutations; Combinations; Counting; Summation; generating functions; recurrence relations; asymptotics.

Graph Theory: Connectivity; spanning trees; Cut vertices & edges; covering; matching; independent sets; Colouring; Planarity; Isomorphism.

Linear Algebra: Algebra of matrices, determinants, systems of linear equations, Eigen values and Eigen vectors.

Numerical Methods: LU decomposition for systems of linear equations; numerical solutions of non linear algebraic equations by Secant, Bisection and Newton-Raphson Methods; Numerical integration by trapezoidal and Simpson's rules.

Calculus: Limit, Continuity & differentiability, Mean value Theorems, Theorems of integral calculus, evaluation of definite & improper integrals, Partial derivatives, Total derivatives, maxima & minima.

FORMAL LANGUAGES AND AUTOMATA

Regular Languages: finite automata, regular expressions, regular grammar.

Context free languages: push down automata, context free grammars

COMPUTER HARDWARE

Digital Logic: Logic functions, minimization, design and synthesis of combinatorial and sequential circuits, number representation and computer arithmetic (fixed and floating point)

Computer organization: Machine instructions and addressing modes, ALU and data path, hardwired and microprogrammed control, memory interface, I/O interface (interrupt and DMA mode), serial communication interface, instruction pipelining, cache, main and secondary storage

SOFTWARE SYSTEMS

Data structures and Algorithms: the notion of abstract data types, stack, queue, list, set, string, tree, binary search tree, heap, graph, tree and graph traversals, connected components, spanning trees, shortest paths, hashing, sorting, searching, design techniques (greedy, dynamic, divide and conquer), asymptotic analysis (best, worst, average cases) of time and space, upper and lower bounds, intractability

Programming Methodology: C programming, program control (iteration, recursion, functions), scope, binding, parameter passing, elementary concepts of object oriented programming

Operating Systems (in the context of Unix): classical concepts (concurrency, synchronization, deadlock), processes, threads and interprocess communication, CPU scheduling, memory management, file systems, I/O systems, protection and security

Information Systems and Software Engineering: information gathering, requirement and feasibility analysis, data flow diagrams, process specifications, input/output design, process life cycle, planning and managing the project, design, coding, testing, implementation, maintenance.

Databases: relational model, database design, integrity constraints, normal forms, query languages (SQL), file structures (sequential, indexed), b-trees, transaction and concurrency control

Data Communication: data encoding and transmission, data link control, multiplexing, packet switching, LAN architecture, LAN systems (Ethernet, token ring), Network devices: switches, gateways, routers

Networks: ISO/OSI stack, sliding window protocols, routing protocols, TCP/UDP, application layer protocols & systems (http, smtp, dns, ftp), network security

Web technologies: three tier web based architecture; JSP, ASP, J2EE, .NET systems; html, XML

AG - AGRICULTURAL ENGINEERING

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

FARM MACHINERY AND POWER:

Sources of power on the farm-human, animal, mechanical, electrical, wind, solar and biomass; design and selection of machine elements - gears, pulleys, chains and sprockets and belts; overload safety devices used in farm machinery; measurement of force, torque, speed, displacement and acceleration on machine elements.

Soil tillage; forces acting on a tillage tool; hitch systems and hitching of tillage implements; functional requirements, principles of working, construction and operation of manual, animal and power operated equipment for tillage. sowing, planting, fertilizer application, inter-cultivation, spraying, mowing, chaff cutting, harvesting, threshing and transport; testing of agricultural machinery and equipment; calculation of performance parameters -field capacity, efficiency, application rate and losses; cost analysis of implements and tractors.

Thermodynamic principles of I.C. engines; I.C. engine cycles; engine components; fuels and combustion; lubricants and their properties; I.C. engine systems - fuel, cooling, lubrication, ignition, electrical, intake and exhaust; selection, operation, maintenance and repair of I.C. engines; power efficiencies and measurement; calculation of power, torque, fuel consumption, heat load and power losses.

Tractors and power tillers - type, selection, maintenance and repair; tractor clutches and brakes; power transmission systems - gear trains, differential, final drives and power take-off; mechanics of tractor chassis; traction theory; three point hitches- free link and restrained link operations; mechanical steering and hydraulic control systems used in tractors; human engineering and safety in tractor design; tractor tests and performance.

SOIL AND WATER CONSERVATION ENGINEERING:

Ideal and real fluids, properties of fluids; hydrostatic pressure and its measurement; hydrostatic forces on plane and curved surface; continuity equation; Bernoulli's theorem; laminar and turbulent flow in pipes, Darcy-Weisbach and Hazen-Williams equations, Moody's diagram; flow through orifices and notches; flow in open channels.

Engineering properties of soils, fundamental definitions and relationships; index properties of soils; permeability and seepage analysis; shear strength, Mohr's circle of stresses; active and passive earth pressures; stability of slopes.

Hydrological cycle; precipitation measurement, analysis of precipitation data; abstraction from precipitation; runoff; hydrograph analysis, unit hydrograph theory and application; stream flow measurement; flood routing, hydrological reservoir and channel routing.

Mechanics of soil erosion, factors affecting erosion; soil loss estimation; biological and engineering measures to control erosion, terraces and bunds; vegetative waterways; gully control structures, drop, drop inlet and chute spillways; farm ponds; earthen dams; principles of watershed management.

Water requirement of crops; consumptive use and evapo-transpiration; irrigation scheduling; irrigation efficiencies; design of prismatic and silt loaded channels; methods of irrigation water application; design and evaluation of irrigation methods; drainage coefficient; surface and subsurface drainage systems; leaching requirement and salinity control; irrigation and drainage water quality; classification of pumps; pump characteristics; pump selection; types of aquifer; evaluation of aquifer properties; well hydraulics; ground water recharge.

AGRICULTURAL PROCESSING AND FOOD ENGINEERING:

Steady state heat transfer in conduction, convection and radiation; transient heat transfer in simple geometry; condensation and boiling heat transfer; working principles of heat exchangers; diffusive and convective mass transfer; simultaneous heat and mass transfer in agricultural processing operations.

Material and energy balances in food processing systems; water activity, sorption and desorption isotherms; centrifugal separation of solids, liquids and gases; kinetics of microbial death - pasteurisation and sterilization of liquid foods; preservation of food by cooling and freezing; psychrometry - properties of air-vapour mixture; concentration and dehydration of liquid foods - evaporators, tray, drum and spray dryers.

Mechanics and energy requirement in size reduction of granular solids; particle size analysis for comminuted solids; size separation by screening; fluidisation of granular solids; cleaning and grading efficiency and effectiveness of grain cleaners; conditioning and hydrothermal treatments for grains; dehydration of food grains; processes and machines for processing of cereals, pulses and oilseeds; design considerations for grain silos.

AR - ARCHITECTURE AND PLANNING

City planning: Historical development of cities; principles of city planning; new towns; survey methods, site planning, planning regulations and building bye-laws.

Housing: Concept of shelter; housing policies and design; community planning; role of government agencies; finance and management.

Landscape Design: Principles of landscape design and site planning; history and landscape styles; landscape elements and materials; planting design.

Computer Aided Design: Application of computers in architecture and planning; understanding elements of hardware and software; computer graphics; programming languages - C and Visual Basic and usage of packages such as AutoCAD.

Environmental and Building Science: Elements of environmental science; ecological principles concerning environment; role of micro-climate in design; climatic control through design elements; thermal comfort; elements of solar architecture; principles of lighting and illumination; basic principles of architectural acoustics; air pollution, noise pollution and their control.

Visual and Urban Design: Principles of visual composition; proportion, scale, rhythm, symmetry, harmony, balance, form and colour; sense of place and space, division of space; focal point, vista, imageability, visual survey.

History of Architecture: Indian - Indus valley, Vedic, Buddhist, Indo-Aryan, Dravidian and Mughal periods; European - Egyptian, Greek, Roman, medieval and renaissance periods.

Development of Contemporary Architecture: Architectural developments and impacts on society since industrial revolution; influence of modern art on architecture; works of national and international architects; post modernism in architecture.

Building Services: Water supply, Sewerage and Drainage systems; Sanitary fittings and fixtures; principles of electrification of buildings; elevators, their standards and uses; air-conditioning systems; fire fighting systems.

Building Construction and Management: Building construction techniques, methods and details; building systems and prefabrication of building elements; principles of modular coordination; estimation, specification, valuation, professional practice; project management, PERT, CPM.

Materials and Structural Systems: Behavioural characteristics of all types of building materials e.g. mud, timber, bamboo, brick, concrete, steel, glass, FRP; principles of strength of materials; design of structural elements in wood, steel and RCC; elastic and limit state design; complex structural systems; principles of pre-stressing.

Planning Theory: Planning process; multilevel planning; comprehensive planning; central place theory; settlement pattern; land use and land utilization.

Techniques of Planning: Planning surveys; Preparation of urban and regional structure plans, development plans, action plans; site planning principles and design; statistical methods; application of remote sensing techniques in urban and regional planning.

Traffic and Transportation Planning: Principles of traffic engineering and transportation planning; methods of conducting surveys; design of roads, intersections and parking areas; hierarchy of roads and levels of services; traffic and transport management in urban areas; traffic safety and traffic laws; public transportation planning; modes of transportation.

Services and Amenities: Principles and design of water supply systems, sewerage systems, solid waste disposal systems, power supply and communication systems; Health, education, recreation and demography related standards at various levels of the settlements.

Development Administration and Management: Planning laws; development control and zoning regulations; laws relating to land acquisition; development enforcements, land ceiling; regional and urban plan preparations; planning and municipal administration; taxation, revenue resources and fiscal management; public participation and role of NGO.

CE - CIVIL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative,

Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

STRUCTURAL ENGINEERING

Mechanics: Bending moments and shear forces in statically determinate beams; simple stress and strain: relationship; stress and strain in two dimensions, principal stresses, stress transformation, Mohr's circle; simple bending theory; flexural shear stress; thin-walled pressure vessels; uniform torsion.

Structural Analysis: Analysis of statically determinate trusses, arches and frames; displacements in statically determinate structures and analysis of statically indeterminate structures by force/energy methods; analysis by displacement methods (slope-deflection and moment-distribution methods); influence lines for determinate and indeterminate structures; basic concepts of matrix methods of structural analysis.

Concrete Structures: Basic working stress and limit states design concepts; analysis of ultimate load capacity and design of members subject to flexure, shear, compression and torsion (beams, columns and isolated footings); basic elements of prestressed concrete: analysis of beam sections at transfer and service loads.

Steel Structures: Analysis and design of tension and compression members, beams and beam-columns, column bases; connections - simple and eccentric, beam-column connections, plate girders and trusses; plastic analysis of beams and frames.

GEOTECHNICAL ENGINEERING

Soil Mechanics: Origin of soils; soil classification; three-phase system, fundamental definitions, relationship and inter-relationships; permeability and seepage; effective stress principle: consolidation, compaction; shear strength.

Foundation Engineering: Sub-surface investigation - scope, drilling bore holes, sampling, penetrometer tests, plate load test; earth pressure theories, effect of water table, layered soils; stability of slopes - infinite slopes, finite slopes; foundation types - foundation design requirements; shallow foundations; bearing capacity, effect of shape, water table and other factors, stress distribution, settlement analysis in sands and clays; deep foundations - pile types, dynamic and static formulae, load capacity of piles in sands and clays.

WATER RESOURCES ENGINEERING

Fluid Mechanics and Hydraulics: Hydrostatics, applications of Bernoulli equation, laminar and turbulent flow in pipes, pipe networks; concept of boundary layer and its growth; uniform flow, critical flow and gradually varied flow in channels, specific energy concept, hydraulic jump; forces on immersed bodies; flow measurement in channels; tanks and pipes;

dimensional analysis and hydraulic modeling. Applications of momentum equation, potential flow, kinematics of flow; velocity triangles and specific speed of pumps and turbines.

Hydrology: Hydrologic cycle; rainfall; evaporation infiltration, unit hydrographs, flood estimation, reservoir design, reservoir and channel routing, well hydraulics.

Irrigation: Duty, delta, estimation of evapo-transpiration; crop water requirements; design of lined and unlined canals; waterways; head works, gravity dams and Ogee spillways. Designs of weirs on permeable foundation, irrigation methods.

ENVIRONMENTAL ENGINEERING

Water requirements; quality and standards, basic unit processes and operations for water treatment, distribution of water. Sewage and sewerage treatment: quantity and characteristic of waste water sewerage; primary and secondary treatment of waste water; sludge disposal; effluent discharge standards.

TRANSPORTATION ENGINEERING

Highway planning; geometric design of highways; testing and specifications of paving materials; design of flexible and rigid pavements.

CH - CHEMICAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

CHEMICAL ENGINEERING

Process Calculations and Thermodynamics: Laws of conservation of mass and energy; use of tie components; recycle, bypass and purge calculations; degree of freedom analysis.

First and Second laws of thermodynamics and their applications; equations of state and thermodynamic properties of real systems; phase equilibria; fugacity, excess properties and correlations of activity coefficients; chemical reaction equilibria.

Fluid Mechanics and Mechanical Operations: Fluid statics, Newtonian and non-Newtonian fluids, Bernoulli equation, Macroscopic friction factors, energy balance, dimensional analysis, shell balances, flow through pipeline systems, flow meters, pumps and compressors, packed and fluidized beds, elementary boundary layer theory, size reduction and size separation; free and hindered settling; centrifuge and cyclones; thickening and classification, filtration, mixing and agitation; conveying of solids.

Heat Transfer: Conduction, convection and radiation, heat transfer coefficients, steady and unsteady heat conduction, boiling, condensation and evaporation; types of heat exchangers and evaporators and their design.

Mass Transfer: Fick's law, molecular diffusion in fluids, mass transfer coefficients, film, penetration and surface renewal theories; momentum, heat and mass transfer analogies; stagewise and continuous contacting and stage efficiencies; HTU & NTU concepts design and operation of equipment for distillation, absorption, leaching, liquid-liquid extraction, crystallization, drying, humidification, dehumidification and adsorption.

Chemical Reaction Engineering: Theories of reaction rates; kinetics of homogeneous reactions, interpretation of kinetic data, single and multiple reactions in ideal reactors, non-ideal reactors; residence time; non-isothermal reactors; kinetics of heterogeneous catalytic reactions; diffusion effects in catalysis.

Instrumentation and Process Control: Measurement of process variables; sensors, transducers and their dynamics, dynamics of simple systems, dynamics such as CSTRs, transfer functions and responses of simple systems, process reaction curve, controller modes (P, PI, and PID); control valves; analysis of closed loop systems including stability, frequency response (including Bode plots) and controller tuning, cascade, feed forward control.

Plant Design and Economics: Design and sizing of chemical engineering equipment such as compressors, heat exchangers, multistage contactors; principles of process economics and cost estimation including total annualized cost, cost indexes, rate of return, payback period, discounted cash flow, optimization in Design.

Chemical Technology: Inorganic chemical industries; sulfuric acid, NaOH, fertilizers (Ammonia, Urea, SSP and TSP); natural products industries (Pulp and Paper, Sugar, Oil, and Fats); petroleum refining and petrochemicals; polymerization industries; polyethylene, polypropylene, PVC and polyester synthetic fibers.

CS - COMPUTER SCIENCE AND ENGINEERING

ENGINEERING MATHEMATICS

Mathematical Logic: Propositional Logic; First Order Logic.

Probability: Conditional Probability; Mean, Median, Mode and Standard Deviation; Random Variables; Distributions; uniform, normal, exponential, Poisson, Binomial.

Set Theory & Algebra: Sets; Relations; Functions; Groups; Partial Orders; Lattice; Boolean Algebra.

Combinatorics: Permutations; Combinations; Counting; Summation; generating functions; recurrence relations; asymptotics.

Graph Theory: Connectivity; spanning trees; Cut vertices & edges; covering; matching; independent sets; Colouring; Planarity; Isomorphism.

Linear Algebra: Algebra of matrices, determinants, systems of linear equations, Eigen values and Eigen vectors.

Numerical Methods: LU decomposition for systems of linear equations; numerical solutions of non linear algebraic equations by Secant, Bisection and Newton-Raphson Methods; Numerical integration by trapezoidal and Simpson's rules.

Calculus: Limit, Continuity & differentiability, Mean value Theorems, Theorems of integral calculus, evaluation of definite & improper integrals, Partial derivatives, Total derivatives, maxima & minima.

THEORY OF COMPUTATION

Formal Languages and Automata Theory: Regular languages and finite automata, Context free languages and Push-down automata, Recursively enumerable sets and Turing machines, Un-decidability;

Analysis of Algorithms and Computational Complexity: Asymptotic analysis (best, worst, average case) of time and space, Upper and lower bounds on the complexity of specific problems, NP-completeness.

COMPUTER HARDWARE

Digital Logic: Logic functions, Minimization, Design and synthesis of Combinational and Sequential circuits; Number representation and Computer Arithmetic (fixed and floating point);

Computer Organization: Machine instructions and addressing modes, ALU and Data-path, hardwired and micro-programmed control, Memory interface, I/O interface (Interrupt and DMA mode), Serial communication interface, Instruction pipelining, Cache, main and secondary storage.

SOFTWARE SYSTEMS

Data structures: Notion of abstract data types, Stack, Queue, List, Set, String, Tree, Binary search tree, Heap, Graph;

Programming Methodology: C programming, Program control (iteration, recursion, Functions), Scope, Binding, Parameter passing, Elementary concepts of Object oriented, Functional and Logic Programming;

Algorithms for problem solving: Tree and graph traversals, Connected components, Spanning trees, Shortest paths; Hashing, Sorting, Searching; Design techniques (Greedy, Dynamic Programming, Divide-and-conquer);

Compiler Design: Lexical analysis, Parsing, Syntax directed translation, Runtime environment, Code generation, Linking (static and dynamic); Operating Systems: Classical concepts (concurrency, synchronization, deadlock), Processes, threads and Inter-process communication, CPU scheduling, Memory management, File systems, I/O systems, Protection and security.

Databases: Relational model (ER-model, relational algebra, tuple calculus), Database design (integrity constraints, normal forms), Query languages (SQL), File structures (sequential files, indexing, B+ trees), Transactions and concurrency control;

Computer Networks: ISO/OSI stack, sliding window protocol, LAN Technologies (Ethernet, Token ring), TCP/UDP, IP, Basic concepts of switches, gateways, and routers.

CH - CHEMISTRY

PHYSICAL CHEMISTRY

Structure: Quantum theory - principles and techniques; applications to particle in a box, harmonic oscillator, rigid rotor and hydrogen atom; valence bond and molecular orbital theories and Huckel approximation, approximate techniques: variation and perturbation; symmetry, point groups; rotational, vibrational, electronic, NMR and ESR spectroscopy.

Equilibrium: First law of thermodynamics, heat, energy and work; second law of thermodynamics and entropy; third law and absolute entropy; free energy; partial molar quantities; ideal and non-ideal solutions; phase transformation: phase rule and phase diagrams- one, two, and three component systems; activity, activity coefficient, fugacity and fugacity coefficient ; chemical equilibrium, response of chemical equilibrium to temperature and pressure; colligative properties; kinetic theory of gases; thermodynamics of electrochemical cells; standard electrode potentials: applications - corrosion and energy conversion; molecular partition function (translational, rotational, vibrational and electronic).

Kinetics: Rates of chemical reactions, theories of reaction rates, collision and transition state theory; temperature dependence of chemical reactions; elementary reactions, consecutive elementary reactions; steady state approximation, kinetics of photochemical reactions and free radical polymerization, homogenous and heterogeneous catalysis.

INORGANIC CHEMISTRY

Non-Transition Elements: General characteristics, structure and reactions of simple and industrially important compounds, boranes, carboranes, silicates, silicones, diamond and graphite; hydrides, oxides and oxoacids of N, P, S and halogens; boron nitride, borazines and phosphazenes; xenon compounds. Shapes of molecules, hard-soft acid base concept.

Transition Elements: General characteristics of d and f block elements; coordination chemistry: structure and isomerism, stability, theories of metal-ligand bonding (CFT and LFT), electronic spectra and magnetic properties of transition metal complexes and lanthanides; metal carbonyls, metal-metal bonds and metal atom clusters, metallocenes; transition metal complexes with bonds to hydrogen, alkyls, alkenes, and arenes; metal carbenes; use of organometallic compounds as catalysts in organic synthesis; mechanisms of substitution and electron transfer reactions of coordination complexes. Role of metals with special reference to Na, K, Mg, Ca, Fe, Co, Zn, and Mo in biological systems.

Solids: Crystal systems and lattices, Miller planes, crystal packing, crystal defects; Bragg's Law; ionic crystals, band theory, metals and semiconductors. Spinels.

Instrumental methods of analysis: atomic absorption, UV-visible spectrometry, chromatographic and electro-analytical methods.

ORGANIC CHEMISTRY

Synthesis, reactions and mechanisms involving the following: Alkenes, alkynes, arenes, alcohols, phenols, aldehydes, ketones, carboxylic acids and their derivatives; halides, nitro compounds and amines; stereochemical and conformational effects on reactivity and specificity; reactions with diborane and peracids. Michael reaction, Robinson annulation, reactivity umpolung, acyl anion equivalents; molecular rearrangements involving electron deficient atoms.

Photochemistry: Basic principles, photochemistry of olefins, carbonyl compounds, arenes, photo oxidation and reduction.

Pericyclic reactions: Cycloadditions, electrocyclic reactions, sigmatropic reactions; Woodward-Hoffmann rules.

Heterocycles: Structural properties and reactions of furan, pyrrole, thiophene, pyridine, indole.

Biomolecules: Structure, properties and reactions of mono- and di-saccharides, physico-chemical properties of amino acids, structural features of proteins and nucleic acids.

Spectroscopy: Principles and applications of IR, UV-visible, NMR and mass spectrometry in the determination of structures of organic compounds.

EC - ELECTRONICS AND COMMUNICATION ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix Algebra, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Mean value theorems, Theorems of integral calculus, Evaluation of definite and improper integrals, Partial Derivatives, Maxima and minima, Multiple integrals, Fourier series. Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equation (linear and nonlinear), Higher order linear differential equations with constant coefficients, Method of variation of parameters, Cauchy's and Euler's equations, Initial and boundary value problems, Partial Differential Equations and variable separable method.

Complex variables: Analytic functions, Cauchy's integral theorem and integral formula, Taylor's and Laurent' series, Residue theorem, solution integrals.

Probability and Statistics: Sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Discrete and continuous distributions, Poisson, Normal and Binomial distribution, Correlation and regression analysis.

Numerical Methods: Solutions of non-linear algebraic equations, single and multi-step methods for differential equations.

Transform Theory: Fourier transform, Laplace transform, Z-transform.

ELECTRONICS & COMMUNICATION ENGINEERING

Networks: Network graphs: matrices associated with graphs; incidence, fundamental cut set and fundamental circuit matrices. Solution methods: nodal and mesh analysis. Network theorems: superposition, Thevenin and Norton's maximum power transfer, Wye-Delta transformation. Steady state sinusoidal analysis using phasors. Linear constant coefficient differential equations; time domain analysis of simple RLC circuits, Solution of network equations using Laplace transform: frequency domain analysis of RLC circuits. 2-port network parameters: driving point and transfer functions. State equations for networks.

Electronic Devices: Energy bands in silicon, intrinsic and extrinsic silicon. Carrier transport in silicon: diffusion current, drift current, mobility, resistivity. Generation and recombination of carriers. p-n junction diode, Zener diode, tunnel diode, BJT, JFET, MOS capacitor, MOSFET, LED, p-I-n and avalanche photo diode, LASERs. Device technology: integrated circuits fabrication process, oxidation, diffusion, ion implantation, photolithography, n-tub, p-tub and twin-tub CMOS process.

Analog Circuits: Equivalent circuits (large and small-signal) of diodes, BJTs, JFETs, and MOSFETs. Simple diode circuits, clipping, clamping, rectifier. Biasing and bias stability of transistor and FET amplifiers. Amplifiers: single-and multi-stage, differential, operational, feedback and power. Analysis of amplifiers; frequency response of amplifiers. Simple op-amp circuits. Filters. Sinusoidal oscillators; criterion for oscillation; single-transistor and op-amp configurations. Function generators and wave-shaping circuits. Power supplies.

Digital circuits: Boolean algebra, minimization of Boolean functions; logic gates digital IC families (DTL, TTL, ECL, MOS, CMOS). Combinational circuits: arithmetic circuits, code converters, multiplexers and decoders. Sequential circuits: latches and flip-flops, counters and shift-registers. Sample and hold circuits, ADCs, DACs. Semiconductor memories. Microprocessor(8085): architecture, programming, memory and I/O interfacing.

Signals and Systems: Definitions and properties of Laplace transform, continuous-time and discrete-time Fourier series, continuous-time and discrete-time Fourier Transform, z-transform. Sampling theorems. Linear Time-Invariant (LTI) Systems: definitions and properties; casuality, stability, impulse response, convolution, poles and zeros frequency response, group delay, phase delay. Signal transmission through LTI systems. Random signals and noise: probability, random variables, probability density function, autocorrelation, power spectral density.

Controls Systems: Basic control system components; block diagrammatic description, reduction of block diagrams. Open loop and closed loop (feedback) systems and stability analysis of these systems. Signal flow graphs and their use in determining transfer functions of systems; transient and steady state analysis of LTI control systems and frequency response. Tools and techniques for LTI control system analysis: root loci, Routh-Hurwitz criterion, Bode and Nyquist plots. Control system compensators: elements of lead and lag compensation, elements of Proportional-Integral-Derivative(PID) control. State variable representation and solution of state equation of LTI control systems.

Communications: Analog communication systems: amplitude and angle modulation and demodulation systems, spectral analysis of these operations, superheterodyne receivers; elements of hardware, realizations of analog communication systems; signal-to-noise ratio (SNR) calculations for amplitude modulation (AM) and frequency modulation (FM) for low noise conditions. Digital communication systems: pulse code modulation (PCM), differential pulse code modulation (DPCM), delta modulation (DM); digital modulation schemes-amplitude, phase and frequency shift keying schemes (ASK, PSK, FSK), matched filter receivers, bandwith consideration and probability of error calculations for these schemes.

Electromagnetics: Elements of vector calculus: divergence and curl; Gauss' and Stokes' theorems, Maxwell's equations: differential and integral forms. Wave equation, Poynting vector. Plane waves: propagation through various media; reflection and refraction; phase and group velocity; skin depth. Transmission lines: characteristic impedance; impedance transformation; Smith chart; impedance matching; pulse excitation. Waveguides: modes in rectangular waveguides; boundary conditions; cut-off frequencies; dispersion relations. Antennas: Dipole antennas; antenna arrays; radiation pattern; reciprocity theorem, antenna gain.

EE - ELECTRICAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix Algebra, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Mean value theorems, Theorems of integral calculus, Evaluation of definite and improper integrals, Partial Derivatives, Maxima and minima, Multiple integrals, Fourier series. Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equation (linear and nonlinear), Higher order linear differential equations with constant coefficients, Method of variation of parameters, Cauchy's and Euler's equations, Initial and boundary value problems, Partial Differential Equations and variable separable method.

Complex variables: Analytic functions, Cauchy's integral theorem and integral formula, Taylor's and Laurent' series, Residue theorem, solution integrals.

Probability and Statistics: Sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Discrete and continuous distributions, Poisson, Normal and Binomial distribution, Correlation and regression analysis.

Numerical Methods: Solutions of non-linear algebraic equations, single and multi-step methods for differential equations.

Transform Theory: Fourier transform, Laplace transform, Z-transform.

ELECTRICAL ENGINEERING

Electrical Circuits and Fields: Network graph, KCL, KVL, node/ cut set, mesh/ tie set analysis, transient response of d.c. and a.c. networks; sinusoidal steady-state analysis; resonance in electrical circuits; concepts of ideal voltage and current sources, network theorems, driving point, immittance and transfer functions of two port networks, elementary concepts of filters; three phase circuits; Fourier series and its application; Gauss theorem, electric field intensity and potential due to point, line, plane and spherical charge distribution, dielectrics, capacitance calculations for simple configurations; Ampere's and Biot-Savart's law, inductance calculations for simple configurations.

Electrical Machines: Single phase transformer - equivalent circuit, phasor diagram, tests, regulation and efficiency; three phase transformers - connections, parallel operation; auto transformer and three-winding transformer; principles of energy conversion, windings of rotating machines: D. C. generators and motors - characteristics, starting and speed control, armature reaction and commutation; three phase induction motors-performance characteristics, starting and speed control; single-phase induction motors; synchronous generators-performance, regulation, parallel operation; synchronous motors - starting, characteristics, applications, synchronous condensers; fractional horse power motors; permanent magnet and stepper motors.

Power Systems: Electric power generation - thermal, hydro, nuclear; transmission line parameters; steady-state performance of overhead transmission lines and cables and surge propagation; distribution systems, insulators, bundle conductors, corona and radio interference effects; per-unit quantities; bus admittance and impedance matrices; load flow; voltage control and power factor correction; economic operation; symmetrical components, analysis of symmetrical and unsymmetrical faults; principles of over current, differential and distance protections; concept of solid state relays and digital protection; circuit breakers; concept of system stability-swing curves and equal area criterion; basic concepts of HVDC transmission.

Control Systems: Principles of feedback; transfer function; block diagrams: steady-state errors; stability-Routh and Nyquist criteria; Bode plots; compensation; root loci; elementary state variable formulation; state transition matrix and response for Linear Time Invariant systems.

Electrical and Electronic Measurements: Bridges and potentiometers, PMMC, moving iron, dynamometer and induction type instruments; measurement of voltage, current, power, energy and power factor; instrument transformers; digital voltmeters and multimeters; phase, time and frequency measurement; Q-meter, oscilloscopes, potentiometric recorders, error analysis.

Analog and Digital Electronics: Characteristics of diodes, BJT, FET, SCR; amplifiers-biasing, equivalent circuit and frequency response; oscillators and feedback amplifiers, operational amplifiers- characteristics and applications; simple active filters; VCOs and timers; combinational and sequential logic circuits, multiplexer, Schmitt trigger, multivibrators, sample and hold circuits, A/D and D/A converters; microprocessors and their applications.

Power Electronics and Electric Drives: Semiconductor power devices-diodes, transistors, thyristors, triacs, GTOs, MOSFETs and IGBTs - static characteristics and principles of operation; triggering circuits; phase control rectifiers; bridge converters-fully controlled and half controlled; principles of choppers and inverters, basic concepts of adjustable speed dc and ac drives.

GG - GEOLOGY AND GEOPHYSICS

PART - I

Earth and planetary system; size, shape, internal structure and composition of the earth; atmosphere and greenhouse effect; isostasy; elements of seismology; continents and continental processes; physical oceanography; palaeomagnetism, continental drift plate tectonics, geothermal energy.

Weathering; soil formation; action of river, wind and glacier; oceans and oceanic features; earthquakes, volcanoes, orogeny and mountain building; elements of structural geology; crystallography; classification, composition and properties of minerals and rocks; engineering properties of rocks and soils, role of geology in the construction of engineering structures.

Processes of ore formation, occurrence and distribution of ores on land and on ocean floor; coal and petroleum resources in India; ground water geology including well hydraulics, geological time scale and geochronology; stratigraphic principles and stratigraphy of India; basics concepts of gravity, magnetic and electrical prospecting for ores and ground water.

PART - IIA: GEOLOGY

Crystal symmetry, forms, twinning; crystal chemistry; optical mineralogy, classification of minerals, diagnostic properties of rock minerals.

Mineralogy, structure, texture and classification of igneous, sedimentary and metamorphic rock, their origin and evolution; application of thermodynamics; structure and petrology of sedimentary rocks; sedimentary processes and environments, sedimentary facies, basin studies; basement cover relationship;

Primary and secondary structures; geometry and genesis of folds, faults, joints, unconformities, cleavage, schistosity and lineation; methods of projection. Tectonites and their significance; shear zone; superposed folding.

Morphology, classification and geological significance of important invertebrates, vertebrates, microfossils and palaeoflora; stratigraphic principles and Indian stratigraphy; geomorphic processes and agents; development and evolution of landforms; slope and drainage; processes on deep oceanic and near-shore regions; quantitative and applied geomorphology; air photo interpretation and remote sensing; chemical and optical properties of ore minerals; formation and localization of ore deposits; prospecting and exploration of economic minerals; coal and petroleum geology; origin and distribution of mineral and fuel deposits in India; ore dressing and mineral economics.

Cosmic abundance; meteorites; geochemical evolution of the earth; geochemical cycles; distribution of major, minor and trace elements; isotope geochemistry; geochemistry of waters including solution equilibria and water rock interaction.

Engineering properties of rocks and soils; rocks as construction material; geology of dams, tunnels and excavation sites; natural hazards; the fly ash problem; ground water geology and exploration; water quality; impact of human activity; Remote sensing techniques for the interpretation of landforms and resource management.

PART - II B: GEOPHYSICS

The earth as a planet; different motions of the earth; gravity filed of the earth and its shape; geochronology; isostasy, seismology and interior of the earth; variation of density, velocity, pressure, temperature, electrical and magnetic properties inside the earth; earthquakes-causes and measurements; zonation and seismic hazards; geomagnetic field, palaeomagnetism; oceanic and continental lithosphere; plate tectonics; heat flow; upper and lower atmospheric phenomena.

Theories of scalar and vector potential fields; Laplace, Maxwell and Helmholtz equations for solution of different types of boundary value problems for Cartesian, cylindrical and spherical polar coordinates; Green's theorem; Image theory; integral equations and conformal transformations in potential theory; Eikonal equation and ray theory.

'G' and 'g' units of measurement, density of rocks, gravimeters, preparation, analysis and interpretation of gravity maps; derivative maps, analytical continuation; gravity anomaly type curves; calculation of mass.

Earth's magnetic field, units of measurement, magnetic susceptibility of rocks, magnetometers, corrections, preparation of magnetic maps, magnetic anomaly type curve, analytical continuation, interpretation and application; magnetic well logging.

Conduction of electricity through rocks, electrical conductivities of metals, metallic, non-metallic and rock forming minerals, D.C. resistivity units and methods of measurement, electrode configuration for sounding and profiling, application of filter theory, interpretation of resistivity field data, application; self potential origin, classification, field measurement, interpretation of induced polarization time frequency, phase domain; IP units and methods of measurement, interpretation and application; ground-water exploration.

Origin of electromagnetic field elliptic polarization, methods of measurement for different source-receiver configuration components in EM measurements, interpretation and applications; earth's natural electromagnetic field, tellurics, magneto-tellurics; geomagnetic depth sounding principles, methods of measurement, processing of data and interpretation.

Seismic methods of prospecting: Reflection, refraction and CDP surveys; land and marine seismic sources, generation and propagation of elastic waves, velocity increasing with depth, geophones, hydrophones, recording instruments (DFS), digital formats, field layouts, seismic noises and noise profile analysis, optimum geophone grouping, noise cancellation by shot and geophone arrays, 2D and 3D seismic data acquisition and processing, CDP stacking charts, binning, filtering, dip-moveout, static and dynamic corrections, deconvolution, migration, signal processing, Fourier and Hilbert transforms, attribute analysis, bright and dim spots, seismic stratigraphy, high resolution seismics, VSP.

Principles and techniques of geophysical well-logging, SP, resistivity, induction, micro gamma ray, neutron, density, sonic, temperature, dip meter, caliper, nuclear magnetic, cement bond logging. Quantitative evaluation of formations from well logs; well hydraulics and application of geophysical methods for groundwater study; application of bore hole geophysics in ground water, mineral and oil exploration. Remote sensing techniques and application of remote sensing methods in geophysics.

IN - INSTRUMENTATION ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix Algebra, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Mean value theorems, Theorems of integral calculus, Evaluation of definite and improper integrals, Partial Derivatives, Maxima and minima, Multiple integrals, Fourier series. Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equation (linear and nonlinear), Higher order linear differential equations with constant coefficients, Method of variation of parameters, Cauchy's and Euler's equations, Initial and boundary value problems, Partial Differential Equations and variable separable method.

Complex variables: Analytic functions, Cauchy's integral theorem and integral formula, Taylor's and Laurent' series, Residue theorem, solution integrals.

Probability and Statistics: Sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Discrete and continuous distributions, Poisson, Normal and Binomial distribution, Correlation and regression analysis.

Numerical Methods: Solutions of non-linear algebraic equations, single and multi-step methods for differential equations.

Transform Theory: Fourier transform, Laplace transform, Z-transform.

INSTRUMENTATION ENGINEERING

Measurement Basics and Metrology: Static and dynamic characteristics of measurement systems. Standards and calibration. Error and uncertainty analysis, statistical analysis of data, and curve fitting. Linear and angular measurements; Measurement of straightness, flatness, roundness and roughness.

Transducers, Mechanical Measurements and Industrial Instrumentation: Transducers - elastic, resistive, inductive, capacitive, thermo-electric, piezoelectric, photoelectric, electro-mechanical, electro-chemical, and ultrasonic. Measurement of displacement, velocity (linear and rotational), acceleration, shock, vibration, force, torque, power, strain, stress, pressure, flow, temperature, humidity, viscosity, and density. energy storing elements, suspension systems and dampers.

Analog Electronics: Characteristics of diodes, BJTs, JFETs and MOSFETs; Diode circuits; Amplifiers: single and multi-stage, feedback; Frequency response; Operational amplifiers - design, characteristic, linear and non-linear applications: difference amplifiers; instrumentation amplifiers; precision rectifiers, I-to-V converters, active filters, oscillators, comparators, signal generators, wave shaping circuits.

Digital Electronics: Combinational logic circuits, minimization of Boolean functions; IC families (TTL, MOS, CMOS), arithmetic circuits, multiplexer and decoders. Sequential circuits: flip-flops, counters, shift registers. Schmitt trigger, timers, and multivibrators. Analog switches, multiplexers, S/H circuits. Analog-to-digital and digital-to-analog converters. Basics of computer organization and architecture. 8-bit microprocessor (8085), applications, memory, I/O interfacing, and microcontrollers.

Signals and Systems: Vectors and matrices; Fourier series; Fourier transforms; Ordinary differential equations. Impulse and frequency responses of first and second order systems. Laplace transform and transfer function, convolution and correlation. Amplitude and frequency modulations and demodulations. Discrete time systems, difference equations, impulse and frequency responses; Z-transforms and transfer functions; IIR and FIR filters.

Electrical and Electronic Measurements: Measurement of R, L and C; bridges and potentiometers. Measurement of voltage, current, power, power factor, and energy; Instrument transformers; Q meter, waveform analyzers. Digital volt-meters and multi-meters. Time, phase and frequency measurements; Oscilloscope. Noise and interference in instrumentation.

Control Systems & Process Control: Principles of feedback; transfer function, signal flow graphs. Stability criteria, Bode plots, root-loci, Routh and Nyquist criteria. Compensation techniques; State space analysis. System components: mechanical, hydraulic, pneumatic, electrical and electronic; Servos and synchros; Stepper motors. On-off, cascade, P, PI, PID and feed-forward controls. Controller tuning and general frequency response.

Analytical, Optical and Biomedical Instrumentation: Principles of spectrometry, UV, visible, IR mass spectrometry, X-ray methods; nuclear radiation measurements, gas, solid and semi conductor lasers and their characteristics, interferometers, basics of fibre optics, transducers in biomedical applications, cardiovascular system measurements, instrumentation for clinical laboratory.

MA - MATHEMATICS

Linear Algebra: Finite dimensional vector spaces. Linear transformations and their matrix representations, rank; systems of linear equations, eigenvalues and eigenvectors, minimal polynomial, Cayley-Hamilton theorem, diagonalisation, Hermitian, Skew-Hermitian and unitary matrices. Finite dimensional inner product spaces, self-adjoint and Normal linear operators, spectral theorem, Quadratic forms.

Complex Analysis: Analytic functions, conformal mappings, bilinear transformations, complex integration: Cauchy's integral theorem and formula, Liouville's theorem, maximum modulus principle, Taylor and Laurent's series, residue theorem and applications for evaluating real integrals.

Real Analysis: Sequences and series of functions, uniform convergence, power series, Fourier series, functions of several variables, maxima, minima, multiple integrals, line, surface and volume integrals, theorems of Green, Stokes and Gauss; metric spaces, completeness, Weierstrass approximation theorem, compactness. Lebesgue measure, measurable functions; Lebesgue integral, Fatou's lemma, dominated convergence theorem.

Ordinary Differential Equations: First order ordinary differential equations, existence and uniqueness theorems, systems of linear first order ordinary differential equations, linear ordinary differential equations of higher order with constant coefficients; linear second order ordinary differential equations with variable coefficients, method of Laplace transforms for solving ordinary differential equations, series solutions; Legendre and Bessel functions and their orthogonality, Sturm Liouville system, Greeen's functions.

Algebra: Normal subgroups and homomorphisms theorems, automorphisms. Group actions, sylow's theorems and their applications groups of order less than or equal to 20, Finite p-groups. Euclidean domains, Principal ideal domains and unique factorizations domains. Prime ideals and maximal ideals in commutative rings.

Functional Analysis: Banach spaces, Hahn-Banach theorems, open mapping and closed graph theorems, principle of uniform boundedness; Hilbert spaces, orthonormal sets, Riesz representation theorem, self-adjoint, unitary and normal linear operators on Hilbert Spaces.

Numerical Analysis: Numerical solution of algebraic and transcendental equations; bisection, secant method, Newton-Raphson method, fixed point iteration, interpolation: existence and error of polynomial interpolation, Lagrange, Newton, Hermite(osculatory)interpolations; numerical differentiation and integration, Trapezoidal and Simpson rules; Gaussian quadrature; (Gauss-Legendre and Gauss-Chebyshev), method of undetermined parameters, least square and orthonormal polynomial approximation; numerical solution of systems of linear equations: direct and iterative methods, (Jacobi Gauss-Seidel and SOR) with convergence; matrix eigenvalue problems: Jacobi and Given's methods, numerical solution of ordinary differential equations: initial value problems, Taylor series method, Runge-Kutta methods, predictor-corrector methods; convergence and stability.

Partial Differential Equations: Linear and quasilinear first order partial differential equations, method of characteristics; second order linear equations in two variables and their classification; Cauchy, Dirichlet and Neumann problems, Green's functions; solutions of Laplace, wave and diffusion equations in two variables Fourier series and transform methods of solutions of the above equations and applications to physical problems.

Mechanics: Forces in three dimensions, Poinsot central axis, virtual work, Lagrange's equations for holonomic systems, theory of small oscillations, Hamiltonian equations;

Topology: Basic concepts of topology, product topology, connectedness, compactness, countability and separation axioms, Urysohn's Lemma, Tietze extension theorem, metrization theorems, Tychonoff theorem on compactness of product spaces.

Probability and Statistics: Probability space, conditional probability, Bayes' theorem, independence, Random variables, joint and conditional distributions, standard probability distributions and their properties, expectation, conditional expectation, moments. Weak and strong law of large numbers, central limit theorem. Sampling distributions, UMVU estimators, sufficiency and consistency, maximum likelihood estimators. Testing of hypotheses, Neyman-Pearson tests, monotone likelihood ratio, likelihood ratio tests, standard parametric tests based on normal, X2 ,t, F-distributions. Linear regression and test for linearity of regression. Interval estimation.

Linear Programming: Linear programming problem and its formulation, convex sets their properties, graphical method, basic feasible solution, simplex method, big-M and two phase methods, infeasible and unbounded LPP's, alternate optima. Dual problem and duality theorems, dual simplex method and its application in post optimality analysis, interpretation of dual variables. Balanced and unbalanced transportation problems, unimodular property and u-v method for solving transportation problems. Hungarian method for solving assignment problems.

Calculus of Variations and Integral Equations: Variational problems with fixed boundaries; sufficient conditions for extremum, Linear integral equations of Fredholm and Volterra type, their iterative solutions. Fredholm alternative.

ME - MECHANICAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

APPLIED MECHANICS AND DESIGN

Engineering Mechanics: Equivalent force systems, free-body concepts, equations of equilibrium, trusses and frames, virtual work and minimum potential energy. Kinematics and dynamics of particles and rigid bodies, impulse and momentum (linear and angular), energy methods, central force motion.

Strength of Materials: Stress and strain, stress-strain relationship and elastic constants, Mohr's circle for plane stress and plane strain, shear force and bending moment diagrams, bending and shear stresses, deflection of beams, torsion of circular shafts, thin and thick cylinders, Euler's theory of columns, strain energy methods, thermal stresses.

Theory of Machines: Displacement, velocity and acceleration, analysis of plane mechanisms, dynamic analysis of slider-crank mechanism, planar cams and followers, gear tooth profiles, kinematics of gears, governors and flywheels, balancing of reciprocating and rotating masses.

Vibrations: Free and forced vibration of single degree freedom systems, effect of damping, vibration isolation, resonance, critical speed of rotors.

Design of Machine Elements: Design for static and dynamic loading, failure theories, fatigue strength; design of bolted, riveted and welded joints; design of shafts and keys; design of spur gears, rolling and sliding contact bearings; brakes and clutches; belt, rope and chain drives.

FLUID MECHANICS AND THERMAL SCIENCES

Fluid Mechanics: Fluid properties, fluid statics, manometry, buoyancy; control-volume analysis of mass, momentum and energy; fluid acceleration; differential equations of continuity and momentum; Bernoulli's equation; viscous flow of incompressible fluids; boundary layer; elementary turbulent flow; flow through pipes, head losses in pipes, bends etc.

Heat-Transfer: Modes of heat transfer; one dimensional heat conduction, resistance concept, electrical analogy, unsteady heat conduction, fins; dimensionless parameters in free and forced convective heat transfer, various correlations for heat transfer in flow over flat plates and through pipes; thermal boundary layer; effect of turbulence; radiative heat transfer, black and grey surfaces, shape factors, network analysis; heat exchanger performance, LMTD and NTU methods.

Thermodynamics: Zeroth, First and Second laws of thermodynamics; thermodynamic system and processes; irreversibility and availability; behaviour of ideal and real gases, properties of pure substances, calculation of work and heat in ideal processes; analysis of thermodynamic cycles related to energy conversion; Carnot, Rankine, Otto, Diesel, Brayton and vapour compression cycles.

Power Plant Engineering: Steam generators; steam power cycles; steam turbines; impulse and reaction principles, velocity diagrams, pressure and velocity compounding; reheating and reheat factor; condensers and feed heaters.

I.C. Engines: Requirements and suitability of fuels in IC engines, fuel ratings, fuel-air mixture requirements; normal combustion in SI and CI engines; engine performance calculations.

Refrigeration and air-conditioning: Refrigerant compressors, expansion devices, condensers and evaporators; properties of moist air, psychrometric chart, basic psychometric processes.

Turbomachinery: Components of gas turbines; compression processes, centrifugal and axial flow compressors; axial flow turbines, elementary theory; hydraulic turbines; Euler-turbine equation; specific speed, Pelton-wheel, Francis and Kaplan turbines; centrifugal pumps.

MANUFACTURING AND INDUSTRIAL ENGINEERING

Engineering Materials: Structure and properties of engineering materials and their applications, heat treatment.

Metal Casting: Casting processes (expendable and non-expendable) -pattern, moulds and cores, heating and pouring, solidification and cooling, gating design, design considerations, defects.

Forming Processes: Stress-strain diagrams for ductile and brittle material, Plastic deformation and yield criteria, fundamentals of hot and cold working processes, Bulk metal forming processes (forging, rolling, extrusion, drawing), sheet metal working processes (punching, blanking, bending, deep drawing, coining, spinning, load estimation using homogeneous deformation methods, defects). processing of powder metals- atomization, compaction, sintering, secondary and finishing operations. forming and shaping of plastics- extrusion, injection moulding.

Joining Processes: Physics of welding, fusion and non-fusion welding processes, brazing and soldering, adhesive bonding, design considerations in welding, weld quality defects.

Machining and Machine Tool Operations: Mechanics of machining, single and multi-point cutting tools, tool geometry and materials, tool life and wear, cutting fluids, machinability, economics of machining, non-traditional machining processes.

Metrology and Inspection: Limits, fits and tolerances, linear and angular measurements, comparators, gauge design, interferometry, form and finish measurement, measurement of screw threads, alignment and testing methods.

Tool Engineering: Principles of work holding, design of jigs and fixtures.

Computer Integrated Manufacturing: Basic concepts of CAD, CAM and their integration tools.

Manufacturing Analysis: Part-print analysis, tolerance analysis in manufacturing and assembly, time and cost analysis.

Work-Study: Method study, work measurement, time study, work sampling, job evaluation, merit rating.

Production Planning and Control: Forecasting models, aggregate production planning, master scheduling, materials requirements planning.

Inventory Control: Deterministic and probabilistic models, safety stock inventory control systems.

Operations Research: Linear programming, simplex and duplex method, transportation, assignment, network flow models, simple queuing models, PERT and CPM

MN - MINING ENGINEERING

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables;

Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

MINING ENGINEERING

Mechanics: Equivalent force systems, equations of equilibrium, two dimensional frames and trusses, free body diagrams, friction forces, particle kinematics and dynamics.

Mine Development, Geomechanics and Strata Control: Drivages for underground mine development, drilling methods and machines, explosives, blasting devices and practices, shaft sinking. Physico-mechanical properties of rocks, rock mass classification, ground control instrumentation and stress measurement techniques, theories of rock failure, ground vibrations, stress distribution around mine openings, subsidence, design of supports in roadways and workings, stability of open pits, slopes.

Mining Methods and Machinery: Surface mining - layout, development, loading, transportation and mechanization, continuous surface mining systems. Underground coal mining - bord and pillar system, longwall mining, thick seam mining methods. Underground metal mining: different stoping methods, stope mechanization, ore handling systems, mine filling. Generation and transmission of mechanical, hydraulic, and pneumatic power. Materials handling - haulages, conveyors, ropeways, face and development machinery, hoisting systems, and pumps.

Ventilation, Underground Hazards and Surface Environment: Underground atmosphere, heat load sources and thermal environment, air cooling, mechanics of air flow distribution, natural and mechanical ventilation, mine fans and their usage, auxiliary ventilation. Subsurface hazards from fires, explosions, gases, dust, and inundation, rescue apparatus and practices, safety in mines, accident analysis, noise, mine lighting. Air and water pollution: causes, dispersion, quality standards, and control.

Surveying, Mine Planning and Systems Engineering: Fundamentals of engineering surveying, Levels and levelling, Theodolite, tacheometry, triangulation, contouring, errors and adjustments, correlation, underground surveying, curves, photogrammetry, field astronomy, GPS fundamentals. Principles of planning - Sampling methods and practices, reserve estimation techniques, basics of geostatistics, optimization of facility location, cash flow concepts and mine valuation, open pit design. Work study, concepts of reliability, reliability of series and parallel systems. Linear programming, transportation and assignment problems, queueing, network analysis, inventory control.

MT - METALLURGICAL ENGINEERING

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables;

Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

METALLURGICAL ENGINEERING

Thermodynamics and Rate Processes: Laws of thermodynamics, activity, equilibrium constant, applications to metallurgical systems, solutions, phase equilibria, basic kinetic laws, order of reactions, rate constants and rate limiting steps principles of electro chemistry, aqueous, corrosion and protection of metals, oxidation and high temperature corrosion - characterization and control; momentum transfer - concepts of viscosity, shell balances, Bernoulli's equation; heat transfer - conduction, convection and heat transfer coefficient relations, radiation, mass transfer - diffusion and Fick's laws.

Extractive Metallurgy: Flotation, gravity and other methods of mineral processing; agglomeration, pyro-hydro-and electro-metallurgical processes; material and energy balances; principles and processes for the extraction of non-ferrous metals - aluminium, copper, zinc, lead, magnesium, nickel, titanium and other rare metals; iron and steel making - principles, blast furnace, direct reduction processes, primary and secondary steel making, deoxidation and inclusion in steel; ingot and continuous casting; stainless steel making, design of furnaces; fuels and refractories.

Physical Metallurgy: Crystal structure and bonding characteristics of metals, alloys, ceramics and polymers; solid solutions; solidification; phase transformation and binary phase diagrams; principles of heat treatment of steels, aluminum alloys and cast irons; recovery, recrystallization and grain growth; industrially important ferrous and non-ferrous alloys; elements of X-ray and electron diffraction; principles of scanning and transmission electron microscopy; elements of ceramics, composites and electronic materials; electronic basis of thermal, optical, electrical and magnetic properties of materials.

Mechanical Metallurgy: Elements of elasticity and plasticity; defects in crystals; elements of dislocation theory - types of dislocations, slip and twinning, stress fields of dislocations, dislocation interactions and reactions, methods of seeing dislocations; strengthening mechanisms; tensile, fatigue and creep behaviour; superplasticity; fracture - Griffith theory, ductile to brittle transition, fracture toughness; failure analysis; mechanical testing - tension, compression, torsion, hardness, impact, creep, fatigue, fracture toughness and formability tests.

Manufacturing Processes: Metal casting - patterns, moulds, melting, gating, feeding and casting processes, defects and castings, hot and cold working of metals; Metal forming - fundamentals of metal forming, rolling wire drawing, extrusion, forming, sheet metal forming processes, defects in forming; Metal joining - soldering, brazing and welding, common welding processes, welding metallurgy, problems associated with welding of steels and aluminium alloys, defects in welding, powder metallurgy; NDT methods - ultrasonic, radiography, eddy current, acoustic emission and magnetic.

PH - PHYSICS

Mathematical Physics: Linear vector space, matrices; vector calculus; linear differential equations; elements of complex analysis; Laplace transforms, Fourier analysis, elementary ideas about tensors.

Classical Mechanics: Conservation laws; central forces; collisions and scattering in laboratory and centre of mass reference frames; mechanics of system of particles; rigid body dynamics; moment of inertia tensor; noninertial frames and pseudo forces; variational principle; Lagrange's and Hamilton's formalisms; equation of motion, cyclic coordinates, Poisson bracket; periodic motion, small oscillations, normal modes; wave equation and wave propagation; special theory of relativity - Lorentz transformations, relativistic kinematics, mass-energy equivalence.

Electromagnetic Theory: Laplace and Poisson equations; conductors and dielectrics; boundary value problems; Ampere's and Biot-Savart's laws; Faraday's law; Maxwell's equations; scalar and vector potentials; Coulomb and Lorentz gauges; boundary conditions at interfaces; electromagnetic waves; interference, diffraction and polarization; radiation from moving charges.

Quantum Mechanics: Physical basis of quantum mechanics; uncertainty principle; Schrodinger equation; one and three dimensional potential problems; Particle in a box, harmonic oscillator, hydrogen atom; linear vectors and operators in Hilbert space; angular momentum and spin; addition of angular momentum; time independent perturbation theory; elementary scattering theory.

Atomic and Molecular Physics: Spectra of one-and many-electron atoms; LS and jj coupling; hyperfine structure; Zeeman and Stark effects; electric dipole transitions and selection rules; X-ray spectra; rotational and vibrational spectra of diatomic molecules; electronic transition in diatomic molecules, Franck-Condon principle; Raman effect; NMR and ESR; lasers.

Thermodynamics and Statistical Physics: Laws of thermodynamics; macrostates, phase space; probability ensembles; partition function, free energy, calculation of thermodynamic quantities; classical and quantum statistics; degenerate Fermi gas; black body radiation and Planck's distribution law; Bose-Einstein condensation; first and second order phase transitions, critical point.

Solid State Physics: Elements of crystallography; diffraction methods for structure determination; bonding in solids; elastic properties of solids; defects in crystals; lattice vibrations and thermal properties of solids; free electron theory; band theory of solids; metals, semiconductors and insulators; transport properties; optical, dielectric and magnetic properties of solids; elements of superconductivity.

Nuclear and Particle Physics: Rutheford scattering; basic properties of nuclei; radioactive decay; nuclear forces; two nucleon problem; nuclear reactions; conservation laws; fission and fusion; nuclear models; particle accelerators, detectors; elementary particles; photons, baryons, mesons and leptons; Quark model.

Electronics: Network analysis; semiconductor devices; bipolar transistors; FETs; power supplies, amplifier, oscillators; operational amplifiers; elements of digital electronics; logic circuits.

PI - PRODUCTION AND INDUSTRIAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional

probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

GENERAL ENGINEERING:

Engineering Materials: Structure and properties of engineering materials and their applications; effect of strain, strain rate and temperature on mechanical properties of metals and alloys; heat treatment of metals and alloys.

Applied Mechanics: Engineering mechanics - equivalent force systems, free body concepts, equations of equilibrium, virtual work and minimum potential energy; strength of materials-stress, strain and their relationship, Mohr's circle, deflection of beams, bending and shear stress, Euler's theory of columns.

Theory of Machines and Design: Analysis of planar mechanisms, plane cams and followers; governers and fly wheels; design of elements-failure theories; design of bolted, riveted and welded joints; design of shafts, keys, belt drives, brakes and clutches.

Thermal Engineering: Fluid machines - fluid statics, Bernoulli's equation, flow through pipes, equations of continuity and momentum; Thermodynamics - zeroth, First and Second laws of thermodynamics, thermodynamic system and processes, calculation of work and heat for systems and control volumes; Heat transfer - fundamentals of conduction, convection and radiation.

PRODUCTION ENGINEERING

Metal Casting: Casting processes; patterns-materials; allowances; moulds and cores - materials, making and testing; melting and founding of cast iron, steels and nonferrous metals and alloys; solidification; design of casting, gating and risering; casting defects and inspection.

Metal working: Stress-strain in elastic and plastic deformation; deformation mechanisms; hot and cold working-forging, rolling, extrusion, wire and tube drawing; sheet metal working; analysis of rolling, forging, extrusion and wire /rod drawing; metal working defects, high energy rate forming processes-explosive, magnetic, electro and electrohydraulic.

Metal Joining Processes: Welding processes - gas shielded metal arc, TIG, MIG, submerged arc, electroslag, thermit, resistance, pressure and forge welding; thermal cutting; other joining processes - soldering, brazing, braze welding; welding codes, welding symbols, design of welded joints, defects and inspection; introduction to modern welding processes - friction, ultrasonic, explosive, electron beam, laser and plasma.

Machining and Machine Tool Operations: Machining processes-turning, drilling, boring, milling, shaping, planing, sawing, gear cutting, thread production, broaching, grinding, lapping, honing super finishing; mechanics of cutting- Merchant's analysis, geometry of cutting tools, cutting forces, power requirements; selection of process parameters; tool materials, tool wear and tool life, cutting fluids, machinability; nontraditional machining processes and hybrid processes- EDM, CHM, ECM, USM, LBM, EBM, AJM, PAM AND WJM; economics of machining.

Metrology and Inspection: Limits and fits, linear and angular measurements by mechanical and optical methods, comparators; design of limit gauges; interferometry; measurement of straightness, flatness, roundness, squareness and symmetry; surface finish measurement; inspection of screw threads and gears; alignment testing.

Powder Metallurgy and Processing of Plastics: Production of powders, compaction, sintering; Polymers and composites; injection, compression and blow molding, extrusion, calendaring and thermoforming; molding of composites.

Tool Engineering: Work-holding-location and clamping; principles and methods; design of jigs and fixtures; design of press working tools, forging dies.

Manufacturing Analysis: Sources of errors in manufacturing; process capability; part-print analysis; tolerance analysis in manufacturing and assembly; process planning; parameter selection and comparison of production alternatives; time and cost analysis; Issues in choosing manufacturing technologies and strategies.

Computer Integrated Manufacturing: Basic concepts of CAD, CAM, CAPP, group technology, NC, CNC, DNC, FMS, Robotics and CIM.

INDUSTRIAL ENGINEERING

Product Design and Development: Principles of good product design, component and tolerance design; efficiency, quality and cost considerations; product life cycle; standardization, simplification, diversification, value analysis, concurrent engineering.

Engineering Economy and Costing: Financial statements; elementary cost accounting, methods of depreciation; break-even analysis, techniques for evaluation of capital investments.

Work System Design: Taylor's scientific management, Gilbreths's contributions; productivity concepts and measurements; method study, micro-motion study, principles of motion economy; human factors engineering, ergonomics; work measurement - time study, PMTS, work sampling; job evaluation, merit rating, wage administration, incentive systems; business process reengineering.

Logistics and Facility Design: Facility location factors, evaluation of alternatives, types of plant layout, evaluation; computer aided layout; assembly line balancing; material handling systems; supply chain management.

Production Planning and Inventory Control: Inventory Function costs, classifications - deterministic and probabilistic models; quantity discount; safety stock; inventory control system; Forecasting techniques - causal and time series models, moving average, exponential smoothing; trend and seasonality; aggregate production planning; master scheduling; bill of materials and material requirement planning; order control and flow control, routing, scheduling and priority dispatching; JIT; Kanban PULL systems; bottleneck scheduling and theory of constraints.

Operation Research: Linear programming - problem formulation, simplex method, duality and sensitivity analysis; transportation; assignment; network flow models, constrained optimization and Lagrange multipliers; simple queuing models; dynamic programming; simulation; PERT and CPM, time-cost trade-off, resource leveling.

Quality Control: Taguchi method; design of experiments; quality costs, statistical quality assurance, process control charts, acceptance sampling, zero defects; quality circles, total quality management.

Reliability and Maintenance: Reliability, availability and maintainability; probabilistic failure and repair times; system reliability; preventive maintenance and replacement, TPM.

Management Information System: Value of information; information storage and retrieval system - database and data structures; interactive systems; knowledge based systems.

Intellectual Property System: Definition of intellectual property, importance of IPR; TRIPS, and its implications, WIPO and Global IP structure, and IPS in India; patent, copyright, industrial design and trademark; meanings, rules and procedures, terms, infringements and remedies.

PY - PHARMACEUTICAL SCIENCES

Natural Products: Pharmacognosy & Phytochemistry - Chemistry, tests, isolation, characterization and estimation of phytopharmaceuticals belonging to the group of Alkaloids, Glycosides, Terpenoids, Steroids, Bioflavanoids, Purines, Guggul lipids. Pharmacognosy of crude drugs which contain the above constituents. Standardisation of raw materials and herbal products. WHO guide lines. Quantitative microscopy including modern techniques used for evaluation. Biotechnological principles and techniques for plant development Tissue culture.

Pharmacology: General pharmacological principles including Toxicology. Drug interaction. Pharmacology of drugs acting on Central nervous system, Cardiovascular system, Autonomic nervous system, Gastro intestinal system and Respiratory system. Pharmacology of Autocoids, Hormones, Chemotherapeutic agents including anticancer drugs. Bioassays. Immuno Pharmacology.

Medicinal Chemistry: Structure, nomenclature, classification, synthesis, SAR and metabolism of the following category of drugs which are official in Indian Pharmacopoeia and British Pharmacopoeia Hypnotics and Sedatives, Analgesics, NSAIDS, Neuroleptics, Antidepressants, Anxiolytics, Anticonvulsants, Antihistaminics, Local anaesthetics, Cardio Vascular drugs - Antianginal agents Vasodilators, Adrenergic & cholinergic drugs, Cardiotonic agents, Diuretics, Antihypertensive drugs, Hypoglycemic agents, Antilipedmic agents, Coagulants, Anticoagulants, Antiplatelet agents. Chemotherapeutic agents - Antibiotics, Antibacterials, Sulphadrugs. Antiproliozoal drugs, Antiviral, Antitubercular, Antimalarial, Anticancer, Antiamoebic drugs. Diagnostic agents. Preparation and storage and uses of official Radiopharmaceuticals. Vitamins and Hormones.

Pharmaceutics: Development, manufacturing standards, labeling, packing as per the pharmacopoeal requirements, Storage of different dosage forms and new drug delivery systems. Biopharmaceutics and Pharmacokinetics and their importance in formulation. Formulation and preparation of cosmetics - lipstick, shampoo, creams, nail preparations and dentifrices. Pharmaceutical calculations.

Pharmaceutical Jurisprudence: Legal aspects of manufacture, storage, sale of drugs. D and C act and rules. Pharmacy act.

Pharmaceutical Analysis: Principles, instrumentation and applications of the following. Absorption spectroscopy (UV, visible & IR), Fluorimetry, Flame photometry, Potentiometry, Conductometry and Plarography. Pharmacopoeial assays. Principles of NMR, ESR, Mass spectroscopy, X-ray diffraction analysis and different chromatographic methods.

Biochemistry and Clinical Pharmacy: Biochemical role of hormones, Vitamins, Enzymes, Nucleic acids. Bioenergetics. General principles of immunology. Immunological techniques. Adverse drug interaction.

Microbiology: Principles and methods of microbiological assays of the Pharmacopoeia. Methods of preparation of official sera and vaccines. Serological and diagnostic tests. Applications of microorganisms in Bio Conversions and in Pharmaceutical industry.

TF - TEXTILE ENGINEERING AND FIBRE SCIENCE

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

TEXTILE ENGINEERING & FIBRE SCIENCE

Textile Fibres: Classification of textile fibres according to their nature and origin; general characteristics of textile fibres-their chemical and physical structures and their properties; essential characteristics of fibre forming polymers; uses of natural and man-made fibres; physical and chemical methods of fibre and blend identification and blend analysis.

Melt Spinning processes with special reference to polyamide and polyester fibres; wet and dry spinning of viscose and acrylic fibres; post spinning operations-drawing, heat setting, texturing- false twist and air-jet, tow-to-top conversion. Methods of investigating fibre structure e.g. X-ray diffraction, birefringence, optical and electron microscopy, I.R. absorption, thermal methods; structure and morphology and principal natural and man-made fibres, mechanical properties of fibres, moisture sorption in fibres; fibre structure and property correlation.

Textile Testing: Sampling techniques, sample size and sampling errors; measurement of fibre length, fineness, crimp, strength and reflectance; measurement of cotton fibre maturity ad trash content; HVI and AFIS for fibre testing. Measurement of yarn count, twist and hairiness; tensile testing of fibres, yarn and fabrics; evenness testing of slivers, rovings and yarns; testing equipment for measurement test methods of fabric properties like thickness, compressibility, air permeability, drape, crease recovery, tear strength bursting strength and abrasion resistance. Correlation analysis, significance tests and analysis of variance; frequency distributions and control charts.

Yarn Manufacture and Yarn Structure: Modern methods of opening, cleaning and blending of fibrous materials; the technology of carding with particular reference to modern developments; causes of irregularity introduced by drafting, the development of modern drafting systems; principles and techniques of preparing material for combing; recent development in combers; functions and synchronization of various mechanisms concerned with roving production; forces acting on yarn and traveller, ring and traveller designs; causes of end breakages; properties of doubles yarns; new methods of yarn production such as rotor spinning, air jet spinning and friction spinning.

Yarn diameter; specific volume, packing coefficient; twist-strength relationship; fibre orientation in yarn; fibre migration.

Fabric Manufacture and Fabric Structure: Principles of cheese and cone winding processes and machines; random and precision winding; package faults and their remedies; yarn clearers and tensioners; different systems of yarn splicing; features of modern cone winding machines; different types of warping creels; features of modern beam and sectional warping machines; different sizing systems, sizing of spun and filament yarns, modern sizing machines; principles of pirn winding processes and machines; primary and secondary motions of loom, effect of their settings and timings on fabric formation, fabric appearance and weaving performance; dobby and jacquard shedding; mechanics of weft insertion with shuttle; warp and weft stop motions, warp protection, weft replenishment; functional principles of weft insertion systems of shuttleless weaving machines, principles of multiphase and circular looms. Principles of weft and warp knitting; basic weft and warp knitted structures; classification, production and areas of application of nonwoven fabrics.

Basic woven fabric constructions and their derivatives; crepe, cord, terry, gauze, lino and double cloth constructions.

Peirce's equations for fabric geometry; thickness, cover and maximum sett of woven fabrics

Textile Chemical Processing: Preparatory processes for natural-and and their blends; mercerization of cotton; machines for yarn and fabric mercerization.

Dyeing and printing of natural- and synthetic- fibre fabrics and their blends with different dye classes; dyeing and printing machines; styles of printing; fastness properties of dyed and printed textile materials.

Finishing of textile materials, wash and wear, durable press, soil release, water repellent, flame retardant and antistatic finishes; shrink-resistance finish for wool; heat setting of synthetic-fibre fabrics, finishing machines; energy efficient processes; pollution control.

XE - ENGINERING SCIENCES

The syllabi of the sections of this paper are as follows:

SECTION A. ENGINEERING MATHEMATICS (Compulsory)

Linear Algebra : Determinates, algebra of matrices, rank, inverse, system of linear equations, symmetric, skew-symmetric and orthogonal matrices. Hermitian, skew-hermitian and unitary matrices. eigenvalues and eigenvectors, diagonalisation of matrices, Cayley-Hamiltonian, quadratic forms.

Calculus : Functions of single variables, limit, continuity and differentiability, Mean value theorems, Intermediate forms and L'Hospital rule, Maxima and minima, Taylor's series, Fundamental and mean value-theorems of integral calculus. Evaluation of definite and improper integrals, Beta and Gamma functions, Functions of two variables, limit, continuity, partial derivatives, Euler's theorem for homogeneous functions, total derivatives, maxima and minima, Lagrange method of multipliers, double and triple integrals and their applications, sequence and series, tests for convergence, power series, Fourier Series, Fourier integrals.

Complex variable: Analytic functions, Cauchy's integral theorem and integral formula without proof. Taylor's and Laurent' series, Residue theorem (without proof) with application to the evaluation of real integarls.

Vector Calculus: Gradient, divergence and curl, vector identities, directional derivatives, line, surface and volume integrals, Stokes, Gauss and Green's theorems (without proofs) with applications.

Ordinary Differential Equations: First order equation (linear and nonlinear), higher order linear differential equations with constant coefficients, method of variation of paramaters, Cauchy's and Euler's equations, initial and boundary value problems, power series solutions, Legendre polynomials and Bessel's functions of the first kind.

Partial Differential Equations: Variables separable method, solutions of one dimensional heat, wave and Laplace equations.

Probability and Statistics: Definitions of probability and simple theorems, conditional probability, mean, mode and standard deviation, random variables, discrete and continuous distributions, Poisson, normal and Binomial distribution, correlation and regression

Numerical Methods: L-U decomposition for systems of linear equations,Newton-Raphson method, numerical integration(trapezoidal and Simpson's rule), numerical methods for first order differential equation (Euler method)

SECTION B. COMPUTATIONAL SCIENCE

Numerical Methods: Truncation errors, round off errors and their propagation; Interpolation; Lagrange, Newton's forward, backward and divided difference formulas, least square curve fitting, solution of non-linear equations of one variables using bisection, false position, secant and Newton Raphson methods; Rate of convergence of these methods, general iterative methods. Simple and multiple roots of polynomials. Solutions of system of linear algebraic equations using Gauss elimination methods, Jacobi and Gauss-Seidel iterative methods and their rate of convergence; ill conditioned and well conditioned system. eigen values and eigen vectors using power methods. Numerical integration using trapezoidal, Simpson's rule and other quadrature formulas. Numerical Differentiation. Solution of boundary value problems. Solution of initial value problems of ordinary differential equations using Euler's method, predictor corrector and Runge Kutta method.

Programming : Elementary concepts and terminology of a computer system and system software, Fortran77 and C programming.

Fortran : Program organization, arithmetic statements, transfer of control, Do loops, subscripted variables, functions and subroutines.

C language : Basic data types and declarations, flow of control- iterative statement, conditional statement, unconditional branching, arrays, functions and procedures.

SECTION C. ELECTRICAL SCIENCES

Electric Circuits: Ideal voltage and current sources; RLC circuits, steady state and transient analysis of DC circuits, network theorems; alternating currents and voltages, single-phase AC circuits, resonance; three-phase circuits.

Magnetic circuits: Mmf and flux, and their relationship with voltage and current; transformer, equivalent circuit of a practical transformer, three-phase transformer connections.

Electrical machines: Principle of operation, characteristics, efficiency and regulation of DC and synchronous machines; equivalent circuit and performance of three-phase and single-phase induction motors.

Electronic Circuits: Characteristics of p-n junction diodes, zener diodes, bipolar junction transistors (BJT) and junction field effect transistors (JFET); MOSFET's structure, characteristics, and operations; rectifiers, filters, and regulated power supplies; biasing circuits, different configurations of transistor amplifiers, class A, B and C of power amplifiers; linear applications of operational amplifiers; oscillators; tuned and phase shift types.

Digital circuits: Number systems, Boolean algebra; logic gates, combinational circuits, flip-flops (RS, JK, D and T) counters.

Measuring instruments: Moving coil, moving iron, and dynamometer type instruments; shunts, instrument transformers, cathode ray oscilloscopes; D/A and A/D converters.

SECTION D. FLUID MECHANICS

Fluid Properties: Relation between stress and strain rate for Newtonian fluids

Hydrostatics, buoyancy, manometry

Concept of local and convective accelerations; control volume analysis for mass, momentum and energy conservation.

Differential equations of continuity and momentum (Euler's equation of motion); concept of fluid rotation, stream function, potential function; Bernoulli's equation and its applications.

Qualitative ideas of boundary layers and its separation; streamlined and bluff bodies; drag and lift forces.

Fully-developed pipe flow; laminar and turbulent flows; friction factor; Darcy Weisbach relation; Moody's friction chart; losses in pipe fittings; flow measurements using venturimeter and orifice plates.

Dimensional analysis; similitude and concept of dynamic similarity; importance of dimensionless numbers in model studies.

SECTION E. MATERIALS SCIENCE

Atomic structure and bonding in materials: metals, ceramics and polymers.

Structure of materials: Crystal systems, unit cells and space lattice; determination of structures of simple crystals by X-ray diffraction; Miller indices for planes and directions. Packing geometry in metallic, ionic and covalent solids.

Concept of amorphous, single and polycrystalline structures and their effects on properties of materials.

Imperfections in crystalline solids and their role in influencing various properties.

Fick´s laws of diffusion and applications of diffusion in sintering, doping of semiconductors and surface hardening of metals.

Alloys: solid solution and solubility limit. Binary phase diagram, intermediate phases and intermetallic compounds; iron-iron carbide phase diagram. Phase transformation in steels. Cold and hot working of metals, recovery, recrystallization and grain growth.

Properties and applications of ferrous and nonferrous alloys.

Structure, properties, processing and applications of traditional and advanced ceramics.

Polymers: classification, polymerization, structure and properties, additives for polymer products, processing and application.

Composites: properties and application of various composites.

Corrosion and environmental degradation of materials (metals, ceramics and polymers).

Mechanical properties of materials: Stress-strain diagrams of metallic, ceramic and polymeric materials, modulus of elasticity, yield strength, plastic deformation and toughness, tensile strength and elongation at break; viscoelasticity, hardness, impact strength. ductile and brittle fracture. creep and fatigue properties of materials.

Heat capacity, thermal conductivity, thermal expansion of materials.

Concept of energy band diagram for materials; conductors, semiconductors and insulators in terms of energy bands. Electrical conductivity, effect of temperature on conductivity in materials, intrinsic and extrinsic semiconductors, dielectric properties of materials.

Refraction, reflection, absorption and transmission of electromagnetic radiation in solids.

Origin of magnetism in metallic and ceramic materials, paramagnetism, diamagnetism, antiferromagnetism, ferromagnetism, ferrimagnetism in materials and magnetic hysteresis.

Advanced materials: Smart materials exhibiting ferroelectric, piezoelectric, optoelectronic, semiconducting behaviour; lasers and optical fibers; photoconductivity and superconductivity in materials.

SECTION F. SOLID MECHANICS

Equivalent force systems; free-body diagrams; equilibrium equations; analysis of determinate and indeterminate trusses and frames; friction.

Simple relative motion of particles; force as function of position, time and speed; force acting on a body in motion; laws of motion; law of conservation of energy; law of conservation of momentum

Stresses and strains; principal stresses and strains; Mohr's circle; generalized Hooke's Law; equilibrium equations; compatibility conditions; yield criteria.

Axial, shear and bending moment diagrams; axial, shear and bending stresses; deflection (for symmetric bending); torsion in circular shafts; thin cylinders; energy methods (Castigliano's Theorems); Euler buckling.

SECTION G. THERMODYNAMICS

Basic Concepts: Continuum, macroscopic approach, thermodynamic system (closed and open or control volume); thermodynamic properties and equilibrium; state of a system, state diagram, path and process; different modes of work; Zeroth law of thermodynamics; concept of temperature; heat.

First Law of Thermodynamics: Energy, enthalpy, specific heats, first law applied to systems and control volumes, steady and unsteady flow analysis.

Second Law of Thermodynamics: Kelvin-Planck and Clausius statements, reversible and irreversible processes, Carnot theorems, thermodynamic temperature scale, Clausius inequality and concept of entropy, principle of increase of entropy; availability and irreversibility.

Properties of Pure Substances: Thermodynamic properties of pure substances in solid, liquid and vapour phases, P-V-T behaviour of simple compressible substances, phase rule, thermodynamic property tables and charts, ideal and real gases, equations of state, compressibility chart.

Thermodynamic Relations: T-ds relations, Maxwell equations, Joule-Thomson coefficient, coefficient of volume expansion, adiabatic and isothermal compressibilities, Clapeyron equation.

Ideal Gas Mixtures: Dalton's and Amagat's laws, calculations of properties, air-water vapour mixtures.

XL - LIFE SCIENCES

The syllabi of the Sections of this paper are as follows:

SECTION H. CHEMISTRY (Compulsory)

Atomic structure and periodicity: Quantum chemistry; Planck's quantum theory, wave particle duality, uncertainty principle, quantum mechanical model of hydrogen atom; electronic configuration of atoms; periodic table and periodic properties; ionization energy, election affinity, electronegativity, atomic size.

Structure and bonding: Ionic and covalent bonding M.O. and V.B. approaches for diatomic molecules, VSEPR theory and shape of molecules, hybridisation, resonance, dipole moment, structure parameters such as bond length, bond angle and bond energy, hydrogen bonding, van der Waals interactions. Ionic solids; ionic radii, lattice energy (Born-Haber Cycle).

s.p. and d Block Elements: Oxides, halides and hydrides of alkali and alkaline earth metals, B, Al, S, N, P and S, silicones, general characteristics of 3d elements, coordination complexes: valence bond and crystal field theory, color, geometry and magnetic properties.

Chemical Equilibria: Colligative properties of solutions, ionic equilibria in solution, solubility product, common ion effect, hydrolysis of salts, pH, buffer and their applications in chemical analysis.

Electrochemistry: Conductance, Kohlrausch law, Half Cell potentials, emf, Nernst equation, galvanic cells, thermodynamic aspects and their applications.

Reaction Kinetics: Rate constant, order of reaction, molecularity, activation energy, zero, first and second order kinetics, equilibrium constants (Kc, Kp and Kx) for homogeneous reactions, catalysis and elementary enzyme reactions.

Thermodynamics: First law, reversible and irreversible processes, internal energy, enthalpy, Kirchoff's equation, heat of reaction, Hess law, heat of formation, Second law, entropy, free energy, and work function. Gibbs-Helmholtz equation, Clausius-Clapeyron equation, free energy change and equilibrium constant, Troutons rule, Third law of thermodynamics.

Mechanistic Basis of Organic Reactions: Elementary treatment of SN1, SN2, E1 and E2 reactions, Hoffmann and Saytzeff rules, Addition reactions, Markonikoff rule and Kharash effect, Diels-Alder reaction, aromatic electrophilic substitution, orientation effect as exemplified by various functional groups.

Structure-Reactivity Correlations: Acids and bases, electronic and steric effects, optical and geometrical isomerism, tautomerism, concept of aromaticity

SECTION I. BIOCHEMISTRY

Organization of life. Importance of water. Cell structure and organelles. Structure and function of biomolecules: Carbohydrates, Lipids, Proteins and Nucleic acids. Biochemical separation techniques. Spectroscopic methods; UV-visible and fluorescence. Protein structure, folding and function: Myoglobin, Hemoglobin, Lysozyme, ribonuclease A, Carboxypeptidase and Chymotrypsin. Enzyme kinetics and regulation, Coenzymes.

Metabolism and bioenergitics. Generation and utilization of ATP. Photosynthesis. Major metabolic pathways and their regulation. Biological membranes. Transport across membranes. Signal transduction; hormones and neurotransmitters.

DNA replication, transcription and translation. Biochemical regulation of gene expression. Recombinant DNA technology and applications. Genomics and Proteomics.

The immune system. Active and passive immunity. Complement system. Antobody structure, function and diversity. Cells of the immune system: T, B and macrophages. T and B cell activation. Major histocompatibilty complex. T cell receptor. Immunological techniques: Immunodiffusion, immunoelectrophoresis, RIA and ELISA.

SECTION J. BIOTECHNOLOGY

Recombinant DNA technology for the production of therapeutic proteins. Micro array technology. Heterologous protein expression systems in bacteria, yeast etc.

Architecture of plant genome; plant tissue culture techniques; methods of gene transfer into plant cells; manipulation of phenotypic traits in plants; plant cell fermentations and production of secondary metabolites using suspension/ immobilized cell culture; methods for plant micro propagation; crop improvement and development of transgenic plants. Expression of animal proteins in plants.

Animal cell metabolism and regulation; cell cycle; primary cell culture; nutritional requirements for animal cell culture; techniques for the mass culture of animal cell lines; production of vaccines; growth hormones and interferons using animal cell culture; cytokines-production and therapeutic uses; hybridoma technology; vectors for gene transfer and expression in animal cells. Transgenic animals and molecular pharming.

Microbial production of industrial enzymes; methods for immobilization of enzymes; kinetics of soluble and immobilized enzymes; application of soluble and immobilized enzymes; enzyme-based sensors.

Microbial growth kinetics; batch, fed batch and continuous culture of microbial cells; media for industrial fermentations; sterilization of air and media; design features and operation of stirred tank, air-lift and fluidized bed reactors; aeration and agitation in aerobic fermentations; recovery and purification of fermentation products- filtration, centrifugation, cell disintegration, solvent extraction and chromatographic separations; industrial fermentations for the production of ethanol, citric acid, lysine, penicillin and other biomolecules; simple calculations based on material and energy balance of fermentation processes; application of microbes in the management of domestic and industrial wastes.

SECTION K. BOTANY

Anatomy: Roots, stem and leaves of land plants, meristems, vascular system, their ontogeny, structure and functions. Plant cell structure, organisation, organelles, cytoskeleton, cell wall and membranes.

Development: Cell cycle, cell division, senescence, hormonal regulation of growth; life cycle of an angiosperm, pollination, fertilization, embryogenesis, seed formation, seed storage proteins, seed dormancy and germination. Concept of cellular totipotency, organogenesis and somatic embryogenesis, somaclonal variation, embryo culture, in vitro fertilization.

Physiology and Biochemistry: Plant water relations, transport of minerals and solutes, N2 metabolism, proteins and nucleic acid, respiration, photophysiology, photosynthesis, photorespiration; biosynthesis, mechanism of action and physiological effects of plant growth regulators.

Genetics: Principles of Mendelian inheritance, linkage, recombination and genetic mapping; extrachromosomal inheritance; eukaryotic genome organization (chromatin structure) and regulation of gene expression, gene mutation, chromosome aberrations (numerical and structural), transposons.

Plant Breeding: Principles, methods - selection, hybridization, heterosis; male sterility, self and inter-specific incompatibility; haploidy; somatic cell hybridization; molecular marker-assisted selection; gene transfer methods viz. direct and vector-mediated, transgenic plants and their applications in agriculture.

Economic Botany: Economically important plants - cereals, pulses, plants yielding fiber, timber, sugar, beverages, oils, rubber, dyes, gums, drugs and narcotics - a general account.

Systematics: Systems of classification (non-phylogenetic vs. phylogenetic - outline), plant groups, molecular systematics.

Plant Pathology: Nature and classification of plant diseases, diseases of important crops caused by fungi, bacteria and viruses, and their control measures, mechanism(s) of pathogenesis and resistance, molecular detection of pathogens; plant-microbe beneficial interactions.

Ecology and Plant Geography: Ecosystems - types, dynamics, degradation, ecological succession; food chains; vegetation types of the world; pollution and global warming; speciation and extinction, conservation strategies, cryopreservation.

SECTION L. MICROBIOLOGY

Historical perspective - Discovery of the microbial world; Controversy over spontaneous generation; Role of microorganisms in transformation of organic matter and in the causation of diseases.

Methods in microbiology - Pure culture techniques; Theory and practice of sterilization; Principles of microbial nutrition; Construction of culture media; Enrichment culture techniques for isolation of chemoautotrophs, chemoheterotrophs and photosynthetic microorganisms.

Microbial evolution, systematics and taxonomy - Evolution of earth and earliest life forms; Primitive organisms and their metabolic strategies; New approaches to bacterial taxonomic classification including ribotyping; Nomenclature.

Microbial diversity - Bacteria, archea and their broad classification; Eukaryotic microbes, yeast, fungi, slime mold and protozoa; Viruses and their classification.

Microbial growth -The definition of growth, mathematical expression of growth, growth curve, measurement of growth and growth yields; Synchronous growth; Continuous culture.

Nutrition and metabolism - Overview of metabolism; Microbial nutrition; Energy classes of microorganisms; Culture media; Energetics, modes of ATP generation; ATP generation by heterotrophs; Fermentation; Glycolysis; Respiration; The citric acid cycle; Electron transport systems; Alternate modes of energy generation; Pathways (anabolism) in the biosynthesis of amino acids, purines, pyrimidines and fatty acids.

Metabolic diversity among microorganisms - Photosynthesis in microorganisms; Role of chlorophylls, carotenoids and phycobilins; Calvin cycle; Chemolithotrophy; Hydrogen- iron-nitrite-oxidizing bacteria; Nitrate and sulfate reduction; Methanogenesis and acetogenesis.

Prokaryotic cells: structure-function - Cells walls of eubacteria (peptidoglycan) and related molecules; Outer-membrane of gram-negative bacteria; Cell wall and cell membrane synthesis; Flagella and motility; Cell inclusions like endospores, gas vesicles.

Microbial diseases and host parasite relationships - Normal microflora of skin; Oral cavity; Gastrointestinal tract; Entry of pathogens into the host; Infectious disease transmission; Respiratory infections caused by bacteria and viruses; Tuberculosis; Sexually transmitted diseases including AIDS; Diseases transmitted by animals (Rabies, plague), insects and ticks (rikettsias, Lyme disease, malaria); Food and water borne diseases; Public health and water quality; Pahtogenic fungi; Emerging and resurgent infectious diseases.

Chemotherapy/Antibiotics - Antimicrobial agents; Sulfa drugs; Antibiotics; Pencillins and cephalosporins; Broad-spectrum antibiotics; Antibiotics from prokaryotes; Antifungal antibiotics; Mode of action; Resistance to antibiotics.

Microbial genetics - Genes, mutation and mutagenesis - UV and chemical mutagnes; Types of mutations; Ames test for mutagenesis; Methods of genetic analysis. Bacterial genetic system - Transformation; Conjugation; Transduction; Recombination; Plasmids and Transposons; Bacterial genetic map with reference to E. coli. Viruses and their genetic system - Phage ? and its life cycle; RNA phages; RNA viruses; Retroviruses; Genetic systems of yeast and Neurospora; Extrachromosomal inheritance and mitochondrial genetics; Basic concept of genomics.

SECTION M. ZOOLOGY

Animal world: Animal diversity, distribution, systematic and classification of animals, the phylogenetic relationship.

Evolution: Origin of life, history of life on earth, evolutionary theories, natural selection, adaptation, speciation.

Genetics: Principles of inheritance, molecular basis of heredity, the genetic material, transmission of genetic material, mutations, cytoplasmic inheritance.

Biochemistry and Molecular Biology: Nucleic acids, proteins and other biological macromolecules. Replication, transcription and translation, regulation of gene expression, organization of genome, Kreb's cycle, glycolysis, enzyme catalysis, hormones and their action.

Cell Biology: Structure of cell, cellular organelles and their structure and function, cell cycle, cell division, cellular differentiation, chromosome and chromatin structure. Eukaryotic gene organisation and expression.

Animal Anatomy and Physiology: Comparative physiology, the respiratory system, circulatory system, digestive system, the nervous system, the excretory system, the endocrine system, the reproductive system, the skeletal system, osmoregulation.

Parasitology and Immunology: Nature of parasite, host-parasite relation, protozoan and helminthic parasites, the immune response, cellular and humoral immune response, evolution of the immune system.

Development Biology: Embryonic development, cellular differentiation, organogenesis, metamorphosis, genetic basis of development.

Ecology: The ecosystem, habitats the food chain, population dynamics, species diversity, zoogeography, biogeochemical cycles, conservation biology.

Animal Behaviour: Types of behaviours, courtship, mating and territoriality, instinct, learning and memory, social behaviour across the animal taxa, communication, pheromones, evolution of animal behaviour.

IT - INFORMATION TECHNOLOGY

ENGINEERING MATHEMATICS

Mathematical Logic: Propositional Logic; First Order Logic.

Probability: Conditional Probability; Mean, Median, Mode and Standard Deviation; Random Variables; Distributions; uniform, normal, exponential, Poisson, Binomial.

Set Theory & Algebra: Sets; Relations; Functions; Groups; Partial Orders; Lattice; Boolean Algebra.

Combinatorics: Permutations; Combinations; Counting; Summation; generating functions; recurrence relations; asymptotics.

Graph Theory: Connectivity; spanning trees; Cut vertices & edges; covering; matching; independent sets; Colouring; Planarity; Isomorphism.

Linear Algebra: Algebra of matrices, determinants, systems of linear equations, Eigen values and Eigen vectors.

Numerical Methods: LU decomposition for systems of linear equations; numerical solutions of non linear algebraic equations by Secant, Bisection and Newton-Raphson Methods; Numerical integration by trapezoidal and Simpson's rules.

Calculus: Limit, Continuity & differentiability, Mean value Theorems, Theorems of integral calculus, evaluation of definite & improper integrals, Partial derivatives, Total derivatives, maxima & minima.

FORMAL LANGUAGES AND AUTOMATA

Regular Languages: finite automata, regular expressions, regular grammar.

Context free languages: push down automata, context free grammars

COMPUTER HARDWARE

Digital Logic: Logic functions, minimization, design and synthesis of combinatorial and sequential circuits, number representation and computer arithmetic (fixed and floating point)

Computer organization: Machine instructions and addressing modes, ALU and data path, hardwired and microprogrammed control, memory interface, I/O interface (interrupt and DMA mode), serial communication interface, instruction pipelining, cache, main and secondary storage

SOFTWARE SYSTEMS

Data structures and Algorithms: the notion of abstract data types, stack, queue, list, set, string, tree, binary search tree, heap, graph, tree and graph traversals, connected components, spanning trees, shortest paths, hashing, sorting, searching, design techniques (greedy, dynamic, divide and conquer), asymptotic analysis (best, worst, average cases) of time and space, upper and lower bounds, intractability

Programming Methodology: C programming, program control (iteration, recursion, functions), scope, binding, parameter passing, elementary concepts of object oriented programming

Operating Systems (in the context of Unix): classical concepts (concurrency, synchronization, deadlock), processes, threads and interprocess communication, CPU scheduling, memory management, file systems, I/O systems, protection and security

Information Systems and Software Engineering: information gathering, requirement and feasibility analysis, data flow diagrams, process specifications, input/output design, process life cycle, planning and managing the project, design, coding, testing, implementation, maintenance.

Databases: relational model, database design, integrity constraints, normal forms, query languages (SQL), file structures (sequential, indexed), b-trees, transaction and concurrency control

Data Communication: data encoding and transmission, data link control, multiplexing, packet switching, LAN architecture, LAN systems (Ethernet, token ring), Network devices: switches, gateways, routers

Networks: ISO/OSI stack, sliding window protocols, routing protocols, TCP/UDP, application layer protocols & systems (http, smtp, dns, ftp), network security

Web technologies: three tier web based architecture; JSP, ASP, J2EE, .NET systems; html, XML

AG - AGRICULTURAL ENGINEERING

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

FARM MACHINERY AND POWER:

Sources of power on the farm-human, animal, mechanical, electrical, wind, solar and biomass; design and selection of machine elements - gears, pulleys, chains and sprockets and belts; overload safety devices used in farm machinery; measurement of force, torque, speed, displacement and acceleration on machine elements.

Soil tillage; forces acting on a tillage tool; hitch systems and hitching of tillage implements; functional requirements, principles of working, construction and operation of manual, animal and power operated equipment for tillage. sowing, planting, fertilizer application, inter-cultivation, spraying, mowing, chaff cutting, harvesting, threshing and transport; testing of agricultural machinery and equipment; calculation of performance parameters -field capacity, efficiency, application rate and losses; cost analysis of implements and tractors.

Thermodynamic principles of I.C. engines; I.C. engine cycles; engine components; fuels and combustion; lubricants and their properties; I.C. engine systems - fuel, cooling, lubrication, ignition, electrical, intake and exhaust; selection, operation, maintenance and repair of I.C. engines; power efficiencies and measurement; calculation of power, torque, fuel consumption, heat load and power losses.

Tractors and power tillers - type, selection, maintenance and repair; tractor clutches and brakes; power transmission systems - gear trains, differential, final drives and power take-off; mechanics of tractor chassis; traction theory; three point hitches- free link and restrained link operations; mechanical steering and hydraulic control systems used in tractors; human engineering and safety in tractor design; tractor tests and performance.

SOIL AND WATER CONSERVATION ENGINEERING:

Ideal and real fluids, properties of fluids; hydrostatic pressure and its measurement; hydrostatic forces on plane and curved surface; continuity equation; Bernoulli's theorem; laminar and turbulent flow in pipes, Darcy-Weisbach and Hazen-Williams equations, Moody's diagram; flow through orifices and notches; flow in open channels.

Engineering properties of soils, fundamental definitions and relationships; index properties of soils; permeability and seepage analysis; shear strength, Mohr's circle of stresses; active and passive earth pressures; stability of slopes.

Hydrological cycle; precipitation measurement, analysis of precipitation data; abstraction from precipitation; runoff; hydrograph analysis, unit hydrograph theory and application; stream flow measurement; flood routing, hydrological reservoir and channel routing.

Mechanics of soil erosion, factors affecting erosion; soil loss estimation; biological and engineering measures to control erosion, terraces and bunds; vegetative waterways; gully control structures, drop, drop inlet and chute spillways; farm ponds; earthen dams; principles of watershed management.

Water requirement of crops; consumptive use and evapo-transpiration; irrigation scheduling; irrigation efficiencies; design of prismatic and silt loaded channels; methods of irrigation water application; design and evaluation of irrigation methods; drainage coefficient; surface and subsurface drainage systems; leaching requirement and salinity control; irrigation and drainage water quality; classification of pumps; pump characteristics; pump selection; types of aquifer; evaluation of aquifer properties; well hydraulics; ground water recharge.

AGRICULTURAL PROCESSING AND FOOD ENGINEERING:

Steady state heat transfer in conduction, convection and radiation; transient heat transfer in simple geometry; condensation and boiling heat transfer; working principles of heat exchangers; diffusive and convective mass transfer; simultaneous heat and mass transfer in agricultural processing operations.

Material and energy balances in food processing systems; water activity, sorption and desorption isotherms; centrifugal separation of solids, liquids and gases; kinetics of microbial death - pasteurisation and sterilization of liquid foods; preservation of food by cooling and freezing; psychrometry - properties of air-vapour mixture; concentration and dehydration of liquid foods - evaporators, tray, drum and spray dryers.

Mechanics and energy requirement in size reduction of granular solids; particle size analysis for comminuted solids; size separation by screening; fluidisation of granular solids; cleaning and grading efficiency and effectiveness of grain cleaners; conditioning and hydrothermal treatments for grains; dehydration of food grains; processes and machines for processing of cereals, pulses and oilseeds; design considerations for grain silos.

AR - ARCHITECTURE AND PLANNING

City planning: Historical development of cities; principles of city planning; new towns; survey methods, site planning, planning regulations and building bye-laws.

Housing: Concept of shelter; housing policies and design; community planning; role of government agencies; finance and management.

Landscape Design: Principles of landscape design and site planning; history and landscape styles; landscape elements and materials; planting design.

Computer Aided Design: Application of computers in architecture and planning; understanding elements of hardware and software; computer graphics; programming languages - C and Visual Basic and usage of packages such as AutoCAD.

Environmental and Building Science: Elements of environmental science; ecological principles concerning environment; role of micro-climate in design; climatic control through design elements; thermal comfort; elements of solar architecture; principles of lighting and illumination; basic principles of architectural acoustics; air pollution, noise pollution and their control.

Visual and Urban Design: Principles of visual composition; proportion, scale, rhythm, symmetry, harmony, balance, form and colour; sense of place and space, division of space; focal point, vista, imageability, visual survey.

History of Architecture: Indian - Indus valley, Vedic, Buddhist, Indo-Aryan, Dravidian and Mughal periods; European - Egyptian, Greek, Roman, medieval and renaissance periods.

Development of Contemporary Architecture: Architectural developments and impacts on society since industrial revolution; influence of modern art on architecture; works of national and international architects; post modernism in architecture.

Building Services: Water supply, Sewerage and Drainage systems; Sanitary fittings and fixtures; principles of electrification of buildings; elevators, their standards and uses; air-conditioning systems; fire fighting systems.

Building Construction and Management: Building construction techniques, methods and details; building systems and prefabrication of building elements; principles of modular coordination; estimation, specification, valuation, professional practice; project management, PERT, CPM.

Materials and Structural Systems: Behavioural characteristics of all types of building materials e.g. mud, timber, bamboo, brick, concrete, steel, glass, FRP; principles of strength of materials; design of structural elements in wood, steel and RCC; elastic and limit state design; complex structural systems; principles of pre-stressing.

Planning Theory: Planning process; multilevel planning; comprehensive planning; central place theory; settlement pattern; land use and land utilization.

Techniques of Planning: Planning surveys; Preparation of urban and regional structure plans, development plans, action plans; site planning principles and design; statistical methods; application of remote sensing techniques in urban and regional planning.

Traffic and Transportation Planning: Principles of traffic engineering and transportation planning; methods of conducting surveys; design of roads, intersections and parking areas; hierarchy of roads and levels of services; traffic and transport management in urban areas; traffic safety and traffic laws; public transportation planning; modes of transportation.

Services and Amenities: Principles and design of water supply systems, sewerage systems, solid waste disposal systems, power supply and communication systems; Health, education, recreation and demography related standards at various levels of the settlements.

Development Administration and Management: Planning laws; development control and zoning regulations; laws relating to land acquisition; development enforcements, land ceiling; regional and urban plan preparations; planning and municipal administration; taxation, revenue resources and fiscal management; public participation and role of NGO.

CE - CIVIL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

STRUCTURAL ENGINEERING

Mechanics: Bending moments and shear forces in statically determinate beams; simple stress and strain: relationship; stress and strain in two dimensions, principal stresses, stress transformation, Mohr's circle; simple bending theory; flexural shear stress; thin-walled pressure vessels; uniform torsion.

Structural Analysis: Analysis of statically determinate trusses, arches and frames; displacements in statically determinate structures and analysis of statically indeterminate structures by force/energy methods; analysis by displacement methods (slope-deflection and moment-distribution methods); influence lines for determinate and indeterminate structures; basic concepts of matrix methods of structural analysis.

Concrete Structures: Basic working stress and limit states design concepts; analysis of ultimate load capacity and design of members subject to flexure, shear, compression and torsion (beams, columns and isolated footings); basic elements of prestressed concrete: analysis of beam sections at transfer and service loads.

Steel Structures: Analysis and design of tension and compression members, beams and beam-columns, column bases; connections - simple and eccentric, beam-column connections, plate girders and trusses; plastic analysis of beams and frames.

GEOTECHNICAL ENGINEERING

Soil Mechanics: Origin of soils; soil classification; three-phase system, fundamental definitions, relationship and inter-relationships; permeability and seepage; effective stress principle: consolidation, compaction; shear strength.

Foundation Engineering: Sub-surface investigation - scope, drilling bore holes, sampling, penetrometer tests, plate load test; earth pressure theories, effect of water table, layered soils; stability of slopes - infinite slopes, finite slopes; foundation types - foundation design requirements; shallow foundations; bearing capacity, effect of shape, water table and other factors, stress distribution, settlement analysis in sands and clays; deep foundations - pile types, dynamic and static formulae, load capacity of piles in sands and clays.

WATER RESOURCES ENGINEERING

Fluid Mechanics and Hydraulics: Hydrostatics, applications of Bernoulli equation, laminar and turbulent flow in pipes, pipe networks; concept of boundary layer and its growth; uniform flow, critical flow and gradually varied flow in channels, specific energy concept, hydraulic jump; forces on immersed bodies; flow measurement in channels; tanks and pipes; dimensional analysis and hydraulic modeling. Applications of momentum equation, potential flow, kinematics of flow; velocity triangles and specific speed of pumps and turbines.

Hydrology: Hydrologic cycle; rainfall; evaporation infiltration, unit hydrographs, flood estimation, reservoir design, reservoir and channel routing, well hydraulics.

Irrigation: Duty, delta, estimation of evapo-transpiration; crop water requirements; design of lined and unlined canals; waterways; head works, gravity dams and Ogee spillways. Designs of weirs on permeable foundation, irrigation methods.

ENVIRONMENTAL ENGINEERING

Water requirements; quality and standards, basic unit processes and operations for water treatment, distribution of water. Sewage and sewerage treatment: quantity and characteristic of waste water sewerage; primary and secondary treatment of waste water; sludge disposal; effluent discharge standards.

TRANSPORTATION ENGINEERING

Highway planning; geometric design of highways; testing and specifications of paving materials; design of flexible and rigid pavements.

CH - CHEMICAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

CHEMICAL ENGINEERING

Process Calculations and Thermodynamics: Laws of conservation of mass and energy; use of tie components; recycle, bypass and purge calculations; degree of freedom analysis.

First and Second laws of thermodynamics and their applications; equations of state and thermodynamic properties of real systems; phase equilibria; fugacity, excess properties and correlations of activity coefficients; chemical reaction equilibria.

Fluid Mechanics and Mechanical Operations: Fluid statics, Newtonian and non-Newtonian fluids, Bernoulli equation, Macroscopic friction factors, energy balance, dimensional analysis, shell balances, flow through pipeline systems, flow meters, pumps and compressors, packed and fluidized beds, elementary boundary layer theory, size reduction and size separation; free and hindered settling; centrifuge and cyclones; thickening and classification, filtration, mixing and agitation; conveying of solids.

Heat Transfer: Conduction, convection and radiation, heat transfer coefficients, steady and unsteady heat conduction, boiling, condensation and evaporation; types of heat exchangers and evaporators and their design.

Mass Transfer: Fick's law, molecular diffusion in fluids, mass transfer coefficients, film, penetration and surface renewal theories; momentum, heat and mass transfer analogies; stagewise and continuous contacting and stage efficiencies; HTU & NTU concepts design and operation of equipment for distillation, absorption, leaching, liquid-liquid extraction, crystallization, drying, humidification, dehumidification and adsorption.

Chemical Reaction Engineering: Theories of reaction rates; kinetics of homogeneous reactions, interpretation of kinetic data, single and multiple reactions in ideal reactors, non-ideal reactors; residence time; non-isothermal reactors; kinetics of heterogeneous catalytic reactions; diffusion effects in catalysis.

Instrumentation and Process Control: Measurement of process variables; sensors, transducers and their dynamics, dynamics of simple systems, dynamics such as CSTRs, transfer functions and responses of simple systems, process reaction curve, controller modes (P, PI, and PID); control valves; analysis of closed loop systems including stability, frequency response (including Bode plots) and controller tuning, cascade, feed forward control.

Plant Design and Economics: Design and sizing of chemical engineering equipment such as compressors, heat exchangers, multistage contactors; principles of process economics and cost estimation including total annualized cost, cost indexes, rate of return, payback period, discounted cash flow, optimization in Design.

Chemical Technology: Inorganic chemical industries; sulfuric acid, NaOH, fertilizers (Ammonia, Urea, SSP and TSP); natural products industries (Pulp and Paper, Sugar, Oil, and Fats); petroleum refining and petrochemicals; polymerization industries; polyethylene, polypropylene, PVC and polyester synthetic fibers.

CS - COMPUTER SCIENCE AND ENGINEERING

ENGINEERING MATHEMATICS

Mathematical Logic: Propositional Logic; First Order Logic.

Probability: Conditional Probability; Mean, Median, Mode and Standard Deviation; Random Variables; Distributions; uniform, normal, exponential, Poisson, Binomial.

Set Theory & Algebra: Sets; Relations; Functions; Groups; Partial Orders; Lattice; Boolean Algebra.

Combinatorics: Permutations; Combinations; Counting; Summation; generating functions; recurrence relations; asymptotics.

Graph Theory: Connectivity; spanning trees; Cut vertices & edges; covering; matching; independent sets; Colouring; Planarity; Isomorphism.

Linear Algebra: Algebra of matrices, determinants, systems of linear equations, Eigen values and Eigen vectors.

Numerical Methods: LU decomposition for systems of linear equations; numerical solutions of non linear algebraic equations by Secant, Bisection and Newton-Raphson Methods; Numerical integration by trapezoidal and Simpson's rules.

Calculus: Limit, Continuity & differentiability, Mean value Theorems, Theorems of integral calculus, evaluation of definite & improper integrals, Partial derivatives, Total derivatives, maxima & minima.

THEORY OF COMPUTATION

Formal Languages and Automata Theory: Regular languages and finite automata, Context free languages and Push-down automata, Recursively enumerable sets and Turing machines, Un-decidability;

Analysis of Algorithms and Computational Complexity: Asymptotic analysis (best, worst, average case) of time and space, Upper and lower bounds on the complexity of specific problems, NP-completeness.

COMPUTER HARDWARE

Digital Logic: Logic functions, Minimization, Design and synthesis of Combinational and Sequential circuits; Number representation and Computer Arithmetic (fixed and floating point);

Computer Organization: Machine instructions and addressing modes, ALU and Data-path, hardwired and micro-programmed control, Memory interface, I/O interface (Interrupt and DMA mode), Serial communication interface, Instruction pipelining, Cache, main and secondary storage.

SOFTWARE SYSTEMS

Data structures: Notion of abstract data types, Stack, Queue, List, Set, String, Tree, Binary search tree, Heap, Graph;

Programming Methodology: C programming, Program control (iteration, recursion, Functions), Scope, Binding, Parameter passing, Elementary concepts of Object oriented, Functional and Logic Programming;

Algorithms for problem solving: Tree and graph traversals, Connected components, Spanning trees, Shortest paths; Hashing, Sorting, Searching; Design techniques (Greedy, Dynamic Programming, Divide-and-conquer);

Compiler Design: Lexical analysis, Parsing, Syntax directed translation, Runtime environment, Code generation, Linking (static and dynamic); Operating Systems: Classical concepts (concurrency, synchronization, deadlock), Processes, threads and Inter-process communication, CPU scheduling, Memory management, File systems, I/O systems, Protection and security.

Databases: Relational model (ER-model, relational algebra, tuple calculus), Database design (integrity constraints, normal forms), Query languages (SQL), File structures (sequential files, indexing, B+ trees), Transactions and concurrency control;

Computer Networks: ISO/OSI stack, sliding window protocol, LAN Technologies (Ethernet, Token ring), TCP/UDP, IP, Basic concepts of switches, gateways, and routers.

CH - CHEMISTRY

PHYSICAL CHEMISTRY

Structure: Quantum theory - principles and techniques; applications to particle in a box, harmonic oscillator, rigid rotor and hydrogen atom; valence bond and molecular orbital theories and Huckel approximation, approximate techniques: variation and perturbation; symmetry, point groups; rotational, vibrational, electronic, NMR and ESR spectroscopy.

Equilibrium: First law of thermodynamics, heat, energy and work; second law of thermodynamics and entropy; third law and absolute entropy; free energy; partial molar quantities; ideal and non-ideal solutions; phase transformation: phase rule and phase diagrams- one, two, and three component systems; activity, activity coefficient, fugacity and fugacity coefficient ; chemical equilibrium, response of chemical equilibrium to temperature and pressure; colligative properties; kinetic theory of gases; thermodynamics of electrochemical cells; standard electrode potentials: applications - corrosion and energy conversion; molecular partition function (translational, rotational, vibrational and electronic).

Kinetics: Rates of chemical reactions, theories of reaction rates, collision and transition state theory; temperature dependence of chemical reactions; elementary reactions, consecutive elementary reactions; steady state approximation, kinetics of photochemical reactions and free radical polymerization, homogenous and heterogeneous catalysis.

INORGANIC CHEMISTRY

Non-Transition Elements: General characteristics, structure and reactions of simple and industrially important compounds, boranes, carboranes, silicates, silicones, diamond and graphite; hydrides, oxides and oxoacids of N, P, S and halogens; boron nitride, borazines and phosphazenes; xenon compounds. Shapes of molecules, hard-soft acid base concept.

Transition Elements: General characteristics of d and f block elements; coordination chemistry: structure and isomerism, stability, theories of metal-ligand bonding (CFT and LFT), electronic spectra and magnetic properties of transition metal complexes and lanthanides; metal carbonyls, metal-metal bonds and metal atom clusters, metallocenes; transition metal complexes with bonds to hydrogen, alkyls, alkenes, and arenes; metal carbenes; use of organometallic compounds as catalysts in organic synthesis; mechanisms of substitution and electron transfer reactions of coordination complexes. Role of metals with special reference to Na, K, Mg, Ca, Fe, Co, Zn, and Mo in biological systems.

Solids: Crystal systems and lattices, Miller planes, crystal packing, crystal defects; Bragg's Law; ionic crystals, band theory, metals and semiconductors. Spinels.

Instrumental methods of analysis: atomic absorption, UV-visible spectrometry, chromatographic and electro-analytical methods.

ORGANIC CHEMISTRY

Synthesis, reactions and mechanisms involving the following: Alkenes, alkynes, arenes, alcohols, phenols, aldehydes, ketones, carboxylic acids and their derivatives; halides, nitro compounds and amines; stereochemical and conformational effects on reactivity and specificity; reactions with diborane and peracids. Michael reaction, Robinson annulation, reactivity umpolung, acyl anion equivalents; molecular rearrangements involving electron deficient atoms.

Photochemistry: Basic principles, photochemistry of olefins, carbonyl compounds, arenes, photo oxidation and reduction.

Pericyclic reactions: Cycloadditions, electrocyclic reactions, sigmatropic reactions; Woodward-Hoffmann rules.

Heterocycles: Structural properties and reactions of furan, pyrrole, thiophene, pyridine, indole.

Biomolecules: Structure, properties and reactions of mono- and di-saccharides, physico-chemical properties of amino acids, structural features of proteins and nucleic acids.

Spectroscopy: Principles and applications of IR, UV-visible, NMR and mass spectrometry in the determination of structures of organic compounds.

EC - ELECTRONICS AND COMMUNICATION ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix Algebra, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Mean value theorems, Theorems of integral calculus, Evaluation of definite and improper integrals, Partial Derivatives, Maxima and minima, Multiple integrals, Fourier series. Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equation (linear and nonlinear), Higher order linear differential equations with constant coefficients, Method of variation of parameters, Cauchy's and Euler's equations, Initial and boundary value problems, Partial Differential Equations and variable separable method.

Complex variables: Analytic functions, Cauchy's integral theorem and integral formula, Taylor's and Laurent' series, Residue theorem, solution integrals.

Probability and Statistics: Sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Discrete and continuous distributions, Poisson, Normal and Binomial distribution, Correlation and regression analysis.

Numerical Methods: Solutions of non-linear algebraic equations, single and multi-step methods for differential equations.

Transform Theory: Fourier transform, Laplace transform, Z-transform.

ELECTRONICS & COMMUNICATION ENGINEERING

Networks: Network graphs: matrices associated with graphs; incidence, fundamental cut set and fundamental circuit matrices. Solution methods: nodal and mesh analysis. Network theorems: superposition, Thevenin and Norton's maximum power transfer, Wye-Delta transformation. Steady state sinusoidal analysis using phasors. Linear constant coefficient differential equations; time domain analysis of simple RLC circuits, Solution of network equations using Laplace transform: frequency domain analysis of RLC circuits. 2-port network parameters: driving point and transfer functions. State equations for networks.

Electronic Devices: Energy bands in silicon, intrinsic and extrinsic silicon. Carrier transport in silicon: diffusion current, drift current, mobility, resistivity. Generation and recombination of carriers. p-n junction diode, Zener diode, tunnel diode, BJT, JFET, MOS capacitor, MOSFET, LED, p-I-n and avalanche photo diode, LASERs. Device technology: integrated circuits fabrication process, oxidation, diffusion, ion implantation, photolithography, n-tub, p-tub and twin-tub CMOS process.

Analog Circuits: Equivalent circuits (large and small-signal) of diodes, BJTs, JFETs, and MOSFETs. Simple diode circuits, clipping, clamping, rectifier. Biasing and bias stability of transistor and FET amplifiers. Amplifiers: single-and multi-stage, differential, operational, feedback and power. Analysis of amplifiers; frequency response of amplifiers. Simple op-amp circuits. Filters. Sinusoidal oscillators; criterion for oscillation; single-transistor and op-amp configurations. Function generators and wave-shaping circuits. Power supplies.

Digital circuits: Boolean algebra, minimization of Boolean functions; logic gates digital IC families (DTL, TTL, ECL, MOS, CMOS). Combinational circuits: arithmetic circuits, code converters, multiplexers and decoders. Sequential circuits: latches and flip-flops, counters and shift-registers. Sample and hold circuits, ADCs, DACs. Semiconductor memories. Microprocessor(8085): architecture, programming, memory and I/O interfacing.

Signals and Systems: Definitions and properties of Laplace transform, continuous-time and discrete-time Fourier series, continuous-time and discrete-time Fourier Transform, z-transform. Sampling theorems. Linear Time-Invariant (LTI) Systems: definitions and properties; casuality, stability, impulse response, convolution, poles and zeros frequency response, group delay, phase delay. Signal transmission through LTI systems. Random signals and noise: probability, random variables, probability density function, autocorrelation, power spectral density.

Controls Systems: Basic control system components; block diagrammatic description, reduction of block diagrams. Open loop and closed loop (feedback) systems and stability analysis of these systems. Signal flow graphs and their use in determining transfer functions of systems; transient and steady state analysis of LTI control systems and frequency response. Tools and techniques for LTI control system analysis: root loci, Routh-Hurwitz criterion, Bode and Nyquist plots. Control system compensators: elements of lead and lag compensation, elements of Proportional-Integral-Derivative(PID) control. State variable representation and solution of state equation of LTI control systems.

Communications: Analog communication systems: amplitude and angle modulation and demodulation systems, spectral analysis of these operations, superheterodyne receivers; elements of hardware, realizations of analog communication systems; signal-to-noise ratio (SNR) calculations for amplitude modulation (AM) and frequency modulation (FM) for low noise conditions. Digital communication systems: pulse code modulation (PCM), differential pulse code modulation (DPCM), delta modulation (DM); digital modulation schemes-amplitude, phase and frequency shift keying schemes (ASK, PSK, FSK), matched filter receivers, bandwith consideration and probability of error calculations for these schemes.

Electromagnetics: Elements of vector calculus: divergence and curl; Gauss' and Stokes' theorems, Maxwell's equations: differential and integral forms. Wave equation, Poynting vector. Plane waves: propagation through various media; reflection and refraction; phase and group velocity; skin depth. Transmission lines: characteristic impedance; impedance transformation; Smith chart; impedance matching; pulse excitation. Waveguides: modes in rectangular waveguides; boundary conditions; cut-off frequencies; dispersion relations. Antennas: Dipole antennas; antenna arrays; radiation pattern; reciprocity theorem, antenna gain.

EE - ELECTRICAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix Algebra, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Mean value theorems, Theorems of integral calculus, Evaluation of definite and improper integrals, Partial Derivatives, Maxima and minima, Multiple integrals, Fourier series. Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equation (linear and nonlinear), Higher order linear differential equations with constant coefficients, Method of variation of parameters, Cauchy's and Euler's equations, Initial and boundary value problems, Partial Differential Equations and variable separable method.

Complex variables: Analytic functions, Cauchy's integral theorem and integral formula, Taylor's and Laurent' series, Residue theorem, solution integrals.

Probability and Statistics: Sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Discrete and continuous distributions, Poisson, Normal and Binomial distribution, Correlation and regression analysis.

Numerical Methods: Solutions of non-linear algebraic equations, single and multi-step methods for differential equations.

Transform Theory: Fourier transform, Laplace transform, Z-transform.

ELECTRICAL ENGINEERING

Electrical Circuits and Fields: Network graph, KCL, KVL, node/ cut set, mesh/ tie set analysis, transient response of d.c. and a.c. networks; sinusoidal steady-state analysis; resonance in electrical circuits; concepts of ideal voltage and current sources, network theorems, driving point, immittance and transfer functions of two port networks, elementary concepts of filters; three phase circuits; Fourier series and its application; Gauss theorem, electric field intensity and potential due to point, line, plane and spherical charge distribution, dielectrics, capacitance calculations for simple configurations; Ampere's and Biot-Savart's law, inductance calculations for simple configurations.

Electrical Machines: Single phase transformer - equivalent circuit, phasor diagram, tests, regulation and efficiency; three phase transformers - connections, parallel operation; auto transformer and three-winding transformer; principles of energy conversion, windings of rotating machines: D. C. generators and motors - characteristics, starting and speed control, armature reaction and commutation; three phase induction motors-performance characteristics, starting and speed control; single-phase induction motors; synchronous generators-performance, regulation, parallel operation; synchronous motors - starting, characteristics, applications, synchronous condensers; fractional horse power motors; permanent magnet and stepper motors.

Power Systems: Electric power generation - thermal, hydro, nuclear; transmission line parameters; steady-state performance of overhead transmission lines and cables and surge propagation; distribution systems, insulators, bundle conductors, corona and radio interference effects; per-unit quantities; bus admittance and impedance matrices; load flow; voltage control and power factor correction; economic operation; symmetrical components, analysis of symmetrical and unsymmetrical faults; principles of over current, differential and distance protections; concept of solid state relays and digital protection; circuit breakers; concept of system stability-swing curves and equal area criterion; basic concepts of HVDC transmission.

Control Systems: Principles of feedback; transfer function; block diagrams: steady-state errors; stability-Routh and Nyquist criteria; Bode plots; compensation; root loci; elementary state variable formulation; state transition matrix and response for Linear Time Invariant systems.

Electrical and Electronic Measurements: Bridges and potentiometers, PMMC, moving iron, dynamometer and induction type instruments; measurement of voltage, current, power, energy and power factor; instrument transformers; digital voltmeters and multimeters; phase, time and frequency measurement; Q-meter, oscilloscopes, potentiometric recorders, error analysis.

Analog and Digital Electronics: Characteristics of diodes, BJT, FET, SCR; amplifiers-biasing, equivalent circuit and frequency response; oscillators and feedback amplifiers, operational amplifiers- characteristics and applications; simple active filters; VCOs and timers; combinational and sequential logic circuits, multiplexer, Schmitt trigger, multivibrators, sample and hold circuits, A/D and D/A converters; microprocessors and their applications.

Power Electronics and Electric Drives: Semiconductor power devices-diodes, transistors, thyristors, triacs, GTOs, MOSFETs and IGBTs - static characteristics and principles of operation; triggering circuits; phase control rectifiers; bridge converters-fully controlled and half controlled; principles of choppers and inverters, basic concepts of adjustable speed dc and ac drives.

GG - GEOLOGY AND GEOPHYSICS

PART - I

Earth and planetary system; size, shape, internal structure and composition of the earth;

atmosphere and greenhouse effect; isostasy; elements of seismology; continents and continental processes; physical oceanography; palaeomagnetism, continental drift plate tectonics, geothermal energy.

Weathering; soil formation; action of river, wind and glacier; oceans and oceanic features; earthquakes, volcanoes, orogeny and mountain building; elements of structural geology; crystallography; classification, composition and properties of minerals and rocks; engineering properties of rocks and soils, role of geology in the construction of engineering structures.

Processes of ore formation, occurrence and distribution of ores on land and on ocean floor; coal and petroleum resources in India; ground water geology including well hydraulics, geological time scale and geochronology; stratigraphic principles and stratigraphy of India; basics concepts of gravity, magnetic and electrical prospecting for ores and ground water.

PART - IIA: GEOLOGY

Crystal symmetry, forms, twinning; crystal chemistry; optical mineralogy, classification of minerals, diagnostic properties of rock minerals.

Mineralogy, structure, texture and classification of igneous, sedimentary and metamorphic rock, their origin and evolution; application of thermodynamics; structure and petrology of sedimentary rocks; sedimentary processes and environments, sedimentary facies, basin studies; basement cover relationship;

Primary and secondary structures; geometry and genesis of folds, faults, joints, unconformities, cleavage, schistosity and lineation; methods of projection. Tectonites and their significance; shear zone; superposed folding.

Morphology, classification and geological significance of important invertebrates, vertebrates, microfossils and palaeoflora; stratigraphic principles and Indian stratigraphy; geomorphic processes and agents; development and evolution of landforms; slope and drainage; processes on deep oceanic and near-shore regions; quantitative and applied geomorphology; air photo interpretation and remote sensing; chemical and optical properties of ore minerals; formation and localization of ore deposits; prospecting and exploration of economic minerals; coal and petroleum geology; origin and distribution of mineral and fuel deposits in India; ore dressing and mineral economics.

Cosmic abundance; meteorites; geochemical evolution of the earth; geochemical cycles; distribution of major, minor and trace elements; isotope geochemistry; geochemistry of waters including solution equilibria and water rock interaction.

Engineering properties of rocks and soils; rocks as construction material; geology of dams, tunnels and excavation sites; natural hazards; the fly ash problem; ground water geology and exploration; water quality; impact of human activity; Remote sensing techniques for the interpretation of landforms and resource management.

PART - II B: GEOPHYSICS

The earth as a planet; different motions of the earth; gravity filed of the earth and its shape; geochronology; isostasy, seismology and interior of the earth; variation of density, velocity, pressure, temperature, electrical and magnetic properties inside the earth; earthquakes-causes and measurements; zonation and seismic hazards; geomagnetic field, palaeomagnetism; oceanic and continental lithosphere; plate tectonics; heat flow; upper and lower atmospheric phenomena.

Theories of scalar and vector potential fields; Laplace, Maxwell and Helmholtz equations for solution of different types of boundary value problems for Cartesian, cylindrical and spherical polar coordinates; Green's theorem; Image theory; integral equations and conformal transformations in potential theory; Eikonal equation and ray theory.

'G' and 'g' units of measurement, density of rocks, gravimeters, preparation, analysis and interpretation of gravity maps; derivative maps, analytical continuation; gravity anomaly type curves; calculation of mass.

Earth's magnetic field, units of measurement, magnetic susceptibility of rocks, magnetometers, corrections, preparation of magnetic maps, magnetic anomaly type curve, analytical continuation, interpretation and application; magnetic well logging.

Conduction of electricity through rocks, electrical conductivities of metals, metallic, non-metallic and rock forming minerals, D.C. resistivity units and methods of measurement, electrode configuration for sounding and profiling, application of filter theory, interpretation of resistivity field data, application; self potential origin, classification, field measurement, interpretation of induced polarization time frequency, phase domain; IP units and methods of measurement, interpretation and application; ground-water exploration.

Origin of electromagnetic field elliptic polarization, methods of measurement for different source-receiver configuration components in EM measurements, interpretation and applications; earth's natural electromagnetic field, tellurics, magneto-tellurics; geomagnetic depth sounding principles, methods of measurement, processing of data and interpretation.

Seismic methods of prospecting: Reflection, refraction and CDP surveys; land and marine seismic sources, generation and propagation of elastic waves, velocity increasing with depth, geophones, hydrophones, recording instruments (DFS), digital formats, field layouts, seismic noises and noise profile analysis, optimum geophone grouping, noise cancellation by shot and geophone arrays, 2D and 3D seismic data acquisition and processing, CDP stacking charts, binning, filtering, dip-moveout, static and dynamic corrections, deconvolution, migration, signal processing, Fourier and Hilbert transforms, attribute analysis, bright and dim spots, seismic stratigraphy, high resolution seismics, VSP.

Principles and techniques of geophysical well-logging, SP, resistivity, induction, micro gamma ray, neutron, density, sonic, temperature, dip meter, caliper, nuclear magnetic, cement bond logging. Quantitative evaluation of formations from well logs; well hydraulics and application of geophysical methods for groundwater study; application of bore hole geophysics in ground water, mineral and oil exploration. Remote sensing techniques and application of remote sensing methods in geophysics.

IN - INSTRUMENTATION ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix Algebra, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Mean value theorems, Theorems of integral calculus, Evaluation of definite and improper integrals, Partial Derivatives, Maxima and minima, Multiple integrals, Fourier series. Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equation (linear and nonlinear), Higher order linear differential equations with constant coefficients, Method of variation of parameters, Cauchy's and Euler's equations, Initial and boundary value problems, Partial Differential Equations and variable separable method.

Complex variables: Analytic functions, Cauchy's integral theorem and integral formula, Taylor's and Laurent' series, Residue theorem, solution integrals.

Probability and Statistics: Sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Discrete and continuous distributions, Poisson, Normal and Binomial distribution, Correlation and regression analysis.

Numerical Methods: Solutions of non-linear algebraic equations, single and multi-step methods for differential equations.

Transform Theory: Fourier transform, Laplace transform, Z-transform.

INSTRUMENTATION ENGINEERING

Measurement Basics and Metrology: Static and dynamic characteristics of measurement systems. Standards and calibration. Error and uncertainty analysis, statistical analysis of data, and curve fitting. Linear and angular measurements; Measurement of straightness, flatness, roundness and roughness.

Transducers, Mechanical Measurements and Industrial Instrumentation: Transducers - elastic, resistive, inductive, capacitive, thermo-electric, piezoelectric, photoelectric, electro-mechanical, electro-chemical, and ultrasonic. Measurement of displacement, velocity (linear and rotational), acceleration, shock, vibration, force, torque, power, strain, stress, pressure, flow, temperature, humidity, viscosity, and density. energy storing elements, suspension systems and dampers.

Analog Electronics: Characteristics of diodes, BJTs, JFETs and MOSFETs; Diode circuits; Amplifiers: single and multi-stage, feedback; Frequency response; Operational amplifiers - design, characteristic, linear and non-linear applications: difference amplifiers; instrumentation amplifiers; precision rectifiers, I-to-V converters, active filters, oscillators, comparators, signal generators, wave shaping circuits.

Digital Electronics: Combinational logic circuits, minimization of Boolean functions; IC families (TTL, MOS, CMOS), arithmetic circuits, multiplexer and decoders. Sequential circuits: flip-flops, counters, shift registers. Schmitt trigger, timers, and multivibrators. Analog switches, multiplexers, S/H circuits. Analog-to-digital and digital-to-analog converters. Basics of computer organization and architecture. 8-bit microprocessor (8085), applications, memory, I/O interfacing, and microcontrollers.

Signals and Systems: Vectors and matrices; Fourier series; Fourier transforms; Ordinary differential equations. Impulse and frequency responses of first and second order systems. Laplace transform and transfer function, convolution and correlation. Amplitude and frequency modulations and demodulations. Discrete time systems, difference equations, impulse and frequency responses; Z-transforms and transfer functions; IIR and FIR filters.

Electrical and Electronic Measurements: Measurement of R, L and C; bridges and potentiometers. Measurement of voltage, current, power, power factor, and energy; Instrument transformers; Q meter, waveform analyzers. Digital volt-meters and multi-meters. Time, phase and frequency measurements; Oscilloscope. Noise and interference in instrumentation.

Control Systems & Process Control: Principles of feedback; transfer function, signal flow graphs. Stability criteria, Bode plots, root-loci, Routh and Nyquist criteria. Compensation techniques; State space analysis. System components: mechanical, hydraulic, pneumatic, electrical and electronic; Servos and synchros; Stepper motors. On-off, cascade, P, PI, PID and feed-forward controls. Controller tuning and general frequency response.

Analytical, Optical and Biomedical Instrumentation: Principles of spectrometry, UV, visible, IR mass spectrometry, X-ray methods; nuclear radiation measurements, gas, solid and semi conductor lasers and their characteristics, interferometers, basics of fibre optics, transducers in biomedical applications, cardiovascular system measurements, instrumentation for clinical laboratory.

MA - MATHEMATICS

Linear Algebra: Finite dimensional vector spaces. Linear transformations and their matrix representations, rank; systems of linear equations, eigenvalues and eigenvectors, minimal polynomial, Cayley-Hamilton theorem, diagonalisation, Hermitian, Skew-Hermitian and unitary matrices. Finite dimensional inner product spaces, self-adjoint and Normal linear operators, spectral theorem, Quadratic forms.

Complex Analysis: Analytic functions, conformal mappings, bilinear transformations, complex integration: Cauchy's integral theorem and formula, Liouville's theorem, maximum modulus principle, Taylor and Laurent's series, residue theorem and applications for evaluating real integrals.

Real Analysis: Sequences and series of functions, uniform convergence, power series, Fourier series, functions of several variables, maxima, minima, multiple integrals, line, surface and volume integrals, theorems of Green, Stokes and Gauss; metric spaces, completeness, Weierstrass approximation theorem, compactness. Lebesgue measure, measurable functions; Lebesgue integral, Fatou's lemma, dominated convergence theorem.

Ordinary Differential Equations: First order ordinary differential equations, existence and uniqueness theorems, systems of linear first order ordinary differential equations, linear ordinary differential equations of higher order with constant coefficients; linear second order ordinary differential equations with variable coefficients, method of Laplace transforms for solving ordinary differential equations, series solutions; Legendre and Bessel functions and their orthogonality, Sturm Liouville system, Greeen's functions.

Algebra: Normal subgroups and homomorphisms theorems, automorphisms. Group actions, sylow's theorems and their applications groups of order less than or equal to 20, Finite p-groups. Euclidean domains, Principal ideal domains and unique factorizations domains. Prime ideals and maximal ideals in commutative rings.

Functional Analysis: Banach spaces, Hahn-Banach theorems, open mapping and closed graph theorems, principle of uniform boundedness; Hilbert spaces, orthonormal sets, Riesz representation theorem, self-adjoint, unitary and normal linear operators on Hilbert Spaces.

Numerical Analysis: Numerical solution of algebraic and transcendental equations; bisection, secant method, Newton-Raphson method, fixed point iteration, interpolation: existence and error of polynomial interpolation, Lagrange, Newton, Hermite(osculatory)interpolations; numerical differentiation and integration, Trapezoidal and Simpson rules; Gaussian quadrature; (Gauss-Legendre and Gauss-Chebyshev), method of undetermined parameters, least square and orthonormal polynomial approximation; numerical solution of systems of linear equations: direct and iterative methods, (Jacobi Gauss-Seidel and SOR) with convergence; matrix eigenvalue problems: Jacobi and Given's methods, numerical solution of ordinary differential equations: initial value problems, Taylor series method, Runge-Kutta methods, predictor-corrector methods; convergence and stability.

Partial Differential Equations: Linear and quasilinear first order partial differential equations, method of characteristics; second order linear equations in two variables and their classification; Cauchy, Dirichlet and Neumann problems, Green's functions; solutions of Laplace, wave and diffusion equations in two variables Fourier series and transform methods of solutions of the above equations and applications to physical problems.

Mechanics: Forces in three dimensions, Poinsot central axis, virtual work, Lagrange's equations for holonomic systems, theory of small oscillations, Hamiltonian equations;

Topology: Basic concepts of topology, product topology, connectedness, compactness, countability and separation axioms, Urysohn's Lemma, Tietze extension theorem, metrization theorems, Tychonoff theorem on compactness of product spaces.

Probability and Statistics: Probability space, conditional probability, Bayes' theorem, independence, Random variables, joint and conditional distributions, standard probability distributions and their properties, expectation, conditional expectation, moments. Weak and strong law of large numbers, central limit theorem. Sampling distributions, UMVU estimators, sufficiency and consistency, maximum likelihood estimators. Testing of hypotheses, Neyman-Pearson tests, monotone likelihood ratio, likelihood ratio tests, standard parametric tests based on normal, X2 ,t, F-distributions. Linear regression and test for linearity of regression. Interval estimation.

Linear Programming: Linear programming problem and its formulation, convex sets their properties, graphical method, basic feasible solution, simplex method, big-M and two phase methods, infeasible and unbounded LPP's, alternate optima. Dual problem and duality theorems, dual simplex method and its application in post optimality analysis, interpretation of dual variables. Balanced and unbalanced transportation problems, unimodular property and u-v method for solving transportation problems. Hungarian method for solving assignment problems.

Calculus of Variations and Integral Equations: Variational problems with fixed boundaries; sufficient conditions for extremum, Linear integral equations of Fredholm and Volterra type, their iterative solutions. Fredholm alternative.

ME - MECHANICAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

APPLIED MECHANICS AND DESIGN

Engineering Mechanics: Equivalent force systems, free-body concepts, equations of equilibrium, trusses and frames, virtual work and minimum potential energy. Kinematics and dynamics of particles and rigid bodies, impulse and momentum (linear and angular), energy methods, central force motion.

Strength of Materials: Stress and strain, stress-strain relationship and elastic constants, Mohr's circle for plane stress and plane strain, shear force and bending moment diagrams, bending and shear stresses, deflection of beams, torsion of circular shafts, thin and thick cylinders, Euler's theory of columns, strain energy methods, thermal stresses.

Theory of Machines: Displacement, velocity and acceleration, analysis of plane mechanisms, dynamic analysis of slider-crank mechanism, planar cams and followers, gear tooth profiles, kinematics of gears, governors and flywheels, balancing of reciprocating and rotating masses.

Vibrations: Free and forced vibration of single degree freedom systems, effect of damping, vibration isolation, resonance, critical speed of rotors.

Design of Machine Elements: Design for static and dynamic loading, failure theories, fatigue strength; design of bolted, riveted and welded joints; design of shafts and keys; design of spur gears, rolling and sliding contact bearings; brakes and clutches; belt, rope and chain drives.

FLUID MECHANICS AND THERMAL SCIENCES

Fluid Mechanics: Fluid properties, fluid statics, manometry, buoyancy; control-volume analysis of mass, momentum and energy; fluid acceleration; differential equations of continuity and momentum; Bernoulli's equation; viscous flow of incompressible fluids; boundary layer; elementary turbulent flow; flow through pipes, head losses in pipes, bends etc.

Heat-Transfer: Modes of heat transfer; one dimensional heat conduction, resistance concept, electrical analogy, unsteady heat conduction, fins; dimensionless parameters in free and forced convective heat transfer, various correlations for heat transfer in flow over flat plates and through pipes; thermal boundary layer; effect of turbulence; radiative heat transfer, black and grey surfaces, shape factors, network analysis; heat exchanger performance, LMTD and NTU methods.

Thermodynamics: Zeroth, First and Second laws of thermodynamics; thermodynamic system and processes; irreversibility and availability; behaviour of ideal and real gases, properties of pure substances, calculation of work and heat in ideal processes; analysis of thermodynamic cycles related to energy conversion; Carnot, Rankine, Otto, Diesel, Brayton and vapour compression cycles.

Power Plant Engineering: Steam generators; steam power cycles; steam turbines; impulse and reaction principles, velocity diagrams, pressure and velocity compounding; reheating and reheat factor; condensers and feed heaters.

I.C. Engines: Requirements and suitability of fuels in IC engines, fuel ratings, fuel-air mixture requirements; normal combustion in SI and CI engines; engine performance calculations.

Refrigeration and air-conditioning: Refrigerant compressors, expansion devices, condensers and evaporators; properties of moist air, psychrometric chart, basic psychometric processes.

Turbomachinery: Components of gas turbines; compression processes, centrifugal and axial flow compressors; axial flow turbines, elementary theory; hydraulic turbines; Euler-turbine equation; specific speed, Pelton-wheel, Francis and Kaplan turbines; centrifugal pumps.

MANUFACTURING AND INDUSTRIAL ENGINEERING

Engineering Materials: Structure and properties of engineering materials and their applications, heat treatment.

Metal Casting: Casting processes (expendable and non-expendable) -pattern, moulds and cores, heating and pouring, solidification and cooling, gating design, design considerations, defects.

Forming Processes: Stress-strain diagrams for ductile and brittle material, Plastic deformation and yield criteria, fundamentals of hot and cold working processes, Bulk metal forming processes (forging, rolling, extrusion, drawing), sheet metal working processes (punching, blanking, bending, deep drawing, coining, spinning, load estimation using homogeneous deformation methods, defects). processing of powder metals- atomization, compaction, sintering, secondary and finishing operations. forming and shaping of plastics- extrusion, injection moulding.

Joining Processes: Physics of welding, fusion and non-fusion welding processes, brazing and soldering, adhesive bonding, design considerations in welding, weld quality defects.

Machining and Machine Tool Operations: Mechanics of machining, single and multi-point cutting tools, tool geometry and materials, tool life and wear, cutting fluids, machinability, economics of machining, non-traditional machining processes.

Metrology and Inspection: Limits, fits and tolerances, linear and angular measurements, comparators, gauge design, interferometry, form and finish measurement, measurement of screw threads, alignment and testing methods.

Tool Engineering: Principles of work holding, design of jigs and fixtures.

Computer Integrated Manufacturing: Basic concepts of CAD, CAM and their integration tools.

Manufacturing Analysis: Part-print analysis, tolerance analysis in manufacturing and assembly, time and cost analysis.

Work-Study: Method study, work measurement, time study, work sampling, job evaluation, merit rating.

Production Planning and Control: Forecasting models, aggregate production planning, master scheduling, materials requirements planning.

Inventory Control: Deterministic and probabilistic models, safety stock inventory control systems.

Operations Research: Linear programming, simplex and duplex method, transportation, assignment, network flow models, simple queuing models, PERT and CPM

MN - MINING ENGINEERING

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

MINING ENGINEERING

Mechanics: Equivalent force systems, equations of equilibrium, two dimensional frames and trusses, free body diagrams, friction forces, particle kinematics and dynamics.

Mine Development, Geomechanics and Strata Control: Drivages for underground mine development, drilling methods and machines, explosives, blasting devices and practices, shaft sinking. Physico-mechanical properties of rocks, rock mass classification, ground control instrumentation and stress measurement techniques, theories of rock failure, ground vibrations, stress distribution around mine openings, subsidence, design of supports in roadways and workings, stability of open pits, slopes.

Mining Methods and Machinery: Surface mining - layout, development, loading, transportation and mechanization, continuous surface mining systems. Underground coal mining - bord and pillar system, longwall mining, thick seam mining methods. Underground metal mining: different stoping methods, stope mechanization, ore handling systems, mine filling. Generation and transmission of mechanical, hydraulic, and pneumatic power. Materials handling - haulages, conveyors, ropeways, face and development machinery, hoisting systems, and pumps.

Ventilation, Underground Hazards and Surface Environment: Underground atmosphere, heat load sources and thermal environment, air cooling, mechanics of air flow distribution, natural and mechanical ventilation, mine fans and their usage, auxiliary ventilation. Subsurface hazards from fires, explosions, gases, dust, and inundation, rescue apparatus and practices, safety in mines, accident analysis, noise, mine lighting. Air and water pollution: causes, dispersion, quality standards, and control.

Surveying, Mine Planning and Systems Engineering: Fundamentals of engineering surveying, Levels and levelling, Theodolite, tacheometry, triangulation, contouring, errors and adjustments, correlation, underground surveying, curves, photogrammetry, field astronomy, GPS fundamentals. Principles of planning - Sampling methods and practices, reserve estimation techniques, basics of geostatistics, optimization of facility location, cash flow concepts and mine valuation, open pit design. Work study, concepts of reliability, reliability of series and parallel systems. Linear programming, transportation and assignment problems, queueing, network analysis, inventory control.

MT - METALLURGICAL ENGINEERING

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

METALLURGICAL ENGINEERING

Thermodynamics and Rate Processes: Laws of thermodynamics, activity, equilibrium constant, applications to metallurgical systems, solutions, phase equilibria, basic kinetic laws, order of reactions, rate constants and rate limiting steps principles of electro chemistry, aqueous, corrosion and protection of metals, oxidation and high temperature corrosion - characterization and control; momentum transfer - concepts of viscosity, shell balances, Bernoulli's equation; heat transfer - conduction, convection and heat transfer coefficient relations, radiation, mass transfer - diffusion and Fick's laws.

Extractive Metallurgy: Flotation, gravity and other methods of mineral processing; agglomeration, pyro-hydro-and electro-metallurgical processes; material and energy balances; principles and processes for the extraction of non-ferrous metals - aluminium, copper, zinc, lead, magnesium, nickel, titanium and other rare metals; iron and steel making - principles, blast furnace, direct reduction processes, primary and secondary steel making, deoxidation and inclusion in steel; ingot and continuous casting; stainless steel making, design of furnaces; fuels and refractories.

Physical Metallurgy: Crystal structure and bonding characteristics of metals, alloys, ceramics and polymers; solid solutions; solidification; phase transformation and binary phase diagrams; principles of heat treatment of steels, aluminum alloys and cast irons; recovery, recrystallization and grain growth; industrially important ferrous and non-ferrous alloys; elements of X-ray and electron diffraction; principles of scanning and transmission electron microscopy; elements of ceramics, composites and electronic materials; electronic basis of thermal, optical, electrical and magnetic properties of materials.

Mechanical Metallurgy: Elements of elasticity and plasticity; defects in crystals; elements of dislocation theory - types of dislocations, slip and twinning, stress fields of dislocations, dislocation interactions and reactions, methods of seeing dislocations; strengthening mechanisms; tensile, fatigue and creep behaviour; superplasticity; fracture - Griffith theory, ductile to brittle transition, fracture toughness; failure analysis; mechanical testing - tension, compression, torsion, hardness, impact, creep, fatigue, fracture toughness and formability tests.

Manufacturing Processes: Metal casting - patterns, moulds, melting, gating, feeding and casting processes, defects and castings, hot and cold working of metals; Metal forming - fundamentals of metal forming, rolling wire drawing, extrusion, forming, sheet metal forming processes, defects in forming; Metal joining - soldering, brazing and welding, common welding processes, welding metallurgy, problems associated with welding of steels and aluminium alloys, defects in welding, powder metallurgy; NDT methods - ultrasonic, radiography, eddy current, acoustic emission and magnetic.

PH - PHYSICS

Mathematical Physics: Linear vector space, matrices; vector calculus; linear differential equations; elements of complex analysis; Laplace transforms, Fourier analysis, elementary ideas about tensors.

Classical Mechanics: Conservation laws; central forces; collisions and scattering in laboratory and centre of mass reference frames; mechanics of system of particles; rigid body dynamics; moment of inertia tensor; noninertial frames and pseudo forces; variational principle; Lagrange's and Hamilton's formalisms; equation of motion, cyclic coordinates, Poisson bracket; periodic motion, small oscillations, normal modes; wave equation and wave propagation; special theory of relativity - Lorentz transformations, relativistic kinematics, mass-energy equivalence.

Electromagnetic Theory: Laplace and Poisson equations; conductors and dielectrics; boundary value problems; Ampere's and Biot-Savart's laws; Faraday's law; Maxwell's equations; scalar and vector potentials; Coulomb and Lorentz gauges; boundary conditions at interfaces; electromagnetic waves; interference, diffraction and polarization; radiation from moving charges.

Quantum Mechanics: Physical basis of quantum mechanics; uncertainty principle; Schrodinger equation; one and three dimensional potential problems; Particle in a box, harmonic oscillator, hydrogen atom; linear vectors and operators in Hilbert space; angular momentum and spin; addition of angular momentum; time independent perturbation theory; elementary scattering theory.

Atomic and Molecular Physics: Spectra of one-and many-electron atoms; LS and jj coupling; hyperfine structure; Zeeman and Stark effects; electric dipole transitions and selection rules; X-ray spectra; rotational and vibrational spectra of diatomic molecules; electronic transition in diatomic molecules, Franck-Condon principle; Raman effect; NMR and ESR; lasers.

Thermodynamics and Statistical Physics: Laws of thermodynamics; macrostates, phase space; probability ensembles; partition function, free energy, calculation of thermodynamic quantities; classical and quantum statistics; degenerate Fermi gas; black body radiation and Planck's distribution law; Bose-Einstein condensation; first and second order phase transitions, critical point.

Solid State Physics: Elements of crystallography; diffraction methods for structure determination; bonding in solids; elastic properties of solids; defects in crystals; lattice vibrations and thermal properties of solids; free electron theory; band theory of solids; metals, semiconductors and insulators; transport properties; optical, dielectric and magnetic properties of solids; elements of superconductivity.

Nuclear and Particle Physics: Rutheford scattering; basic properties of nuclei; radioactive decay; nuclear forces; two nucleon problem; nuclear reactions; conservation laws; fission and fusion; nuclear models; particle accelerators, detectors; elementary particles; photons, baryons, mesons and leptons; Quark model.

Electronics: Network analysis; semiconductor devices; bipolar transistors; FETs; power supplies, amplifier, oscillators; operational amplifiers; elements of digital electronics; logic circuits.

PI - PRODUCTION AND INDUSTRIAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

GENERAL ENGINEERING:

Engineering Materials: Structure and properties of engineering materials and their applications; effect of strain, strain rate and temperature on mechanical properties of metals and alloys; heat treatment of metals and alloys.

Applied Mechanics: Engineering mechanics - equivalent force systems, free body concepts, equations of equilibrium, virtual work and minimum potential energy; strength of materials-stress, strain and their relationship, Mohr's circle, deflection of beams, bending and shear stress, Euler's theory of columns.

Theory of Machines and Design: Analysis of planar mechanisms, plane cams and followers; governers and fly wheels; design of elements-failure theories; design of bolted, riveted and welded joints; design of shafts, keys, belt drives, brakes and clutches.

Thermal Engineering: Fluid machines - fluid statics, Bernoulli's equation, flow through pipes, equations of continuity and momentum; Thermodynamics - zeroth, First and Second laws of thermodynamics, thermodynamic system and processes, calculation of work and heat for systems and control volumes; Heat transfer - fundamentals of conduction, convection and radiation.

PRODUCTION ENGINEERING

Metal Casting: Casting processes; patterns-materials; allowances; moulds and cores - materials, making and testing; melting and founding of cast iron, steels and nonferrous metals and alloys; solidification; design of casting, gating and risering; casting defects and inspection.

Metal working: Stress-strain in elastic and plastic deformation; deformation mechanisms; hot and cold working-forging, rolling, extrusion, wire and tube drawing; sheet metal working; analysis of rolling, forging, extrusion and wire /rod drawing; metal working defects, high energy rate forming processes-explosive, magnetic, electro and electrohydraulic.

Metal Joining Processes: Welding processes - gas shielded metal arc, TIG, MIG, submerged arc, electroslag, thermit, resistance, pressure and forge welding; thermal cutting; other joining processes - soldering, brazing, braze welding; welding codes, welding symbols, design of welded joints, defects and inspection; introduction to modern welding processes - friction, ultrasonic, explosive, electron beam, laser and plasma.

Machining and Machine Tool Operations: Machining processes-turning, drilling, boring, milling, shaping, planing, sawing, gear cutting, thread production, broaching, grinding, lapping, honing super finishing; mechanics of cutting- Merchant's analysis, geometry of cutting tools, cutting forces, power requirements; selection of process parameters; tool materials, tool wear and tool life, cutting fluids, machinability; nontraditional machining processes and hybrid processes- EDM, CHM, ECM, USM, LBM, EBM, AJM, PAM AND WJM; economics of machining.

Metrology and Inspection: Limits and fits, linear and angular measurements by mechanical and optical methods, comparators; design of limit gauges; interferometry; measurement of straightness, flatness, roundness, squareness and symmetry; surface finish measurement; inspection of screw threads and gears; alignment testing.

Powder Metallurgy and Processing of Plastics: Production of powders, compaction, sintering; Polymers and composites; injection, compression and blow molding, extrusion, calendaring and thermoforming; molding of composites.

Tool Engineering: Work-holding-location and clamping; principles and methods; design of jigs and fixtures; design of press working tools, forging dies.

Manufacturing Analysis: Sources of errors in manufacturing; process capability; part-print analysis; tolerance analysis in manufacturing and assembly; process planning; parameter selection and comparison of production alternatives; time and cost analysis; Issues in choosing manufacturing technologies and strategies.

Computer Integrated Manufacturing: Basic concepts of CAD, CAM, CAPP, group technology, NC, CNC, DNC, FMS, Robotics and CIM.

INDUSTRIAL ENGINEERING

Product Design and Development: Principles of good product design, component and tolerance design; efficiency, quality and cost considerations; product life cycle; standardization, simplification, diversification, value analysis, concurrent engineering.

Engineering Economy and Costing: Financial statements; elementary cost accounting, methods of depreciation; break-even analysis, techniques for evaluation of capital investments.

Work System Design: Taylor's scientific management, Gilbreths's contributions; productivity concepts and measurements; method study, micro-motion study, principles of motion economy; human factors engineering, ergonomics; work measurement - time study, PMTS, work sampling; job evaluation, merit rating, wage administration, incentive systems; business process reengineering.

Logistics and Facility Design: Facility location factors, evaluation of alternatives, types of plant layout, evaluation; computer aided layout; assembly line balancing; material handling systems; supply chain management.

Production Planning and Inventory Control: Inventory Function costs, classifications - deterministic and probabilistic models; quantity discount; safety stock; inventory control system; Forecasting techniques - causal and time series models, moving average, exponential smoothing; trend and seasonality; aggregate production planning; master scheduling; bill of materials and material requirement planning; order control and flow control, routing, scheduling and priority dispatching; JIT; Kanban PULL systems; bottleneck scheduling and theory of constraints.

Operation Research: Linear programming - problem formulation, simplex method, duality and sensitivity analysis; transportation; assignment; network flow models, constrained optimization and Lagrange multipliers; simple queuing models; dynamic programming; simulation; PERT and CPM, time-cost trade-off, resource leveling.

Quality Control: Taguchi method; design of experiments; quality costs, statistical quality assurance, process control charts, acceptance sampling, zero defects; quality circles, total quality management.

Reliability and Maintenance: Reliability, availability and maintainability; probabilistic failure and repair times; system reliability; preventive maintenance and replacement, TPM.

Management Information System: Value of information; information storage and retrieval system - database and data structures; interactive systems; knowledge based systems.

Intellectual Property System: Definition of intellectual property, importance of IPR; TRIPS, and its implications, WIPO and Global IP structure, and IPS in India; patent, copyright, industrial design and trademark; meanings, rules and procedures, terms, infringements and remedies.

PY - PHARMACEUTICAL SCIENCES

Natural Products: Pharmacognosy & Phytochemistry - Chemistry, tests, isolation, characterization and estimation of phytopharmaceuticals belonging to the group of Alkaloids, Glycosides, Terpenoids, Steroids, Bioflavanoids, Purines, Guggul lipids. Pharmacognosy of crude drugs which contain the above constituents. Standardisation of raw materials and herbal products. WHO guide lines. Quantitative microscopy including modern techniques used for evaluation. Biotechnological principles and techniques for plant development Tissue culture.

Pharmacology: General pharmacological principles including Toxicology. Drug interaction. Pharmacology of drugs acting on Central nervous system, Cardiovascular system, Autonomic nervous system, Gastro intestinal system and Respiratory system. Pharmacology of Autocoids, Hormones, Chemotherapeutic agents including anticancer drugs. Bioassays. Immuno Pharmacology.

Medicinal Chemistry: Structure, nomenclature, classification, synthesis, SAR and metabolism of the following category of drugs which are official in Indian Pharmacopoeia and British Pharmacopoeia Hypnotics and Sedatives, Analgesics, NSAIDS, Neuroleptics, Antidepressants, Anxiolytics, Anticonvulsants, Antihistaminics, Local anaesthetics, Cardio Vascular drugs - Antianginal agents Vasodilators, Adrenergic & cholinergic drugs, Cardiotonic agents, Diuretics, Antihypertensive drugs, Hypoglycemic agents, Antilipedmic agents, Coagulants, Anticoagulants, Antiplatelet agents. Chemotherapeutic agents - Antibiotics, Antibacterials, Sulphadrugs. Antiproliozoal drugs, Antiviral, Antitubercular, Antimalarial, Anticancer, Antiamoebic drugs. Diagnostic agents. Preparation and storage and uses of official Radiopharmaceuticals. Vitamins and Hormones.

Pharmaceutics: Development, manufacturing standards, labeling, packing as per the pharmacopoeal requirements, Storage of different dosage forms and new drug delivery systems. Biopharmaceutics and Pharmacokinetics and their importance in formulation. Formulation and preparation of cosmetics - lipstick, shampoo, creams, nail preparations and dentifrices. Pharmaceutical calculations.

Pharmaceutical Jurisprudence: Legal aspects of manufacture, storage, sale of drugs. D and C act and rules. Pharmacy act.

Pharmaceutical Analysis: Principles, instrumentation and applications of the following. Absorption spectroscopy (UV, visible & IR), Fluorimetry, Flame photometry, Potentiometry, Conductometry and Plarography. Pharmacopoeial assays. Principles of NMR, ESR, Mass spectroscopy, X-ray diffraction analysis and different chromatographic methods.

Biochemistry and Clinical Pharmacy: Biochemical role of hormones, Vitamins, Enzymes, Nucleic acids. Bioenergetics. General principles of immunology. Immunological techniques. Adverse drug interaction.

Microbiology: Principles and methods of microbiological assays of the Pharmacopoeia. Methods of preparation of official sera and vaccines. Serological and diagnostic tests. Applications of microorganisms in Bio Conversions and in Pharmaceutical industry.

TF - TEXTILE ENGINEERING AND FIBRE SCIENCE

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

TEXTILE ENGINEERING & FIBRE SCIENCE

Textile Fibres: Classification of textile fibres according to their nature and origin; general characteristics of textile fibres-their chemical and physical structures and their properties; essential characteristics of fibre forming polymers; uses of natural and man-made fibres; physical and chemical methods of fibre and blend identification and blend analysis.

Melt Spinning processes with special reference to polyamide and polyester fibres; wet and dry spinning of viscose and acrylic fibres; post spinning operations-drawing, heat setting, texturing- false twist and air-jet, tow-to-top conversion. Methods of investigating fibre structure e.g. X-ray diffraction, birefringence, optical and electron microscopy, I.R. absorption, thermal methods; structure and morphology and principal natural and man-made fibres, mechanical properties of fibres, moisture sorption in fibres; fibre structure and property correlation.

Textile Testing: Sampling techniques, sample size and sampling errors; measurement of fibre length, fineness, crimp, strength and reflectance; measurement of cotton fibre maturity ad trash content; HVI and AFIS for fibre testing. Measurement of yarn count, twist and hairiness; tensile testing of fibres, yarn and fabrics; evenness testing of slivers, rovings and yarns; testing equipment for measurement test methods of fabric properties like thickness, compressibility, air permeability, drape, crease recovery, tear strength bursting strength and abrasion resistance. Correlation analysis, significance tests and analysis of variance; frequency distributions and control charts.

Yarn Manufacture and Yarn Structure: Modern methods of opening, cleaning and blending of fibrous materials; the technology of carding with particular reference to modern developments; causes of irregularity introduced by drafting, the development of modern drafting systems; principles and techniques of preparing material for combing; recent development in combers; functions and synchronization of various mechanisms concerned with roving production; forces acting on yarn and traveller, ring and traveller designs; causes of end breakages; properties of doubles yarns; new methods of yarn production such as rotor spinning, air jet spinning and friction spinning.

Yarn diameter; specific volume, packing coefficient; twist-strength relationship; fibre orientation in yarn; fibre migration.

Fabric Manufacture and Fabric Structure: Principles of cheese and cone winding processes and machines; random and precision winding; package faults and their remedies; yarn clearers and tensioners; different systems of yarn splicing; features of modern cone winding machines; different types of warping creels; features of modern beam and sectional warping machines; different sizing systems, sizing of spun and filament yarns, modern sizing machines; principles of pirn winding processes and machines; primary and secondary motions of loom, effect of their settings and timings on fabric formation, fabric appearance and weaving performance; dobby and jacquard shedding; mechanics of weft insertion with shuttle; warp and weft stop motions, warp protection, weft replenishment; functional principles of weft insertion systems of shuttleless weaving machines, principles of multiphase and circular looms. Principles of weft and warp knitting; basic weft and warp knitted structures; classification, production and areas of application of nonwoven fabrics.

Basic woven fabric constructions and their derivatives; crepe, cord, terry, gauze, lino and double cloth constructions.

Peirce's equations for fabric geometry; thickness, cover and maximum sett of woven fabrics

Textile Chemical Processing: Preparatory processes for natural-and and their blends; mercerization of cotton; machines for yarn and fabric mercerization.

Dyeing and printing of natural- and synthetic- fibre fabrics and their blends with different dye classes; dyeing and printing machines; styles of printing; fastness properties of dyed and printed textile materials.

Finishing of textile materials, wash and wear, durable press, soil release, water repellent, flame retardant and antistatic finishes; shrink-resistance finish for wool; heat setting of synthetic-fibre fabrics, finishing machines; energy efficient processes; pollution control.

XE - ENGINERING SCIENCES

The syllabi of the sections of this paper are as follows:

SECTION A. ENGINEERING MATHEMATICS (Compulsory)

Linear Algebra : Determinates, algebra of matrices, rank, inverse, system of linear equations, symmetric, skew-symmetric and orthogonal matrices. Hermitian, skew-hermitian and unitary matrices. eigenvalues and eigenvectors, diagonalisation of matrices, Cayley-Hamiltonian, quadratic forms.

Calculus : Functions of single variables, limit, continuity and differentiability, Mean value theorems, Intermediate forms and L'Hospital rule, Maxima and minima, Taylor's series, Fundamental and mean value-theorems of integral calculus. Evaluation of definite and improper integrals, Beta and Gamma functions, Functions of two variables, limit, continuity, partial derivatives, Euler's theorem for homogeneous functions, total derivatives, maxima and minima, Lagrange method of multipliers, double and triple integrals and their applications, sequence and series, tests for convergence, power series, Fourier Series, Fourier integrals.

Complex variable: Analytic functions, Cauchy's integral theorem and integral formula without proof. Taylor's and Laurent' series, Residue theorem (without proof) with application to the evaluation of real integarls.

Vector Calculus: Gradient, divergence and curl, vector identities, directional derivatives, line, surface and volume integrals, Stokes, Gauss and Green's theorems (without proofs) with applications.

Ordinary Differential Equations: First order equation (linear and nonlinear), higher order linear differential equations with constant coefficients, method of variation of paramaters, Cauchy's and Euler's equations, initial and boundary value problems, power series solutions, Legendre polynomials and Bessel's functions of the first kind.

Partial Differential Equations: Variables separable method, solutions of one dimensional heat, wave and Laplace equations.

Probability and Statistics: Definitions of probability and simple theorems, conditional probability, mean, mode and standard deviation, random variables, discrete and continuous distributions, Poisson, normal and Binomial distribution, correlation and regression

Numerical Methods: L-U decomposition for systems of linear equations,Newton-Raphson method, numerical integration(trapezoidal and Simpson's rule), numerical methods for first order differential equation (Euler method)

SECTION B. COMPUTATIONAL SCIENCE

Numerical Methods: Truncation errors, round off errors and their propagation; Interpolation; Lagrange, Newton's forward, backward and divided difference formulas, least square curve fitting, solution of non-linear equations of one variables using bisection, false position, secant and Newton Raphson methods; Rate of convergence of these methods, general iterative methods. Simple and multiple roots of polynomials. Solutions of system of linear algebraic equations using Gauss elimination methods, Jacobi and Gauss-Seidel iterative methods and their rate of convergence; ill conditioned and well conditioned system. eigen values and eigen vectors using power methods. Numerical integration using trapezoidal, Simpson's rule and other quadrature formulas. Numerical Differentiation. Solution of boundary value problems. Solution of initial value problems of ordinary differential equations using Euler's method, predictor corrector and Runge Kutta method.

Programming : Elementary concepts and terminology of a computer system and system software, Fortran77 and C programming.

Fortran : Program organization, arithmetic statements, transfer of control, Do loops, subscripted variables, functions and subroutines.

C language : Basic data types and declarations, flow of control- iterative statement, conditional statement, unconditional branching, arrays, functions and procedures.

SECTION C. ELECTRICAL SCIENCES

Electric Circuits: Ideal voltage and current sources; RLC circuits, steady state and transient analysis of DC circuits, network theorems; alternating currents and voltages, single-phase AC circuits, resonance; three-phase circuits.

Magnetic circuits: Mmf and flux, and their relationship with voltage and current; transformer, equivalent circuit of a practical transformer, three-phase transformer connections.

Electrical machines: Principle of operation, characteristics, efficiency and regulation of DC and synchronous machines; equivalent circuit and performance of three-phase and single-phase induction motors.

Electronic Circuits: Characteristics of p-n junction diodes, zener diodes, bipolar junction transistors (BJT) and junction field effect transistors (JFET); MOSFET's structure, characteristics, and operations; rectifiers, filters, and regulated power supplies; biasing circuits, different configurations of transistor amplifiers, class A, B and C of power amplifiers; linear applications of operational amplifiers; oscillators; tuned and phase shift types.

Digital circuits: Number systems, Boolean algebra; logic gates, combinational circuits, flip-flops (RS, JK, D and T) counters.

Measuring instruments: Moving coil, moving iron, and dynamometer type instruments; shunts, instrument transformers, cathode ray oscilloscopes; D/A and A/D converters.

SECTION D. FLUID MECHANICS

Fluid Properties: Relation between stress and strain rate for Newtonian fluids

Hydrostatics, buoyancy, manometry

Concept of local and convective accelerations; control volume analysis for mass, momentum and energy conservation.

Differential equations of continuity and momentum (Euler's equation of motion); concept of fluid rotation, stream function, potential function; Bernoulli's equation and its applications.

Qualitative ideas of boundary layers and its separation; streamlined and bluff bodies; drag and lift forces.

Fully-developed pipe flow; laminar and turbulent flows; friction factor; Darcy Weisbach relation; Moody's friction chart; losses in pipe fittings; flow measurements using venturimeter and orifice plates.

Dimensional analysis; similitude and concept of dynamic similarity; importance of dimensionless numbers in model studies.

SECTION E. MATERIALS SCIENCE

Atomic structure and bonding in materials: metals, ceramics and polymers.

Structure of materials: Crystal systems, unit cells and space lattice; determination of structures of simple crystals by X-ray diffraction; Miller indices for planes and directions. Packing geometry in metallic, ionic and covalent solids.

Concept of amorphous, single and polycrystalline structures and their effects on properties of materials.

Imperfections in crystalline solids and their role in influencing various properties.

Fick´s laws of diffusion and applications of diffusion in sintering, doping of semiconductors and surface hardening of metals.

Alloys: solid solution and solubility limit. Binary phase diagram, intermediate phases and intermetallic compounds; iron-iron carbide phase diagram. Phase transformation in steels. Cold and hot working of metals, recovery, recrystallization and grain growth.

Properties and applications of ferrous and nonferrous alloys.

Structure, properties, processing and applications of traditional and advanced ceramics.

Polymers: classification, polymerization, structure and properties, additives for polymer products, processing and application.

Composites: properties and application of various composites.

Corrosion and environmental degradation of materials (metals, ceramics and polymers).

Mechanical properties of materials: Stress-strain diagrams of metallic, ceramic and polymeric materials, modulus of elasticity, yield strength, plastic deformation and toughness, tensile strength and elongation at break; viscoelasticity, hardness, impact strength. ductile and brittle fracture. creep and fatigue properties of materials.

Heat capacity, thermal conductivity, thermal expansion of materials.

Concept of energy band diagram for materials; conductors, semiconductors and insulators in terms of energy bands. Electrical conductivity, effect of temperature on conductivity in materials, intrinsic and extrinsic semiconductors, dielectric properties of materials.

Refraction, reflection, absorption and transmission of electromagnetic radiation in solids.

Origin of magnetism in metallic and ceramic materials, paramagnetism, diamagnetism, antiferromagnetism, ferromagnetism, ferrimagnetism in materials and magnetic hysteresis.

Advanced materials: Smart materials exhibiting ferroelectric, piezoelectric, optoelectronic, semiconducting behaviour; lasers and optical fibers; photoconductivity and superconductivity in materials.

SECTION F. SOLID MECHANICS

Equivalent force systems; free-body diagrams; equilibrium equations; analysis of determinate and indeterminate trusses and frames; friction.

Simple relative motion of particles; force as function of position, time and speed; force acting on a body in motion; laws of motion; law of conservation of energy; law of conservation of momentum

Stresses and strains; principal stresses and strains; Mohr's circle; generalized Hooke's Law; equilibrium equations; compatibility conditions; yield criteria.

Axial, shear and bending moment diagrams; axial, shear and bending stresses; deflection (for symmetric bending); torsion in circular shafts; thin cylinders; energy methods (Castigliano's Theorems); Euler buckling.

SECTION G. THERMODYNAMICS

Basic Concepts: Continuum, macroscopic approach, thermodynamic system (closed and open or control volume); thermodynamic properties and equilibrium; state of a system, state diagram, path and process; different modes of work; Zeroth law of thermodynamics; concept of temperature; heat.

First Law of Thermodynamics: Energy, enthalpy, specific heats, first law applied to systems and control volumes, steady and unsteady flow analysis.

Second Law of Thermodynamics: Kelvin-Planck and Clausius statements, reversible and irreversible processes, Carnot theorems, thermodynamic temperature scale, Clausius inequality and concept of entropy, principle of increase of entropy; availability and irreversibility.

Properties of Pure Substances: Thermodynamic properties of pure substances in solid, liquid and vapour phases, P-V-T behaviour of simple compressible substances, phase rule, thermodynamic property tables and charts, ideal and real gases, equations of state, compressibility chart.

Thermodynamic Relations: T-ds relations, Maxwell equations, Joule-Thomson coefficient, coefficient of volume expansion, adiabatic and isothermal compressibilities, Clapeyron equation.

Ideal Gas Mixtures: Dalton's and Amagat's laws, calculations of properties, air-water vapour mixtures.

XL - LIFE SCIENCES

The syllabi of the Sections of this paper are as follows:

SECTION H. CHEMISTRY (Compulsory)

Atomic structure and periodicity: Quantum chemistry; Planck's quantum theory, wave particle duality, uncertainty principle, quantum mechanical model of hydrogen atom; electronic configuration of atoms; periodic table and periodic properties; ionization energy, election affinity, electronegativity, atomic size.

Structure and bonding: Ionic and covalent bonding M.O. and V.B. approaches for diatomic molecules, VSEPR theory and shape of molecules, hybridisation, resonance, dipole moment, structure parameters such as bond length, bond angle and bond energy, hydrogen bonding, van der Waals interactions. Ionic solids; ionic radii, lattice energy (Born-Haber Cycle).

s.p. and d Block Elements: Oxides, halides and hydrides of alkali and alkaline earth metals, B, Al, S, N, P and S, silicones, general characteristics of 3d elements, coordination complexes: valence bond and crystal field theory, color, geometry and magnetic properties.

Chemical Equilibria: Colligative properties of solutions, ionic equilibria in solution, solubility product, common ion effect, hydrolysis of salts, pH, buffer and their applications in chemical analysis.

Electrochemistry: Conductance, Kohlrausch law, Half Cell potentials, emf, Nernst equation, galvanic cells, thermodynamic aspects and their applications.

Reaction Kinetics: Rate constant, order of reaction, molecularity, activation energy, zero, first and second order kinetics, equilibrium constants (Kc, Kp and Kx) for homogeneous reactions, catalysis and elementary enzyme reactions.

Thermodynamics: First law, reversible and irreversible processes, internal energy, enthalpy, Kirchoff's equation, heat of reaction, Hess law, heat of formation, Second law, entropy, free energy, and work function. Gibbs-Helmholtz equation, Clausius-Clapeyron equation, free energy change and equilibrium constant, Troutons rule, Third law of thermodynamics.

Mechanistic Basis of Organic Reactions: Elementary treatment of SN1, SN2, E1 and E2 reactions, Hoffmann and Saytzeff rules, Addition reactions, Markonikoff rule and Kharash effect, Diels-Alder reaction, aromatic electrophilic substitution, orientation effect as exemplified by various functional groups.

Structure-Reactivity Correlations: Acids and bases, electronic and steric effects, optical and geometrical isomerism, tautomerism, concept of aromaticity

SECTION I. BIOCHEMISTRY

Organization of life. Importance of water. Cell structure and organelles. Structure and function of biomolecules: Carbohydrates, Lipids, Proteins and Nucleic acids. Biochemical separation techniques. Spectroscopic methods; UV-visible and fluorescence. Protein structure, folding and function: Myoglobin, Hemoglobin, Lysozyme, ribonuclease A, Carboxypeptidase and Chymotrypsin. Enzyme kinetics and regulation, Coenzymes.

Metabolism and bioenergitics. Generation and utilization of ATP. Photosynthesis. Major metabolic pathways and their regulation. Biological membranes. Transport across membranes. Signal transduction; hormones and neurotransmitters.

DNA replication, transcription and translation. Biochemical regulation of gene expression. Recombinant DNA technology and applications. Genomics and Proteomics.

The immune system. Active and passive immunity. Complement system. Antobody structure, function and diversity. Cells of the immune system: T, B and macrophages. T and B cell activation. Major histocompatibilty complex. T cell receptor. Immunological techniques: Immunodiffusion, immunoelectrophoresis, RIA and ELISA.

SECTION J. BIOTECHNOLOGY

Recombinant DNA technology for the production of therapeutic proteins. Micro array technology. Heterologous protein expression systems in bacteria, yeast etc.

Architecture of plant genome; plant tissue culture techniques; methods of gene transfer into plant cells; manipulation of phenotypic traits in plants; plant cell fermentations and production of secondary metabolites using suspension/ immobilized cell culture; methods for plant micro propagation; crop improvement and development of transgenic plants. Expression of animal proteins in plants.

Animal cell metabolism and regulation; cell cycle; primary cell culture; nutritional requirements for animal cell culture; techniques for the mass culture of animal cell lines; production of vaccines; growth hormones and interferons using animal cell culture; cytokines-production and therapeutic uses; hybridoma technology; vectors for gene transfer and expression in animal cells. Transgenic animals and molecular pharming.

Microbial production of industrial enzymes; methods for immobilization of enzymes; kinetics of soluble and immobilized enzymes; application of soluble and immobilized enzymes; enzyme-based sensors.

Microbial growth kinetics; batch, fed batch and continuous culture of microbial cells; media for industrial fermentations; sterilization of air and media; design features and operation of stirred tank, air-lift and fluidized bed reactors; aeration and agitation in aerobic fermentations; recovery and purification of fermentation products- filtration, centrifugation, cell disintegration, solvent extraction and chromatographic separations; industrial fermentations for the production of ethanol, citric acid, lysine, penicillin and other biomolecules; simple calculations based on material and energy balance of fermentation processes; application of microbes in the management of domestic and industrial wastes.

SECTION K. BOTANY

Anatomy: Roots, stem and leaves of land plants, meristems, vascular system, their ontogeny, structure and functions. Plant cell structure, organisation, organelles, cytoskeleton, cell wall and membranes.

Development: Cell cycle, cell division, senescence, hormonal regulation of growth; life cycle of an angiosperm, pollination, fertilization, embryogenesis, seed formation, seed storage proteins, seed dormancy and germination. Concept of cellular totipotency, organogenesis and somatic embryogenesis, somaclonal variation, embryo culture, in vitro fertilization.

Physiology and Biochemistry: Plant water relations, transport of minerals and solutes, N2 metabolism, proteins and nucleic acid, respiration, photophysiology, photosynthesis, photorespiration; biosynthesis, mechanism of action and physiological effects of plant growth regulators.

Genetics: Principles of Mendelian inheritance, linkage, recombination and genetic mapping; extrachromosomal inheritance; eukaryotic genome organization (chromatin structure) and regulation of gene expression, gene mutation, chromosome aberrations (numerical and structural), transposons.

Plant Breeding: Principles, methods - selection, hybridization, heterosis; male sterility, self and inter-specific incompatibility; haploidy; somatic cell hybridization; molecular marker-assisted selection; gene transfer methods viz. direct and vector-mediated, transgenic plants and their applications in agriculture.

Economic Botany: Economically important plants - cereals, pulses, plants yielding fiber, timber, sugar, beverages, oils, rubber, dyes, gums, drugs and narcotics - a general account.

Systematics: Systems of classification (non-phylogenetic vs. phylogenetic - outline), plant groups, molecular systematics.

Plant Pathology: Nature and classification of plant diseases, diseases of important crops caused by fungi, bacteria and viruses, and their control measures, mechanism(s) of pathogenesis and resistance, molecular detection of pathogens; plant-microbe beneficial interactions.

Ecology and Plant Geography: Ecosystems - types, dynamics, degradation, ecological succession; food chains; vegetation types of the world; pollution and global warming; speciation and extinction, conservation strategies, cryopreservation.

SECTION L. MICROBIOLOGY

Historical perspective - Discovery of the microbial world; Controversy over spontaneous generation; Role of microorganisms in transformation of organic matter and in the causation of diseases.

Methods in microbiology - Pure culture techniques; Theory and practice of sterilization; Principles of microbial nutrition; Construction of culture media; Enrichment culture techniques for isolation of chemoautotrophs, chemoheterotrophs and photosynthetic microorganisms.

Microbial evolution, systematics and taxonomy - Evolution of earth and earliest life forms; Primitive organisms and their metabolic strategies; New approaches to bacterial taxonomic classification including ribotyping; Nomenclature.

Microbial diversity - Bacteria, archea and their broad classification; Eukaryotic microbes, yeast, fungi, slime mold and protozoa; Viruses and their classification.

Microbial growth -The definition of growth, mathematical expression of growth, growth curve, measurement of growth and growth yields; Synchronous growth; Continuous culture.

Nutrition and metabolism - Overview of metabolism; Microbial nutrition; Energy classes of microorganisms; Culture media; Energetics, modes of ATP generation; ATP generation by heterotrophs; Fermentation; Glycolysis; Respiration; The citric acid cycle; Electron transport systems; Alternate modes of energy generation; Pathways (anabolism) in the biosynthesis of amino acids, purines, pyrimidines and fatty acids.

Metabolic diversity among microorganisms - Photosynthesis in microorganisms; Role of chlorophylls, carotenoids and phycobilins; Calvin cycle; Chemolithotrophy; Hydrogen- iron- nitrite-oxidizing bacteria; Nitrate and sulfate reduction; Methanogenesis and acetogenesis.

Prokaryotic cells: structure-function - Cells walls of eubacteria (peptidoglycan) and related molecules; Outer-membrane of gram-negative bacteria; Cell wall and cell membrane synthesis; Flagella and motility; Cell inclusions like endospores, gas vesicles.

Microbial diseases and host parasite relationships - Normal microflora of skin; Oral cavity; Gastrointestinal tract; Entry of pathogens into the host; Infectious disease transmission; Respiratory infections caused by bacteria and viruses; Tuberculosis; Sexually transmitted diseases including AIDS; Diseases transmitted by animals (Rabies, plague), insects and ticks (rikettsias, Lyme disease, malaria); Food and water borne diseases; Public health and water quality; Pahtogenic fungi; Emerging and resurgent infectious diseases.

Chemotherapy/Antibiotics - Antimicrobial agents; Sulfa drugs; Antibiotics; Pencillins and cephalosporins; Broad-spectrum antibiotics; Antibiotics from prokaryotes; Antifungal antibiotics; Mode of action; Resistance to antibiotics.

Microbial genetics - Genes, mutation and mutagenesis - UV and chemical mutagnes; Types of mutations; Ames test for mutagenesis; Methods of genetic analysis. Bacterial genetic system - Transformation; Conjugation; Transduction; Recombination; Plasmids and Transposons; Bacterial genetic map with reference to E. coli. Viruses and their genetic system - Phage ? and its life cycle; RNA phages; RNA viruses; Retroviruses; Genetic systems of yeast and Neurospora; Extrachromosomal inheritance and mitochondrial genetics; Basic concept of genomics.

SECTION M. ZOOLOGY

Animal world: Animal diversity, distribution, systematic and classification of animals, the phylogenetic relationship.

Evolution: Origin of life, history of life on earth, evolutionary theories, natural selection, adaptation, speciation.

Genetics: Principles of inheritance, molecular basis of heredity, the genetic material, transmission of genetic material, mutations, cytoplasmic inheritance.

Biochemistry and Molecular Biology: Nucleic acids, proteins and other biological macromolecules. Replication, transcription and translation, regulation of gene expression, organization of genome, Kreb's cycle, glycolysis, enzyme catalysis, hormones and their action.

Cell Biology: Structure of cell, cellular organelles and their structure and function, cell cycle, cell division, cellular differentiation, chromosome and chromatin structure. Eukaryotic gene organisation and expression.

Animal Anatomy and Physiology: Comparative physiology, the respiratory system, circulatory system, digestive system, the nervous system, the excretory system, the endocrine system, the reproductive system, the skeletal system, osmoregulation.

Parasitology and Immunology: Nature of parasite, host-parasite relation, protozoan and helminthic parasites, the immune response, cellular and humoral immune response, evolution of the immune system.

Development Biology: Embryonic development, cellular differentiation, organogenesis, metamorphosis, genetic basis of development.

Ecology: The ecosystem, habitats the food chain, population dynamics, species diversity, zoogeography, biogeochemical cycles, conservation biology.

Animal Behaviour: Types of behaviours, courtship, mating and territoriality, instinct, learning and memory, social behaviour across the animal taxa, communication, pheromones, evolution of animal behaviour.

IT - INFORMATION TECHNOLOGY

ENGINEERING MATHEMATICS

Mathematical Logic: Propositional Logic; First Order Logic.

Probability: Conditional Probability; Mean, Median, Mode and Standard Deviation; Random Variables; Distributions; uniform, normal, exponential, Poisson, Binomial.

Set Theory & Algebra: Sets; Relations; Functions; Groups; Partial Orders; Lattice; Boolean Algebra.

Combinatorics: Permutations; Combinations; Counting; Summation; generating functions; recurrence relations; asymptotics.

Graph Theory: Connectivity; spanning trees; Cut vertices & edges; covering; matching; independent sets; Colouring; Planarity; Isomorphism.

Linear Algebra: Algebra of matrices, determinants, systems of linear equations, Eigen values and Eigen vectors.

Numerical Methods: LU decomposition for systems of linear equations; numerical solutions of non linear algebraic equations by Secant, Bisection and Newton-Raphson Methods; Numerical integration by trapezoidal and Simpson's rules.

Calculus: Limit, Continuity & differentiability, Mean value Theorems, Theorems of integral calculus, evaluation of definite & improper integrals, Partial derivatives, Total derivatives, maxima & minima.

FORMAL LANGUAGES AND AUTOMATA

Regular Languages: finite automata, regular expressions, regular grammar.

Context free languages: push down automata, context free grammars

COMPUTER HARDWARE

Digital Logic: Logic functions, minimization, design and synthesis of combinatorial and sequential circuits, number representation and computer arithmetic (fixed and floating point)

Computer organization: Machine instructions and addressing modes, ALU and data path, hardwired and microprogrammed control, memory interface, I/O interface (interrupt and DMA mode), serial communication interface, instruction pipelining, cache, main and secondary storage

SOFTWARE SYSTEMS

Data structures and Algorithms: the notion of abstract data types, stack, queue, list, set, string, tree, binary search tree, heap, graph, tree and graph traversals, connected components, spanning trees, shortest paths, hashing, sorting, searching, design techniques (greedy, dynamic, divide and conquer), asymptotic analysis (best, worst, average cases) of time and space, upper and lower bounds, intractability

Programming Methodology: C programming, program control (iteration, recursion, functions), scope, binding, parameter passing, elementary concepts of object oriented programming

Operating Systems (in the context of Unix): classical concepts (concurrency, synchronization, deadlock), processes, threads and interprocess communication, CPU scheduling, memory management, file systems, I/O systems, protection and security

Information Systems and Software Engineering: information gathering, requirement and feasibility analysis, data flow diagrams, process specifications, input/output design, process life cycle, planning and managing the project, design, coding, testing, implementation, maintenance.

Databases: relational model, database design, integrity constraints, normal forms, query languages (SQL), file structures (sequential, indexed), b-trees, transaction and concurrency control

Data Communication: data encoding and transmission, data link control, multiplexing, packet switching, LAN architecture, LAN systems (Ethernet, token ring), Network devices: switches, gateways, routers

Networks: ISO/OSI stack, sliding window protocols, routing protocols, TCP/UDP, application layer protocols & systems (http, smtp, dns, ftp), network security

Web technologies: three tier web based architecture; JSP, ASP, J2EE, .NET systems; html, XML

AG - AGRICULTURAL ENGINEERING

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

FARM MACHINERY AND POWER:

Sources of power on the farm-human, animal, mechanical, electrical, wind, solar and biomass; design and selection of machine elements - gears, pulleys, chains and sprockets and belts; overload safety devices used in farm machinery; measurement of force, torque, speed, displacement and acceleration on machine elements.

Soil tillage; forces acting on a tillage tool; hitch systems and hitching of tillage implements; functional requirements, principles of working, construction and operation of manual, animal and power operated equipment for tillage. sowing, planting, fertilizer application, inter-cultivation, spraying, mowing, chaff cutting, harvesting, threshing and transport; testing of agricultural machinery and equipment; calculation of performance parameters -field capacity, efficiency, application rate and losses; cost analysis of implements and tractors.

Thermodynamic principles of I.C. engines; I.C. engine cycles; engine components; fuels and combustion; lubricants and their properties; I.C. engine systems - fuel, cooling, lubrication, ignition, electrical, intake and exhaust; selection, operation, maintenance and repair of I.C. engines; power efficiencies and measurement; calculation of power, torque, fuel consumption, heat load and power losses.

Tractors and power tillers - type, selection, maintenance and repair; tractor clutches and brakes; power transmission systems - gear trains, differential, final drives and power take-off; mechanics of tractor chassis; traction theory; three point hitches- free link and restrained link operations; mechanical steering and hydraulic control systems used in tractors; human engineering and safety in tractor design; tractor tests and performance.

SOIL AND WATER CONSERVATION ENGINEERING:

Ideal and real fluids, properties of fluids; hydrostatic pressure and its measurement; hydrostatic forces on plane and curved surface; continuity equation; Bernoulli's theorem; laminar and turbulent flow in pipes, Darcy-Weisbach and Hazen-Williams equations, Moody's diagram; flow through orifices and notches; flow in open channels.

Engineering properties of soils, fundamental definitions and relationships; index properties of soils; permeability and seepage analysis; shear strength, Mohr's circle of stresses; active and passive earth pressures; stability of slopes.

Hydrological cycle; precipitation measurement, analysis of precipitation data; abstraction from precipitation; runoff; hydrograph analysis, unit hydrograph theory and application; stream flow measurement; flood routing, hydrological reservoir and channel routing.

Mechanics of soil erosion, factors affecting erosion; soil loss estimation; biological and engineering measures to control erosion, terraces and bunds; vegetative waterways; gully control structures, drop, drop inlet and chute spillways; farm ponds; earthen dams; principles of watershed management.

Water requirement of crops; consumptive use and evapo-transpiration; irrigation scheduling; irrigation efficiencies; design of prismatic and silt loaded channels; methods of irrigation water application; design and evaluation of irrigation methods; drainage coefficient; surface and subsurface drainage systems; leaching requirement and salinity control; irrigation and drainage water quality; classification of pumps; pump characteristics; pump selection; types of aquifer; evaluation of aquifer properties; well hydraulics; ground water recharge.

AGRICULTURAL PROCESSING AND FOOD ENGINEERING:

Steady state heat transfer in conduction, convection and radiation; transient heat transfer in simple geometry; condensation and boiling heat transfer; working principles of heat exchangers; diffusive and convective mass transfer; simultaneous heat and mass transfer in agricultural processing operations.

Material and energy balances in food processing systems; water activity, sorption and desorption isotherms; centrifugal separation of solids, liquids and gases; kinetics of microbial death - pasteurisation and sterilization of liquid foods; preservation of food by cooling and freezing; psychrometry - properties of air-vapour mixture; concentration and dehydration of liquid foods - evaporators, tray, drum and spray dryers.

Mechanics and energy requirement in size reduction of granular solids; particle size analysis for comminuted solids; size separation by screening; fluidisation of granular solids; cleaning and grading efficiency and effectiveness of grain cleaners; conditioning and hydrothermal treatments for grains; dehydration of food grains; processes and machines for processing of cereals, pulses and oilseeds; design considerations for grain silos.

AR - ARCHITECTURE AND PLANNING

City planning: Historical development of cities; principles of city planning; new towns; survey methods, site planning, planning regulations and building bye-laws.

Housing: Concept of shelter; housing policies and design; community planning; role of government agencies; finance and management.

Landscape Design: Principles of landscape design and site planning; history and landscape styles; landscape elements and materials; planting design.

Computer Aided Design: Application of computers in architecture and planning; understanding elements of hardware and software; computer graphics; programming languages - C and Visual Basic and usage of packages such as AutoCAD.

Environmental and Building Science: Elements of environmental science; ecological principles concerning environment; role of micro-climate in design; climatic control through design elements; thermal comfort; elements of solar architecture; principles of lighting and illumination; basic principles of architectural acoustics; air pollution, noise pollution and their control.

Visual and Urban Design: Principles of visual composition; proportion, scale, rhythm, symmetry, harmony, balance, form and colour; sense of place and space, division of space; focal point, vista, imageability, visual survey.

History of Architecture: Indian - Indus valley, Vedic, Buddhist, Indo-Aryan, Dravidian and Mughal periods; European - Egyptian, Greek, Roman, medieval and renaissance periods.

Development of Contemporary Architecture: Architectural developments and impacts on society since industrial revolution; influence of modern art on architecture; works of national and international architects; post modernism in architecture.

Building Services: Water supply, Sewerage and Drainage systems; Sanitary fittings and fixtures; principles of electrification of buildings; elevators, their standards and uses; air-conditioning systems; fire fighting systems.

Building Construction and Management: Building construction techniques, methods and details; building systems and prefabrication of building elements; principles of modular coordination; estimation, specification, valuation, professional practice; project management, PERT, CPM.

Materials and Structural Systems: Behavioural characteristics of all types of building materials e.g. mud, timber, bamboo, brick, concrete, steel, glass, FRP; principles of strength of materials; design of structural elements in wood, steel and RCC; elastic and limit state design; complex structural systems; principles of pre-stressing.

Planning Theory: Planning process; multilevel planning; comprehensive planning; central place theory; settlement pattern; land use and land utilization.

Techniques of Planning: Planning surveys; Preparation of urban and regional structure plans, development plans, action plans; site planning principles and design; statistical methods; application of remote sensing techniques in urban and regional planning.

Traffic and Transportation Planning: Principles of traffic engineering and transportation planning; methods of conducting surveys; design of roads, intersections and parking areas; hierarchy of roads and levels of services; traffic and transport management in urban areas; traffic safety and traffic laws; public transportation planning; modes of transportation.

Services and Amenities: Principles and design of water supply systems, sewerage systems, solid waste disposal systems, power supply and communication systems; Health, education, recreation and demography related standards at various levels of the settlements.

Development Administration and Management: Planning laws; development control and zoning regulations; laws relating to land acquisition; development enforcements, land ceiling; regional and urban plan preparations; planning and municipal administration; taxation, revenue resources and fiscal management; public participation and role of NGO.

CE - CIVIL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

STRUCTURAL ENGINEERING

Mechanics: Bending moments and shear forces in statically determinate beams; simple stress and strain: relationship; stress and strain in two dimensions, principal stresses, stress transformation, Mohr's circle; simple bending theory; flexural shear stress; thin-walled pressure vessels; uniform torsion.

Structural Analysis: Analysis of statically determinate trusses, arches and frames; displacements in statically determinate structures and analysis of statically indeterminate structures by force/energy methods; analysis by displacement methods (slope-deflection and moment-distribution methods); influence lines for determinate and indeterminate structures; basic concepts of matrix methods of structural analysis.

Concrete Structures: Basic working stress and limit states design concepts; analysis of ultimate load capacity and design of members subject to flexure, shear, compression and torsion (beams, columns and isolated footings); basic elements of prestressed concrete: analysis of beam sections at transfer and service loads.

Steel Structures: Analysis and design of tension and compression members, beams and beam-columns, column bases; connections - simple and eccentric, beam-column connections, plate girders and trusses; plastic analysis of beams and frames.

GEOTECHNICAL ENGINEERING

Soil Mechanics: Origin of soils; soil classification; three-phase system, fundamental definitions, relationship and inter-relationships; permeability and seepage; effective stress principle: consolidation, compaction; shear strength.

Foundation Engineering: Sub-surface investigation - scope, drilling bore holes, sampling, penetrometer tests, plate load test; earth pressure theories, effect of water table, layered soils; stability of slopes - infinite slopes, finite slopes; foundation types - foundation design requirements; shallow foundations; bearing capacity, effect of shape, water table and other factors, stress distribution, settlement analysis in sands and clays; deep foundations - pile types, dynamic and static formulae, load capacity of piles in sands and clays.

WATER RESOURCES ENGINEERING

Fluid Mechanics and Hydraulics: Hydrostatics, applications of Bernoulli equation, laminar and turbulent flow in pipes, pipe networks; concept of boundary layer and its growth; uniform flow, critical flow and gradually varied flow in channels, specific energy concept, hydraulic jump; forces on immersed bodies; flow measurement in channels; tanks and pipes; dimensional analysis and hydraulic modeling. Applications of momentum equation, potential flow, kinematics of flow; velocity triangles and specific speed of pumps and turbines.

Hydrology: Hydrologic cycle; rainfall; evaporation infiltration, unit hydrographs, flood estimation, reservoir design, reservoir and channel routing, well hydraulics.

Irrigation: Duty, delta, estimation of evapo-transpiration; crop water requirements; design of lined and unlined canals; waterways; head works, gravity dams and Ogee spillways. Designs of weirs on permeable foundation, irrigation methods.

ENVIRONMENTAL ENGINEERING

Water requirements; quality and standards, basic unit processes and operations for water treatment, distribution of water. Sewage and sewerage treatment: quantity and characteristic of waste water sewerage; primary and secondary treatment of waste water; sludge disposal; effluent discharge standards.

TRANSPORTATION ENGINEERING

Highway planning; geometric design of highways; testing and specifications of paving materials; design of flexible and rigid pavements.

CH - CHEMICAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

CHEMICAL ENGINEERING

Process Calculations and Thermodynamics: Laws of conservation of mass and energy; use of tie components; recycle, bypass and purge calculations; degree of freedom analysis.

First and Second laws of thermodynamics and their applications; equations of state and thermodynamic properties of real systems; phase equilibria; fugacity, excess properties and correlations of activity coefficients; chemical reaction equilibria.

Fluid Mechanics and Mechanical Operations: Fluid statics, Newtonian and non-Newtonian fluids, Bernoulli equation, Macroscopic friction factors, energy balance, dimensional analysis, shell balances, flow through pipeline systems, flow meters, pumps and compressors, packed and fluidized beds, elementary boundary layer theory, size reduction and size separation; free and hindered settling; centrifuge and cyclones; thickening and classification, filtration, mixing and agitation; conveying of solids.

Heat Transfer: Conduction, convection and radiation, heat transfer coefficients, steady and unsteady heat conduction, boiling, condensation and evaporation; types of heat exchangers and evaporators and their design.

Mass Transfer: Fick's law, molecular diffusion in fluids, mass transfer coefficients, film, penetration and surface renewal theories; momentum, heat and mass transfer analogies; stagewise and continuous contacting and stage efficiencies; HTU & NTU concepts design and operation of equipment for distillation, absorption, leaching, liquid-liquid extraction, crystallization, drying, humidification, dehumidification and adsorption.

Chemical Reaction Engineering: Theories of reaction rates; kinetics of homogeneous reactions, interpretation of kinetic data, single and multiple reactions in ideal reactors, non-ideal reactors; residence time; non-isothermal reactors; kinetics of heterogeneous catalytic reactions; diffusion effects in catalysis.

Instrumentation and Process Control: Measurement of process variables; sensors, transducers and their dynamics, dynamics of simple systems, dynamics such as CSTRs, transfer functions and responses of simple systems, process reaction curve, controller modes (P, PI, and PID); control valves; analysis of closed loop systems including stability, frequency response (including Bode plots) and controller tuning, cascade, feed forward control.

Plant Design and Economics: Design and sizing of chemical engineering equipment such as compressors, heat exchangers, multistage contactors; principles of process economics and cost estimation including total annualized cost, cost indexes, rate of return, payback period, discounted cash flow, optimization in Design.

Chemical Technology: Inorganic chemical industries; sulfuric acid, NaOH, fertilizers (Ammonia, Urea, SSP and TSP); natural products industries (Pulp and Paper, Sugar, Oil, and Fats); petroleum refining and petrochemicals; polymerization industries; polyethylene, polypropylene, PVC and polyester synthetic fibers.

CS - COMPUTER SCIENCE AND ENGINEERING

ENGINEERING MATHEMATICS

Mathematical Logic: Propositional Logic; First Order Logic.

Probability: Conditional Probability; Mean, Median, Mode and Standard Deviation; Random Variables; Distributions; uniform, normal, exponential, Poisson, Binomial.

Set Theory & Algebra: Sets; Relations; Functions; Groups; Partial Orders; Lattice; Boolean Algebra.

Combinatorics: Permutations; Combinations; Counting; Summation; generating functions; recurrence relations; asymptotics.

Graph Theory: Connectivity; spanning trees; Cut vertices & edges; covering; matching; independent sets; Colouring; Planarity; Isomorphism.

Linear Algebra: Algebra of matrices, determinants, systems of linear equations, Eigen values and Eigen vectors.

Numerical Methods: LU decomposition for systems of linear equations; numerical solutions of non linear algebraic equations by Secant, Bisection and Newton-Raphson Methods; Numerical integration by trapezoidal and Simpson's rules.

Calculus: Limit, Continuity & differentiability, Mean value Theorems, Theorems of integral calculus, evaluation of definite & improper integrals, Partial derivatives, Total derivatives, maxima & minima.

THEORY OF COMPUTATION

Formal Languages and Automata Theory: Regular languages and finite automata, Context free languages and Push-down automata, Recursively enumerable sets and Turing machines, Un-decidability;

Analysis of Algorithms and Computational Complexity: Asymptotic analysis (best, worst, average case) of time and space, Upper and lower bounds on the complexity of specific problems, NP-completeness.

COMPUTER HARDWARE

Digital Logic: Logic functions, Minimization, Design and synthesis of Combinational and Sequential circuits; Number representation and Computer Arithmetic (fixed and floating point);

Computer Organization: Machine instructions and addressing modes, ALU and Data-path, hardwired and micro-programmed control, Memory interface, I/O interface (Interrupt and DMA mode), Serial communication interface, Instruction pipelining, Cache, main and secondary storage.

SOFTWARE SYSTEMS

Data structures: Notion of abstract data types, Stack, Queue, List, Set, String, Tree, Binary search tree, Heap, Graph;

Programming Methodology: C programming, Program control (iteration, recursion, Functions), Scope, Binding, Parameter passing, Elementary concepts of Object oriented, Functional and Logic Programming;

Algorithms for problem solving: Tree and graph traversals, Connected components, Spanning trees, Shortest paths; Hashing, Sorting, Searching; Design techniques (Greedy, Dynamic Programming, Divide-and-conquer);

Compiler Design: Lexical analysis, Parsing, Syntax directed translation, Runtime environment, Code generation, Linking (static and dynamic); Operating Systems: Classical concepts (concurrency, synchronization, deadlock), Processes, threads and Inter-process communication, CPU scheduling, Memory management, File systems, I/O systems, Protection and security.

Databases: Relational model (ER-model, relational algebra, tuple calculus), Database design (integrity constraints, normal forms), Query languages (SQL), File structures (sequential files, indexing, B+ trees), Transactions and concurrency control;

Computer Networks: ISO/OSI stack, sliding window protocol, LAN Technologies (Ethernet, Token ring), TCP/UDP, IP, Basic concepts of switches, gateways, and routers.

CH - CHEMISTRY

PHYSICAL CHEMISTRY

Structure: Quantum theory - principles and techniques; applications to particle in a box, harmonic oscillator, rigid rotor and hydrogen atom; valence bond and molecular orbital theories and Huckel approximation, approximate techniques: variation and perturbation; symmetry, point groups; rotational, vibrational, electronic, NMR and ESR spectroscopy.

Equilibrium: First law of thermodynamics, heat, energy and work; second law of thermodynamics and entropy; third law and absolute entropy; free energy; partial molar quantities; ideal and non-ideal solutions; phase transformation: phase rule and phase diagrams- one, two, and three component systems; activity, activity coefficient, fugacity and fugacity coefficient ; chemical equilibrium, response of chemical equilibrium to temperature and pressure; colligative properties; kinetic theory of gases; thermodynamics of electrochemical cells; standard electrode potentials: applications - corrosion and energy conversion; molecular partition function (translational, rotational, vibrational and electronic).

Kinetics: Rates of chemical reactions, theories of reaction rates, collision and transition state theory; temperature dependence of chemical reactions; elementary reactions, consecutive elementary reactions; steady state approximation, kinetics of photochemical reactions and free radical polymerization, homogenous and heterogeneous catalysis.

INORGANIC CHEMISTRY

Non-Transition Elements: General characteristics, structure and reactions of simple and industrially important compounds, boranes, carboranes, silicates, silicones, diamond and graphite; hydrides, oxides and oxoacids of N, P, S and halogens; boron nitride, borazines and phosphazenes; xenon compounds. Shapes of molecules, hard-soft acid base concept.

Transition Elements: General characteristics of d and f block elements; coordination chemistry: structure and isomerism, stability, theories of metal-ligand bonding (CFT and LFT), electronic spectra and magnetic properties of transition metal complexes and lanthanides; metal carbonyls, metal-metal bonds and metal atom clusters, metallocenes; transition metal complexes with bonds to hydrogen, alkyls, alkenes, and arenes; metal carbenes; use of organometallic compounds as catalysts in organic synthesis; mechanisms of substitution and electron transfer reactions of coordination complexes. Role of metals with special reference to Na, K, Mg, Ca, Fe, Co, Zn, and Mo in biological systems.

Solids: Crystal systems and lattices, Miller planes, crystal packing, crystal defects; Bragg's Law; ionic crystals, band theory, metals and semiconductors. Spinels.

Instrumental methods of analysis: atomic absorption, UV-visible spectrometry, chromatographic and electro-analytical methods.

ORGANIC CHEMISTRY

Synthesis, reactions and mechanisms involving the following: Alkenes, alkynes, arenes, alcohols, phenols, aldehydes, ketones, carboxylic acids and their derivatives; halides, nitro compounds and amines; stereochemical and conformational effects on reactivity and specificity; reactions with diborane and peracids. Michael reaction, Robinson annulation, reactivity umpolung, acyl anion equivalents; molecular rearrangements involving electron deficient atoms.

Photochemistry: Basic principles, photochemistry of olefins, carbonyl compounds, arenes, photo oxidation and reduction.

Pericyclic reactions: Cycloadditions, electrocyclic reactions, sigmatropic reactions; Woodward-Hoffmann rules.

Heterocycles: Structural properties and reactions of furan, pyrrole, thiophene, pyridine, indole.

Biomolecules: Structure, properties and reactions of mono- and di-saccharides, physico-chemical properties of amino acids, structural features of proteins and nucleic acids.

Spectroscopy: Principles and applications of IR, UV-visible, NMR and mass spectrometry in the determination of structures of organic compounds.

EC - ELECTRONICS AND COMMUNICATION ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix Algebra, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Mean value theorems, Theorems of integral calculus, Evaluation of definite and improper integrals, Partial Derivatives, Maxima and minima, Multiple integrals, Fourier series. Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equation (linear and nonlinear), Higher order linear differential equations with constant coefficients, Method of variation of parameters, Cauchy's and Euler's equations, Initial and boundary value problems, Partial Differential Equations and variable separable method.

Complex variables: Analytic functions, Cauchy's integral theorem and integral formula, Taylor's and Laurent' series, Residue theorem, solution integrals.

Probability and Statistics: Sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Discrete and continuous distributions, Poisson, Normal and Binomial distribution, Correlation and regression analysis.

Numerical Methods: Solutions of non-linear algebraic equations, single and multi-step methods for differential equations.

Transform Theory: Fourier transform, Laplace transform, Z-transform.

ELECTRONICS & COMMUNICATION ENGINEERING

Networks: Network graphs: matrices associated with graphs; incidence, fundamental cut set and fundamental circuit matrices. Solution methods: nodal and mesh analysis. Network theorems: superposition, Thevenin and Norton's maximum power transfer, Wye-Delta transformation. Steady state sinusoidal analysis using phasors. Linear constant coefficient differential equations; time domain analysis of simple RLC circuits, Solution of network equations using Laplace transform: frequency domain analysis of RLC circuits. 2-port network parameters: driving point and transfer functions. State equations for networks.

Electronic Devices: Energy bands in silicon, intrinsic and extrinsic silicon. Carrier transport in silicon: diffusion current, drift current, mobility, resistivity. Generation and recombination of carriers. p-n junction diode, Zener diode, tunnel diode, BJT, JFET, MOS capacitor, MOSFET, LED, p-I-n and avalanche photo diode, LASERs. Device technology: integrated circuits fabrication process, oxidation, diffusion, ion implantation, photolithography, n-tub, p-tub and twin-tub CMOS process.

Analog Circuits: Equivalent circuits (large and small-signal) of diodes, BJTs, JFETs, and MOSFETs. Simple diode circuits, clipping, clamping, rectifier. Biasing and bias stability of transistor and FET amplifiers. Amplifiers: single-and multi-stage, differential, operational, feedback and power. Analysis of amplifiers; frequency response of amplifiers. Simple op-amp circuits. Filters. Sinusoidal oscillators; criterion for oscillation; single-transistor and op-amp configurations. Function generators and wave-shaping circuits. Power supplies.

Digital circuits: Boolean algebra, minimization of Boolean functions; logic gates digital IC families (DTL, TTL, ECL, MOS, CMOS). Combinational circuits: arithmetic circuits, code converters, multiplexers and decoders. Sequential circuits: latches and flip-flops, counters and shift-registers. Sample and hold circuits, ADCs, DACs. Semiconductor memories. Microprocessor(8085): architecture, programming, memory and I/O interfacing.

Signals and Systems: Definitions and properties of Laplace transform, continuous-time and discrete-time Fourier series, continuous-time and discrete-time Fourier Transform, z-transform. Sampling theorems. Linear Time-Invariant (LTI) Systems: definitions and properties; casuality, stability, impulse response, convolution, poles and zeros frequency response, group delay, phase delay. Signal transmission through LTI systems. Random signals and noise: probability, random variables, probability density function, autocorrelation, power spectral density.

Controls Systems: Basic control system components; block diagrammatic description, reduction of block diagrams. Open loop and closed loop (feedback) systems and stability analysis of these systems. Signal flow graphs and their use in determining transfer functions of systems; transient and steady state analysis of LTI control systems and frequency response. Tools and techniques for LTI control system analysis: root loci, Routh-Hurwitz criterion, Bode and Nyquist plots. Control system compensators: elements of lead and lag compensation, elements of Proportional-Integral-Derivative(PID) control. State variable representation and solution of state equation of LTI control systems.

Communications: Analog communication systems: amplitude and angle modulation and demodulation systems, spectral analysis of these operations, superheterodyne receivers; elements of hardware, realizations of analog communication systems; signal-to-noise ratio (SNR) calculations for amplitude modulation (AM) and frequency modulation (FM) for low noise conditions. Digital communication systems: pulse code modulation (PCM), differential pulse code modulation (DPCM), delta modulation (DM); digital modulation schemes-amplitude, phase and frequency shift keying schemes (ASK, PSK, FSK), matched filter receivers, bandwith consideration and probability of error calculations for these schemes.

Electromagnetics: Elements of vector calculus: divergence and curl; Gauss' and Stokes' theorems, Maxwell's equations: differential and integral forms. Wave equation, Poynting vector. Plane waves: propagation through various media; reflection and refraction; phase and group velocity; skin depth. Transmission lines: characteristic impedance; impedance transformation; Smith chart; impedance matching; pulse excitation. Waveguides: modes in rectangular waveguides; boundary conditions; cut-off frequencies; dispersion relations. Antennas: Dipole antennas; antenna arrays; radiation pattern; reciprocity theorem, antenna gain.

EE - ELECTRICAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix Algebra, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Mean value theorems, Theorems of integral calculus, Evaluation of definite and improper integrals, Partial Derivatives, Maxima and minima, Multiple integrals, Fourier series. Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equation (linear and nonlinear), Higher order linear differential equations with constant coefficients, Method of variation of parameters, Cauchy's and Euler's equations, Initial and boundary value problems, Partial Differential Equations and variable separable method.

Complex variables: Analytic functions, Cauchy's integral theorem and integral formula, Taylor's and Laurent' series, Residue theorem, solution integrals.

Probability and Statistics: Sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Discrete and continuous distributions, Poisson, Normal and Binomial distribution, Correlation and regression analysis.

Numerical Methods: Solutions of non-linear algebraic equations, single and multi-step methods for differential equations.

Transform Theory: Fourier transform, Laplace transform, Z-transform.

ELECTRICAL ENGINEERING

Electrical Circuits and Fields: Network graph, KCL, KVL, node/ cut set, mesh/ tie set analysis, transient response of d.c. and a.c. networks; sinusoidal steady-state analysis; resonance in electrical circuits; concepts of ideal voltage and current sources, network theorems, driving point, immittance and transfer functions of two port networks, elementary concepts of filters; three phase circuits; Fourier series and its application; Gauss theorem, electric field intensity and potential due to point, line, plane and spherical charge distribution, dielectrics, capacitance calculations for simple configurations; Ampere's and Biot-Savart's law, inductance calculations for simple configurations.

Electrical Machines: Single phase transformer - equivalent circuit, phasor diagram, tests, regulation and efficiency; three phase transformers - connections, parallel operation; auto transformer and three-winding transformer; principles of energy conversion, windings of rotating machines: D. C. generators and motors - characteristics, starting and speed control, armature reaction and commutation; three phase induction motors-performance characteristics, starting and speed control; single-phase induction motors; synchronous generators-performance, regulation, parallel operation; synchronous motors - starting, characteristics, applications, synchronous condensers; fractional horse power motors; permanent magnet and stepper motors.

Power Systems: Electric power generation - thermal, hydro, nuclear; transmission line parameters; steady-state performance of overhead transmission lines and cables and surge propagation; distribution systems, insulators, bundle conductors, corona and radio interference effects; per-unit quantities; bus admittance and impedance matrices; load flow; voltage control and power factor correction; economic operation; symmetrical components, analysis of symmetrical and unsymmetrical faults; principles of over current, differential and distance protections; concept of solid state relays and digital protection; circuit breakers; concept of system stability-swing curves and equal area criterion; basic concepts of HVDC transmission.

Control Systems: Principles of feedback; transfer function; block diagrams: steady-state errors; stability-Routh and Nyquist criteria; Bode plots; compensation; root loci; elementary state variable formulation; state transition matrix and response for Linear Time Invariant systems.

Electrical and Electronic Measurements: Bridges and potentiometers, PMMC, moving iron, dynamometer and induction type instruments; measurement of voltage, current, power, energy and power factor; instrument transformers; digital voltmeters and multimeters; phase, time and frequency measurement; Q-meter, oscilloscopes, potentiometric recorders, error analysis.

Analog and Digital Electronics: Characteristics of diodes, BJT, FET, SCR; amplifiers-biasing, equivalent circuit and frequency response; oscillators and feedback amplifiers, operational amplifiers- characteristics and applications; simple active filters; VCOs and timers; combinational and sequential logic circuits, multiplexer, Schmitt trigger, multivibrators, sample and hold circuits, A/D and D/A converters; microprocessors and their applications.

Power Electronics and Electric Drives: Semiconductor power devices-diodes, transistors, thyristors, triacs, GTOs, MOSFETs and IGBTs - static characteristics and principles of operation; triggering circuits; phase control rectifiers; bridge converters-fully controlled and half controlled; principles of choppers and inverters, basic concepts of adjustable speed dc and ac drives.

GG - GEOLOGY AND GEOPHYSICS

PART - I

Earth and planetary system; size, shape, internal structure and composition of the earth; atmosphere and greenhouse effect; isostasy; elements of seismology; continents and continental processes; physical oceanography; palaeomagnetism, continental drift plate tectonics, geothermal energy.

Weathering; soil formation; action of river, wind and glacier; oceans and oceanic features; earthquakes, volcanoes, orogeny and mountain building; elements of structural geology; crystallography; classification, composition and properties of minerals and rocks; engineering properties of rocks and soils, role of geology in the construction of engineering structures.

Processes of ore formation, occurrence and distribution of ores on land and on ocean floor; coal and petroleum resources in India; ground water geology including well hydraulics, geological time scale and geochronology; stratigraphic principles and stratigraphy of India; basics concepts of gravity, magnetic and electrical prospecting for ores and ground water.

PART - IIA: GEOLOGY

Crystal symmetry, forms, twinning; crystal chemistry; optical mineralogy, classification of minerals, diagnostic properties of rock minerals.

Mineralogy, structure, texture and classification of igneous, sedimentary and metamorphic rock, their origin and evolution; application of thermodynamics; structure and petrology of sedimentary rocks; sedimentary processes and environments, sedimentary facies, basin studies; basement cover relationship;

Primary and secondary structures; geometry and genesis of folds, faults, joints, unconformities, cleavage, schistosity and lineation; methods of projection. Tectonites and their significance; shear zone; superposed folding.

Morphology, classification and geological significance of important invertebrates, vertebrates, microfossils and palaeoflora; stratigraphic principles and Indian stratigraphy; geomorphic processes and agents; development and evolution of landforms; slope and drainage; processes on deep oceanic and near-shore regions; quantitative and applied geomorphology; air photo interpretation and remote sensing; chemical and optical properties of ore minerals; formation and localization of ore deposits; prospecting and exploration of economic minerals; coal and petroleum geology; origin and distribution of mineral and fuel deposits in India; ore dressing and mineral economics.

Cosmic abundance; meteorites; geochemical evolution of the earth; geochemical cycles; distribution of major, minor and trace elements; isotope geochemistry; geochemistry of waters including solution equilibria and water rock interaction.

Engineering properties of rocks and soils; rocks as construction material; geology of dams, tunnels and excavation sites; natural hazards; the fly ash problem; ground water geology and exploration; water quality; impact of human activity; Remote sensing techniques for the interpretation of landforms and resource management.

PART - II B: GEOPHYSICS

The earth as a planet; different motions of the earth; gravity filed of the earth and its shape; geochronology; isostasy, seismology and interior of the earth; variation of density, velocity, pressure, temperature, electrical and magnetic properties inside the earth; earthquakes-causes and measurements; zonation and seismic hazards; geomagnetic field, palaeomagnetism; oceanic and continental lithosphere; plate tectonics; heat flow; upper and lower atmospheric phenomena.

Theories of scalar and vector potential fields; Laplace, Maxwell and Helmholtz equations for solution of different types of boundary value problems for Cartesian, cylindrical and spherical polar coordinates; Green's theorem; Image theory; integral equations and conformal transformations in potential theory; Eikonal equation and ray theory.

'G' and 'g' units of measurement, density of rocks, gravimeters, preparation, analysis and interpretation of gravity maps; derivative maps, analytical continuation; gravity anomaly type curves; calculation of mass.

Earth's magnetic field, units of measurement, magnetic susceptibility of rocks, magnetometers, corrections, preparation of magnetic maps, magnetic anomaly type curve, analytical continuation, interpretation and application; magnetic well logging.

Conduction of electricity through rocks, electrical conductivities of metals, metallic, non-metallic and rock forming minerals, D.C. resistivity units and methods of measurement, electrode configuration for sounding and profiling, application of filter theory, interpretation of resistivity field data, application; self potential origin, classification, field measurement, interpretation of induced polarization time frequency, phase domain; IP units and methods of measurement, interpretation and application; ground-water exploration.

Origin of electromagnetic field elliptic polarization, methods of measurement for different source-receiver configuration components in EM measurements, interpretation and applications; earth's natural electromagnetic field, tellurics, magneto-tellurics; geomagnetic depth sounding principles, methods of measurement, processing of data and interpretation.

Seismic methods of prospecting: Reflection, refraction and CDP surveys; land and marine seismic sources, generation and propagation of elastic waves, velocity increasing with depth, geophones, hydrophones, recording instruments (DFS), digital formats, field layouts, seismic noises and noise profile analysis, optimum geophone grouping, noise cancellation by shot and geophone arrays, 2D and 3D seismic data acquisition and processing, CDP stacking charts, binning, filtering, dip-moveout, static and dynamic corrections, deconvolution, migration, signal processing, Fourier and Hilbert transforms, attribute analysis, bright and dim spots, seismic stratigraphy, high resolution seismics, VSP.

Principles and techniques of geophysical well-logging, SP, resistivity, induction, micro gamma ray, neutron, density, sonic, temperature, dip meter, caliper, nuclear magnetic, cement bond logging. Quantitative evaluation of formations from well logs; well hydraulics and application of geophysical methods for groundwater study; application of bore hole geophysics in ground water, mineral and oil exploration. Remote sensing techniques and application of remote sensing methods in geophysics.

IN - INSTRUMENTATION ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix Algebra, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Mean value theorems, Theorems of integral calculus, Evaluation of definite and improper integrals, Partial Derivatives, Maxima and minima, Multiple integrals, Fourier series. Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equation (linear and nonlinear), Higher order linear differential equations with constant coefficients, Method of variation of parameters, Cauchy's and Euler's equations, Initial and boundary value problems, Partial Differential Equations and variable separable method.

Complex variables: Analytic functions, Cauchy's integral theorem and integral formula, Taylor's and Laurent' series, Residue theorem, solution integrals.

Probability and Statistics: Sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Discrete and continuous distributions, Poisson, Normal and Binomial distribution, Correlation and regression analysis.

Numerical Methods: Solutions of non-linear algebraic equations, single and multi-step methods for differential equations.

Transform Theory: Fourier transform, Laplace transform, Z-transform.

INSTRUMENTATION ENGINEERING

Measurement Basics and Metrology: Static and dynamic characteristics of measurement systems. Standards and calibration. Error and uncertainty analysis, statistical analysis of data, and curve fitting. Linear and angular measurements; Measurement of straightness, flatness, roundness and roughness.

Transducers, Mechanical Measurements and Industrial Instrumentation: Transducers - elastic, resistive, inductive, capacitive, thermo-electric, piezoelectric, photoelectric, electro-mechanical, electro-chemical, and ultrasonic. Measurement of displacement, velocity (linear and rotational), acceleration, shock, vibration, force, torque, power, strain, stress, pressure, flow, temperature, humidity, viscosity, and density. energy storing elements, suspension systems and dampers.

Analog Electronics: Characteristics of diodes, BJTs, JFETs and MOSFETs; Diode circuits; Amplifiers: single and multi-stage, feedback; Frequency response; Operational amplifiers - design, characteristic, linear and non-linear applications: difference amplifiers; instrumentation amplifiers; precision rectifiers, I-to-V converters, active filters, oscillators, comparators, signal generators, wave shaping circuits.

Digital Electronics: Combinational logic circuits, minimization of Boolean functions; IC families (TTL, MOS, CMOS), arithmetic circuits, multiplexer and decoders. Sequential circuits: flip-flops, counters, shift registers. Schmitt trigger, timers, and multivibrators. Analog switches, multiplexers, S/H circuits. Analog-to-digital and digital-to-analog converters. Basics of computer organization and architecture. 8-bit microprocessor (8085), applications, memory, I/O interfacing, and microcontrollers.

Signals and Systems: Vectors and matrices; Fourier series; Fourier transforms; Ordinary differential equations. Impulse and frequency responses of first and second order systems. Laplace transform and transfer function, convolution and correlation. Amplitude and frequency modulations and demodulations. Discrete time systems, difference equations, impulse and frequency responses; Z-transforms and transfer functions; IIR and FIR filters.

Electrical and Electronic Measurements: Measurement of R, L and C; bridges and potentiometers. Measurement of voltage, current, power, power factor, and energy; Instrument transformers; Q meter, waveform analyzers. Digital volt-meters and multi-meters. Time, phase and frequency measurements; Oscilloscope. Noise and interference in instrumentation.

Control Systems & Process Control: Principles of feedback; transfer function, signal flow graphs. Stability criteria, Bode plots, root-loci, Routh and Nyquist criteria. Compensation techniques; State space analysis. System components: mechanical, hydraulic, pneumatic, electrical and electronic; Servos and synchros; Stepper motors. On-off, cascade, P, PI, PID and feed-forward controls. Controller tuning and general frequency response.

Analytical, Optical and Biomedical Instrumentation: Principles of spectrometry, UV, visible, IR mass spectrometry, X-ray methods; nuclear radiation measurements, gas, solid and semi conductor lasers and their characteristics, interferometers, basics of fibre optics, transducers in biomedical applications, cardiovascular system measurements, instrumentation for clinical laboratory.

MA - MATHEMATICS

Linear Algebra: Finite dimensional vector spaces. Linear transformations and their matrix representations, rank; systems of linear equations, eigenvalues and eigenvectors, minimal polynomial, Cayley-Hamilton theorem, diagonalisation, Hermitian, Skew-Hermitian and unitary matrices. Finite dimensional inner product spaces, self-adjoint and Normal linear operators, spectral theorem, Quadratic forms.

Complex Analysis: Analytic functions, conformal mappings, bilinear transformations, complex integration: Cauchy's integral theorem and formula, Liouville's theorem, maximum modulus principle, Taylor and Laurent's series, residue theorem and applications for evaluating real integrals.

Real Analysis: Sequences and series of functions, uniform convergence, power series, Fourier series, functions of several variables, maxima, minima, multiple integrals, line, surface and volume integrals, theorems of Green, Stokes and Gauss; metric spaces, completeness, Weierstrass approximation theorem, compactness. Lebesgue measure, measurable functions; Lebesgue integral, Fatou's lemma, dominated convergence theorem.

Ordinary Differential Equations: First order ordinary differential equations, existence and uniqueness theorems, systems of linear first order ordinary differential equations, linear ordinary differential equations of higher order with constant coefficients; linear second order ordinary differential equations with variable coefficients, method of Laplace transforms for solving ordinary differential equations, series solutions; Legendre and Bessel functions and their orthogonality, Sturm Liouville system, Greeen's functions.

Algebra: Normal subgroups and homomorphisms theorems, automorphisms. Group actions, sylow's theorems and their applications groups of order less than or equal to 20, Finite p-groups. Euclidean domains, Principal ideal domains and unique factorizations domains. Prime ideals and maximal ideals in commutative rings.

Functional Analysis: Banach spaces, Hahn-Banach theorems, open mapping and closed graph theorems, principle of uniform boundedness; Hilbert spaces, orthonormal sets, Riesz representation theorem, self-adjoint, unitary and normal linear operators on Hilbert Spaces.

Numerical Analysis: Numerical solution of algebraic and transcendental equations; bisection, secant method, Newton-Raphson method, fixed point iteration, interpolation: existence and error of polynomial interpolation, Lagrange, Newton, Hermite(osculatory)interpolations; numerical differentiation and integration, Trapezoidal and Simpson rules; Gaussian quadrature; (Gauss-Legendre and Gauss-Chebyshev), method of undetermined parameters, least square and orthonormal polynomial approximation; numerical solution of systems of linear equations: direct and iterative methods, (Jacobi Gauss-Seidel and SOR) with convergence; matrix eigenvalue problems: Jacobi and Given's methods, numerical solution of ordinary differential equations: initial value problems, Taylor series method, Runge-Kutta methods, predictor-corrector methods; convergence and stability.

Partial Differential Equations: Linear and quasilinear first order partial differential equations, method of characteristics; second order linear equations in two variables and their classification; Cauchy, Dirichlet and Neumann problems, Green's functions; solutions of Laplace, wave and diffusion equations in two variables Fourier series and transform methods of solutions of the above equations and applications to physical problems.

Mechanics: Forces in three dimensions, Poinsot central axis, virtual work, Lagrange's equations for holonomic systems, theory of small oscillations, Hamiltonian equations;

Topology: Basic concepts of topology, product topology, connectedness, compactness, countability and separation axioms, Urysohn's Lemma, Tietze extension theorem, metrization theorems, Tychonoff theorem on compactness of product spaces.

Probability and Statistics: Probability space, conditional probability, Bayes' theorem, independence, Random variables, joint and conditional distributions, standard probability distributions and their properties, expectation, conditional expectation, moments. Weak and strong law of large numbers, central limit theorem. Sampling distributions, UMVU estimators, sufficiency and consistency, maximum likelihood estimators. Testing of hypotheses, Neyman-Pearson tests, monotone likelihood ratio, likelihood ratio tests, standard parametric tests based on normal, X2 ,t, F-distributions. Linear regression and test for linearity of regression. Interval estimation.

Linear Programming: Linear programming problem and its formulation, convex sets their properties, graphical method, basic feasible solution, simplex method, big-M and two phase methods, infeasible and unbounded LPP's, alternate optima. Dual problem and duality theorems, dual simplex method and its application in post optimality analysis, interpretation of dual variables. Balanced and unbalanced transportation problems, unimodular property and u-v method for solving transportation problems. Hungarian method for solving assignment problems.

Calculus of Variations and Integral Equations: Variational problems with fixed boundaries; sufficient conditions for extremum, Linear integral equations of Fredholm and Volterra type, their iterative solutions. Fredholm alternative.

ME - MECHANICAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

APPLIED MECHANICS AND DESIGN

Engineering Mechanics: Equivalent force systems, free-body concepts, equations of equilibrium, trusses and frames, virtual work and minimum potential energy. Kinematics and dynamics of particles and rigid bodies, impulse and momentum (linear and angular), energy methods, central force motion.

Strength of Materials: Stress and strain, stress-strain relationship and elastic constants, Mohr's circle for plane stress and plane strain, shear force and bending moment diagrams, bending and shear stresses, deflection of beams, torsion of circular shafts, thin and thick cylinders, Euler's theory of columns, strain energy methods, thermal stresses.

Theory of Machines: Displacement, velocity and acceleration, analysis of plane mechanisms, dynamic analysis of slider-crank mechanism, planar cams and followers, gear tooth profiles, kinematics of gears, governors and flywheels, balancing of reciprocating and rotating masses.

Vibrations: Free and forced vibration of single degree freedom systems, effect of damping, vibration isolation, resonance, critical speed of rotors.

Design of Machine Elements: Design for static and dynamic loading, failure theories, fatigue strength; design of bolted, riveted and welded joints; design of shafts and keys; design of spur gears, rolling and sliding contact bearings; brakes and clutches; belt, rope and chain drives.

FLUID MECHANICS AND THERMAL SCIENCES

Fluid Mechanics: Fluid properties, fluid statics, manometry, buoyancy; control-volume analysis of mass, momentum and energy; fluid acceleration; differential equations of continuity and momentum; Bernoulli's equation; viscous flow of incompressible fluids; boundary layer; elementary turbulent flow; flow through pipes, head losses in pipes, bends etc.

Heat-Transfer: Modes of heat transfer; one dimensional heat conduction, resistance concept, electrical analogy, unsteady heat conduction, fins; dimensionless parameters in free and forced convective heat transfer, various correlations for heat transfer in flow over flat plates and through pipes; thermal boundary layer; effect of turbulence; radiative heat transfer, black and grey surfaces, shape factors, network analysis; heat exchanger performance, LMTD and NTU methods.

Thermodynamics: Zeroth, First and Second laws of thermodynamics; thermodynamic system and processes; irreversibility and availability; behaviour of ideal and real gases, properties of pure substances, calculation of work and heat in ideal processes; analysis of thermodynamic cycles related to energy conversion; Carnot, Rankine, Otto, Diesel, Brayton and vapour compression cycles.

Power Plant Engineering: Steam generators; steam power cycles; steam turbines; impulse and reaction principles, velocity diagrams, pressure and velocity compounding; reheating and reheat factor; condensers and feed heaters.

I.C. Engines: Requirements and suitability of fuels in IC engines, fuel ratings, fuel-air mixture requirements; normal combustion in SI and CI engines; engine performance calculations.

Refrigeration and air-conditioning: Refrigerant compressors, expansion devices, condensers and evaporators; properties of moist air, psychrometric chart, basic psychometric processes.

Turbomachinery: Components of gas turbines; compression processes, centrifugal and axial flow compressors; axial flow turbines, elementary theory; hydraulic turbines; Euler-turbine equation; specific speed, Pelton-wheel, Francis and Kaplan turbines; centrifugal pumps.

MANUFACTURING AND INDUSTRIAL ENGINEERING

Engineering Materials: Structure and properties of engineering materials and their applications, heat treatment.

Metal Casting: Casting processes (expendable and non-expendable) -pattern, moulds and cores, heating and pouring, solidification and cooling, gating design, design considerations, defects.

Forming Processes: Stress-strain diagrams for ductile and brittle material, Plastic deformation and yield criteria, fundamentals of hot and cold working processes, Bulk metal forming processes (forging, rolling, extrusion, drawing), sheet metal working processes (punching, blanking, bending, deep drawing, coining, spinning, load estimation using homogeneous deformation methods, defects). processing of powder metals- atomization, compaction, sintering, secondary and finishing operations. forming and shaping of plastics- extrusion, injection moulding.

Joining Processes: Physics of welding, fusion and non-fusion welding processes, brazing and soldering, adhesive bonding, design considerations in welding, weld quality defects.

Machining and Machine Tool Operations: Mechanics of machining, single and multi-point cutting tools, tool geometry and materials, tool life and wear, cutting fluids, machinability, economics of machining, non-traditional machining processes.

Metrology and Inspection: Limits, fits and tolerances, linear and angular measurements, comparators, gauge design, interferometry, form and finish measurement, measurement of screw threads, alignment and testing methods.

Tool Engineering: Principles of work holding, design of jigs and fixtures.

Computer Integrated Manufacturing: Basic concepts of CAD, CAM and their integration tools.

Manufacturing Analysis: Part-print analysis, tolerance analysis in manufacturing and assembly, time and cost analysis.

Work-Study: Method study, work measurement, time study, work sampling, job evaluation, merit rating.

Production Planning and Control: Forecasting models, aggregate production planning, master scheduling, materials requirements planning.

Inventory Control: Deterministic and probabilistic models, safety stock inventory control systems.

Operations Research: Linear programming, simplex and duplex method, transportation, assignment, network flow models, simple queuing models, PERT and CPM

MN - MINING ENGINEERING

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

MINING ENGINEERING

Mechanics: Equivalent force systems, equations of equilibrium, two dimensional frames and trusses, free body diagrams, friction forces, particle kinematics and dynamics.

Mine Development, Geomechanics and Strata Control: Drivages for underground mine development, drilling methods and machines, explosives, blasting devices and practices, shaft sinking. Physico-mechanical properties of rocks, rock mass classification, ground control instrumentation and stress measurement techniques, theories of rock failure, ground vibrations, stress distribution around mine openings, subsidence, design of supports in roadways and workings, stability of open pits, slopes.

Mining Methods and Machinery: Surface mining - layout, development, loading, transportation and mechanization, continuous surface mining systems. Underground coal mining - bord and pillar system, longwall mining, thick seam mining methods. Underground metal mining: different stoping methods, stope mechanization, ore handling systems, mine filling. Generation and transmission of mechanical, hydraulic, and pneumatic power. Materials handling - haulages, conveyors, ropeways, face and development machinery, hoisting systems, and pumps.

Ventilation, Underground Hazards and Surface Environment: Underground atmosphere, heat load sources and thermal environment, air cooling, mechanics of air flow distribution, natural and mechanical ventilation, mine fans and their usage, auxiliary ventilation. Subsurface hazards from fires, explosions, gases, dust, and inundation, rescue apparatus and practices, safety in mines, accident analysis, noise, mine lighting. Air and water pollution: causes, dispersion, quality standards, and control.

Surveying, Mine Planning and Systems Engineering: Fundamentals of engineering surveying, Levels and levelling, Theodolite, tacheometry, triangulation, contouring, errors and adjustments, correlation, underground surveying, curves, photogrammetry, field astronomy, GPS fundamentals. Principles of planning - Sampling methods and practices, reserve estimation techniques, basics of geostatistics, optimization of facility location, cash flow concepts and mine valuation, open pit design. Work study, concepts of reliability, reliability of series and parallel systems. Linear programming, transportation and assignment problems, queueing, network analysis, inventory control.

MT - METALLURGICAL ENGINEERING

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

METALLURGICAL ENGINEERING

Thermodynamics and Rate Processes: Laws of thermodynamics, activity, equilibrium constant, applications to metallurgical systems, solutions, phase equilibria, basic kinetic laws, order of reactions, rate constants and rate limiting steps principles of electro chemistry, aqueous, corrosion and protection of metals, oxidation and high temperature corrosion - characterization and control; momentum transfer - concepts of viscosity, shell balances, Bernoulli's equation; heat transfer - conduction, convection and heat transfer coefficient relations, radiation, mass transfer - diffusion and Fick's laws.

Extractive Metallurgy: Flotation, gravity and other methods of mineral processing; agglomeration, pyro-hydro-and electro-metallurgical processes; material and energy balances; principles and processes for the extraction of non-ferrous metals - aluminium, copper, zinc, lead, magnesium, nickel, titanium and other rare metals; iron and steel making - principles, blast furnace, direct reduction processes, primary and secondary steel making, deoxidation and inclusion in steel; ingot and continuous casting; stainless steel making, design of furnaces; fuels and refractories.

Physical Metallurgy: Crystal structure and bonding characteristics of metals, alloys, ceramics and polymers; solid solutions; solidification; phase transformation and binary phase diagrams; principles of heat treatment of steels, aluminum alloys and cast irons; recovery, recrystallization and grain growth; industrially important ferrous and non-ferrous alloys; elements of X-ray and electron diffraction; principles of scanning and transmission electron microscopy; elements of ceramics, composites and electronic materials; electronic basis of thermal, optical, electrical and magnetic properties of materials.

Mechanical Metallurgy: Elements of elasticity and plasticity; defects in crystals; elements of dislocation theory - types of dislocations, slip and twinning, stress fields of dislocations, dislocation interactions and reactions, methods of seeing dislocations; strengthening mechanisms; tensile, fatigue and creep behaviour; superplasticity; fracture - Griffith theory, ductile to brittle transition, fracture toughness; failure analysis; mechanical testing - tension, compression, torsion, hardness, impact, creep, fatigue, fracture toughness and formability tests.

Manufacturing Processes: Metal casting - patterns, moulds, melting, gating, feeding and casting processes, defects and castings, hot and cold working of metals; Metal forming - fundamentals of metal forming, rolling wire drawing, extrusion, forming, sheet metal forming processes, defects in forming; Metal joining - soldering, brazing and welding, common welding processes, welding metallurgy, problems associated with welding of steels and aluminium alloys, defects in welding, powder metallurgy; NDT methods - ultrasonic, radiography, eddy current, acoustic emission and magnetic.

PH - PHYSICS

Mathematical Physics: Linear vector space, matrices; vector calculus; linear differential equations; elements of complex analysis; Laplace transforms, Fourier analysis, elementary ideas about tensors.

Classical Mechanics: Conservation laws; central forces; collisions and scattering in laboratory and centre of mass reference frames; mechanics of system of particles; rigid body dynamics; moment of inertia tensor; noninertial frames and pseudo forces; variational principle; Lagrange's and Hamilton's formalisms; equation of motion, cyclic coordinates, Poisson bracket; periodic motion, small oscillations, normal modes; wave equation and wave propagation; special theory of relativity - Lorentz transformations, relativistic kinematics, mass-energy equivalence.

Electromagnetic Theory: Laplace and Poisson equations; conductors and dielectrics; boundary value problems; Ampere's and Biot-Savart's laws; Faraday's law; Maxwell's equations; scalar and vector potentials; Coulomb and Lorentz gauges; boundary conditions at interfaces; electromagnetic waves; interference, diffraction and polarization; radiation from moving charges.

Quantum Mechanics: Physical basis of quantum mechanics; uncertainty principle; Schrodinger equation; one and three dimensional potential problems; Particle in a box, harmonic oscillator, hydrogen atom; linear vectors and operators in Hilbert space; angular momentum and spin; addition of angular momentum; time independent perturbation theory; elementary scattering theory.

Atomic and Molecular Physics: Spectra of one-and many-electron atoms; LS and jj coupling; hyperfine structure; Zeeman and Stark effects; electric dipole transitions and selection rules; X-ray spectra; rotational and vibrational spectra of diatomic molecules; electronic transition in diatomic molecules, Franck-Condon principle; Raman effect; NMR and ESR; lasers.

Thermodynamics and Statistical Physics: Laws of thermodynamics; macrostates, phase space; probability ensembles; partition function, free energy, calculation of thermodynamic quantities; classical and quantum statistics; degenerate Fermi gas; black body radiation and Planck's distribution law; Bose-Einstein condensation; first and second order phase transitions, critical point.

Solid State Physics: Elements of crystallography; diffraction methods for structure determination; bonding in solids; elastic properties of solids; defects in crystals; lattice vibrations and thermal properties of solids; free electron theory; band theory of solids; metals, semiconductors and insulators; transport properties; optical, dielectric and magnetic properties of solids; elements of superconductivity.

Nuclear and Particle Physics: Rutheford scattering; basic properties of nuclei; radioactive decay; nuclear forces; two nucleon problem; nuclear reactions; conservation laws; fission and fusion; nuclear models; particle accelerators, detectors; elementary particles; photons, baryons, mesons and leptons; Quark model.

Electronics: Network analysis; semiconductor devices; bipolar transistors; FETs; power supplies, amplifier, oscillators; operational amplifiers; elements of digital electronics; logic circuits.

PI - PRODUCTION AND INDUSTRIAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

GENERAL ENGINEERING:

Engineering Materials: Structure and properties of engineering materials and their applications; effect of strain, strain rate and temperature on mechanical properties of metals and alloys; heat treatment of metals and alloys.

Applied Mechanics: Engineering mechanics - equivalent force systems, free body concepts, equations of equilibrium, virtual work and minimum potential energy; strength of materials-stress, strain and their relationship, Mohr's circle, deflection of beams, bending and shear stress, Euler's theory of columns.

Theory of Machines and Design: Analysis of planar mechanisms, plane cams and followers; governers and fly wheels; design of elements-failure theories; design of bolted, riveted and welded joints; design of shafts, keys, belt drives, brakes and clutches.

Thermal Engineering: Fluid machines - fluid statics, Bernoulli's equation, flow through pipes, equations of continuity and momentum; Thermodynamics - zeroth, First and Second laws of thermodynamics, thermodynamic system and processes, calculation of work and heat for systems and control volumes; Heat transfer - fundamentals of conduction, convection and radiation.

PRODUCTION ENGINEERING

Metal Casting: Casting processes; patterns-materials; allowances; moulds and cores - materials, making and testing; melting and founding of cast iron, steels and nonferrous metals and alloys; solidification; design of casting, gating and risering; casting defects and inspection.

Metal working: Stress-strain in elastic and plastic deformation; deformation mechanisms; hot and cold working-forging, rolling, extrusion, wire and tube drawing; sheet metal working; analysis of rolling, forging, extrusion and wire /rod drawing; metal working defects, high energy rate forming processes-explosive, magnetic, electro and electrohydraulic.

Metal Joining Processes: Welding processes - gas shielded metal arc, TIG, MIG, submerged arc, electroslag, thermit, resistance, pressure and forge welding; thermal cutting; other joining processes - soldering, brazing, braze welding; welding codes, welding symbols, design of welded joints, defects and inspection; introduction to modern welding processes - friction, ultrasonic, explosive, electron beam, laser and plasma.

Machining and Machine Tool Operations: Machining processes-turning, drilling, boring, milling, shaping, planing, sawing, gear cutting, thread production, broaching, grinding, lapping, honing super finishing; mechanics of cutting- Merchant's analysis, geometry of cutting tools, cutting forces, power requirements; selection of process parameters; tool materials, tool wear and tool life, cutting fluids, machinability; nontraditional machining processes and hybrid processes- EDM, CHM, ECM, USM, LBM, EBM, AJM, PAM AND WJM; economics of machining.

Metrology and Inspection: Limits and fits, linear and angular measurements by mechanical and optical methods, comparators; design of limit gauges; interferometry; measurement of straightness, flatness, roundness, squareness and symmetry; surface finish measurement; inspection of screw threads and gears; alignment testing.

Powder Metallurgy and Processing of Plastics: Production of powders, compaction, sintering; Polymers and composites; injection, compression and blow molding, extrusion, calendaring and thermoforming; molding of composites.

Tool Engineering: Work-holding-location and clamping; principles and methods; design of jigs and fixtures; design of press working tools, forging dies.

Manufacturing Analysis: Sources of errors in manufacturing; process capability; part-print analysis; tolerance analysis in manufacturing and assembly; process planning; parameter selection and comparison of production alternatives; time and cost analysis; Issues in choosing manufacturing technologies and strategies.

Computer Integrated Manufacturing: Basic concepts of CAD, CAM, CAPP, group technology, NC, CNC, DNC, FMS, Robotics and CIM.

INDUSTRIAL ENGINEERING

Product Design and Development: Principles of good product design, component and tolerance design; efficiency, quality and cost considerations; product life cycle; standardization, simplification, diversification, value analysis, concurrent engineering.

Engineering Economy and Costing: Financial statements; elementary cost accounting, methods of depreciation; break-even analysis, techniques for evaluation of capital investments.

Work System Design: Taylor's scientific management, Gilbreths's contributions; productivity concepts and measurements; method study, micro-motion study, principles of motion economy; human factors engineering, ergonomics; work measurement - time study, PMTS, work sampling; job evaluation, merit rating, wage administration, incentive systems; business process reengineering.

Logistics and Facility Design: Facility location factors, evaluation of alternatives, types of plant layout, evaluation; computer aided layout; assembly line balancing; material handling systems; supply chain management.

Production Planning and Inventory Control: Inventory Function costs, classifications - deterministic and probabilistic models; quantity discount; safety stock; inventory control system; Forecasting techniques - causal and time series models, moving average, exponential smoothing; trend and seasonality; aggregate production planning; master scheduling; bill of materials and material requirement planning; order control and flow control, routing, scheduling and priority dispatching; JIT; Kanban PULL systems; bottleneck scheduling and theory of constraints.

Operation Research: Linear programming - problem formulation, simplex method, duality and sensitivity analysis; transportation; assignment; network flow models, constrained optimization and Lagrange multipliers; simple queuing models; dynamic programming; simulation; PERT and CPM, time-cost trade-off, resource leveling.

Quality Control: Taguchi method; design of experiments; quality costs, statistical quality assurance, process control charts, acceptance sampling, zero defects; quality circles, total quality management.

Reliability and Maintenance: Reliability, availability and maintainability; probabilistic failure and repair times; system reliability; preventive maintenance and replacement, TPM.

Management Information System: Value of information; information storage and retrieval system - database and data structures; interactive systems; knowledge based systems.

Intellectual Property System: Definition of intellectual property, importance of IPR; TRIPS, and its implications, WIPO and Global IP structure, and IPS in India; patent, copyright, industrial design and trademark; meanings, rules and procedures, terms, infringements and remedies.

PY - PHARMACEUTICAL SCIENCES

Natural Products: Pharmacognosy & Phytochemistry - Chemistry, tests, isolation, characterization and estimation of phytopharmaceuticals belonging to the group of Alkaloids, Glycosides, Terpenoids, Steroids, Bioflavanoids, Purines, Guggul lipids. Pharmacognosy of crude drugs which contain the above constituents. Standardisation of raw materials and herbal products. WHO guide lines. Quantitative microscopy including modern techniques used for evaluation. Biotechnological principles and techniques for plant development Tissue culture.

Pharmacology: General pharmacological principles including Toxicology. Drug interaction. Pharmacology of drugs acting on Central nervous system, Cardiovascular system, Autonomic nervous system, Gastro intestinal system and Respiratory system. Pharmacology of Autocoids, Hormones, Chemotherapeutic agents including anticancer drugs. Bioassays. Immuno

Pharmacology.

Medicinal Chemistry: Structure, nomenclature, classification, synthesis, SAR and metabolism of the following category of drugs which are official in Indian Pharmacopoeia and British Pharmacopoeia Hypnotics and Sedatives, Analgesics, NSAIDS, Neuroleptics, Antidepressants, Anxiolytics, Anticonvulsants, Antihistaminics, Local anaesthetics, Cardio Vascular drugs - Antianginal agents Vasodilators, Adrenergic & cholinergic drugs, Cardiotonic agents, Diuretics, Antihypertensive drugs, Hypoglycemic agents, Antilipedmic agents, Coagulants, Anticoagulants, Antiplatelet agents. Chemotherapeutic agents - Antibiotics, Antibacterials, Sulphadrugs. Antiproliozoal drugs, Antiviral, Antitubercular, Antimalarial, Anticancer, Antiamoebic drugs. Diagnostic agents. Preparation and storage and uses of official Radiopharmaceuticals. Vitamins and Hormones.

Pharmaceutics: Development, manufacturing standards, labeling, packing as per the pharmacopoeal requirements, Storage of different dosage forms and new drug delivery systems. Biopharmaceutics and Pharmacokinetics and their importance in formulation. Formulation and preparation of cosmetics - lipstick, shampoo, creams, nail preparations and dentifrices. Pharmaceutical calculations.

Pharmaceutical Jurisprudence: Legal aspects of manufacture, storage, sale of drugs. D and C act and rules. Pharmacy act.

Pharmaceutical Analysis: Principles, instrumentation and applications of the following. Absorption spectroscopy (UV, visible & IR), Fluorimetry, Flame photometry, Potentiometry, Conductometry and Plarography. Pharmacopoeial assays. Principles of NMR, ESR, Mass spectroscopy, X-ray diffraction analysis and different chromatographic methods.

Biochemistry and Clinical Pharmacy: Biochemical role of hormones, Vitamins, Enzymes, Nucleic acids. Bioenergetics. General principles of immunology. Immunological techniques. Adverse drug interaction.

Microbiology: Principles and methods of microbiological assays of the Pharmacopoeia. Methods of preparation of official sera and vaccines. Serological and diagnostic tests. Applications of microorganisms in Bio Conversions and in Pharmaceutical industry.

TF - TEXTILE ENGINEERING AND FIBRE SCIENCE

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

TEXTILE ENGINEERING & FIBRE SCIENCE

Textile Fibres: Classification of textile fibres according to their nature and origin; general characteristics of textile fibres-their chemical and physical structures and their properties; essential characteristics of fibre forming polymers; uses of natural and man-made fibres; physical and chemical methods of fibre and blend identification and blend analysis.

Melt Spinning processes with special reference to polyamide and polyester fibres; wet and dry spinning of viscose and acrylic fibres; post spinning operations-drawing, heat setting, texturing- false twist and air-jet, tow-to-top conversion. Methods of investigating fibre structure e.g. X-ray diffraction, birefringence, optical and electron microscopy, I.R. absorption, thermal methods; structure and morphology and principal natural and man-made fibres, mechanical properties of fibres, moisture sorption in fibres; fibre structure and property correlation.

Textile Testing: Sampling techniques, sample size and sampling errors; measurement of fibre length, fineness, crimp, strength and reflectance; measurement of cotton fibre maturity ad trash content; HVI and AFIS for fibre testing. Measurement of yarn count, twist and hairiness; tensile testing of fibres, yarn and fabrics; evenness testing of slivers, rovings and yarns; testing equipment for measurement test methods of fabric properties like thickness, compressibility, air permeability, drape, crease recovery, tear strength bursting strength and abrasion resistance. Correlation analysis, significance tests and analysis of variance; frequency distributions and control charts.

Yarn Manufacture and Yarn Structure: Modern methods of opening, cleaning and blending of fibrous materials; the technology of carding with particular reference to modern developments; causes of irregularity introduced by drafting, the development of modern drafting systems; principles and techniques of preparing material for combing; recent development in combers; functions and synchronization of various mechanisms concerned with roving production; forces acting on yarn and traveller, ring and traveller designs; causes of end breakages; properties of doubles yarns; new methods of yarn production such as rotor spinning, air jet spinning and friction spinning.

Yarn diameter; specific volume, packing coefficient; twist-strength relationship; fibre orientation in yarn; fibre migration.

Fabric Manufacture and Fabric Structure: Principles of cheese and cone winding processes and machines; random and precision winding; package faults and their remedies; yarn clearers and tensioners; different systems of yarn splicing; features of modern cone winding machines; different types of warping creels; features of modern beam and sectional warping machines; different sizing systems, sizing of spun and filament yarns, modern sizing machines; principles of pirn winding processes and machines; primary and secondary motions of loom, effect of their settings and timings on fabric formation, fabric appearance and weaving performance; dobby and jacquard shedding; mechanics of weft insertion with shuttle; warp and weft stop motions, warp protection, weft replenishment; functional principles of weft insertion systems of shuttleless weaving machines, principles of multiphase and circular looms. Principles of weft and warp knitting; basic weft and warp knitted structures; classification, production and areas of application of nonwoven fabrics.

Basic woven fabric constructions and their derivatives; crepe, cord, terry, gauze, lino and double cloth constructions.

Peirce's equations for fabric geometry; thickness, cover and maximum sett of woven fabrics

Textile Chemical Processing: Preparatory processes for natural-and and their blends; mercerization of cotton; machines for yarn and fabric mercerization.

Dyeing and printing of natural- and synthetic- fibre fabrics and their blends with different dye classes; dyeing and printing machines; styles of printing; fastness properties of dyed and printed textile materials.

Finishing of textile materials, wash and wear, durable press, soil release, water repellent, flame retardant and antistatic finishes; shrink-resistance finish for wool; heat setting of synthetic-fibre fabrics, finishing machines; energy efficient processes; pollution control.

XE - ENGINERING SCIENCES

The syllabi of the sections of this paper are as follows:

SECTION A. ENGINEERING MATHEMATICS (Compulsory)

Linear Algebra : Determinates, algebra of matrices, rank, inverse, system of linear equations, symmetric, skew-symmetric and orthogonal matrices. Hermitian, skew-hermitian and unitary matrices. eigenvalues and eigenvectors, diagonalisation of matrices, Cayley-Hamiltonian, quadratic forms.

Calculus : Functions of single variables, limit, continuity and differentiability, Mean value theorems, Intermediate forms and L'Hospital rule, Maxima and minima, Taylor's series, Fundamental and mean value-theorems of integral calculus. Evaluation of definite and improper integrals, Beta and Gamma functions, Functions of two variables, limit, continuity, partial derivatives, Euler's theorem for homogeneous functions, total derivatives, maxima and minima, Lagrange method of multipliers, double and triple integrals and their applications, sequence and series, tests for convergence, power series, Fourier Series, Fourier integrals.

Complex variable: Analytic functions, Cauchy's integral theorem and integral formula without proof. Taylor's and Laurent' series, Residue theorem (without proof) with application to the evaluation of real integarls.

Vector Calculus: Gradient, divergence and curl, vector identities, directional derivatives, line, surface and volume integrals, Stokes, Gauss and Green's theorems (without proofs) with applications.

Ordinary Differential Equations: First order equation (linear and nonlinear), higher order linear differential equations with constant coefficients, method of variation of paramaters, Cauchy's and Euler's equations, initial and boundary value problems, power series solutions, Legendre polynomials and Bessel's functions of the first kind.

Partial Differential Equations: Variables separable method, solutions of one dimensional heat, wave and Laplace equations.

Probability and Statistics: Definitions of probability and simple theorems, conditional probability, mean, mode and standard deviation, random variables, discrete and continuous distributions, Poisson, normal and Binomial distribution, correlation and regression

Numerical Methods: L-U decomposition for systems of linear equations,Newton-Raphson method, numerical integration(trapezoidal and Simpson's rule), numerical methods for first order differential equation (Euler method)

SECTION B. COMPUTATIONAL SCIENCE

Numerical Methods: Truncation errors, round off errors and their propagation; Interpolation; Lagrange, Newton's forward, backward and divided difference formulas, least square curve fitting, solution of non-linear equations of one variables using bisection, false position, secant and Newton Raphson methods; Rate of convergence of these methods, general iterative methods. Simple and multiple roots of polynomials. Solutions of system of linear algebraic equations using Gauss elimination methods, Jacobi and Gauss-Seidel iterative methods and their rate of convergence; ill conditioned and well conditioned system. eigen values and eigen vectors using power methods. Numerical integration using trapezoidal, Simpson's rule and other quadrature formulas. Numerical Differentiation. Solution of boundary value problems.

Solution of initial value problems of ordinary differential equations using Euler's method, predictor corrector and Runge Kutta method.

Programming : Elementary concepts and terminology of a computer system and system software, Fortran77 and C programming.

Fortran : Program organization, arithmetic statements, transfer of control, Do loops, subscripted variables, functions and subroutines.

C language : Basic data types and declarations, flow of control- iterative statement, conditional statement, unconditional branching, arrays, functions and procedures.

SECTION C. ELECTRICAL SCIENCES

Electric Circuits: Ideal voltage and current sources; RLC circuits, steady state and transient analysis of DC circuits, network theorems; alternating currents and voltages, single-phase AC circuits, resonance; three-phase circuits.

Magnetic circuits: Mmf and flux, and their relationship with voltage and current; transformer, equivalent circuit of a practical transformer, three-phase transformer connections.

Electrical machines: Principle of operation, characteristics, efficiency and regulation of DC and synchronous machines; equivalent circuit and performance of three-phase and single-phase induction motors.

Electronic Circuits: Characteristics of p-n junction diodes, zener diodes, bipolar junction transistors (BJT) and junction field effect transistors (JFET); MOSFET's structure, characteristics, and operations; rectifiers, filters, and regulated power supplies; biasing circuits, different configurations of transistor amplifiers, class A, B and C of power amplifiers; linear applications of operational amplifiers; oscillators; tuned and phase shift types.

Digital circuits: Number systems, Boolean algebra; logic gates, combinational circuits, flip-flops (RS, JK, D and T) counters.

Measuring instruments: Moving coil, moving iron, and dynamometer type instruments; shunts, instrument transformers, cathode ray oscilloscopes; D/A and A/D converters.

SECTION D. FLUID MECHANICS

Fluid Properties: Relation between stress and strain rate for Newtonian fluids

Hydrostatics, buoyancy, manometry

Concept of local and convective accelerations; control volume analysis for mass, momentum and energy conservation.

Differential equations of continuity and momentum (Euler's equation of motion); concept of fluid rotation, stream function, potential function; Bernoulli's equation and its applications.

Qualitative ideas of boundary layers and its separation; streamlined and bluff bodies; drag and lift forces.

Fully-developed pipe flow; laminar and turbulent flows; friction factor; Darcy Weisbach relation; Moody's friction chart; losses in pipe fittings; flow measurements using venturimeter and orifice plates.

Dimensional analysis; similitude and concept of dynamic similarity; importance of dimensionless numbers in model studies.

SECTION E. MATERIALS SCIENCE

Atomic structure and bonding in materials: metals, ceramics and polymers.

Structure of materials: Crystal systems, unit cells and space lattice; determination of structures of simple crystals by X-ray diffraction; Miller indices for planes and directions. Packing geometry in metallic, ionic and covalent solids.

Concept of amorphous, single and polycrystalline structures and their effects on properties of materials.

Imperfections in crystalline solids and their role in influencing various properties.

Fick´s laws of diffusion and applications of diffusion in sintering, doping of semiconductors and surface hardening of metals.

Alloys: solid solution and solubility limit. Binary phase diagram, intermediate phases and intermetallic compounds; iron-iron carbide phase diagram. Phase transformation in steels. Cold and hot working of metals, recovery, recrystallization and grain growth.

Properties and applications of ferrous and nonferrous alloys.

Structure, properties, processing and applications of traditional and advanced ceramics.

Polymers: classification, polymerization, structure and properties, additives for polymer products, processing and application.

Composites: properties and application of various composites.

Corrosion and environmental degradation of materials (metals, ceramics and polymers).

Mechanical properties of materials: Stress-strain diagrams of metallic, ceramic and polymeric materials, modulus of elasticity, yield strength, plastic deformation and toughness, tensile strength and elongation at break; viscoelasticity, hardness, impact strength. ductile and brittle fracture. creep and fatigue properties of materials.

Heat capacity, thermal conductivity, thermal expansion of materials.

Concept of energy band diagram for materials; conductors, semiconductors and insulators in terms of energy bands. Electrical conductivity, effect of temperature on conductivity in materials, intrinsic and extrinsic semiconductors, dielectric properties of materials.

Refraction, reflection, absorption and transmission of electromagnetic radiation in solids.

Origin of magnetism in metallic and ceramic materials, paramagnetism, diamagnetism, antiferromagnetism, ferromagnetism, ferrimagnetism in materials and magnetic hysteresis.

Advanced materials: Smart materials exhibiting ferroelectric, piezoelectric, optoelectronic, semiconducting behaviour; lasers and optical fibers; photoconductivity and superconductivity in materials.

SECTION F. SOLID MECHANICS

Equivalent force systems; free-body diagrams; equilibrium equations; analysis of determinate and indeterminate trusses and frames; friction.

Simple relative motion of particles; force as function of position, time and speed; force acting on a body in motion; laws of motion; law of conservation of energy; law of conservation of momentum

Stresses and strains; principal stresses and strains; Mohr's circle; generalized Hooke's Law; equilibrium equations; compatibility conditions; yield criteria.

Axial, shear and bending moment diagrams; axial, shear and bending stresses; deflection (for symmetric bending); torsion in circular shafts; thin cylinders; energy methods (Castigliano's Theorems); Euler buckling.

SECTION G. THERMODYNAMICS

Basic Concepts: Continuum, macroscopic approach, thermodynamic system (closed and open or control volume); thermodynamic properties and equilibrium; state of a system, state diagram, path and process; different modes of work; Zeroth law of thermodynamics; concept of temperature; heat.

First Law of Thermodynamics: Energy, enthalpy, specific heats, first law applied to systems and control volumes, steady and unsteady flow analysis.

Second Law of Thermodynamics: Kelvin-Planck and Clausius statements, reversible and irreversible processes, Carnot theorems, thermodynamic temperature scale, Clausius inequality and concept of entropy, principle of increase of entropy; availability and irreversibility.

Properties of Pure Substances: Thermodynamic properties of pure substances in solid, liquid and vapour phases, P-V-T behaviour of simple compressible substances, phase rule, thermodynamic property tables and charts, ideal and real gases, equations of state, compressibility chart.

Thermodynamic Relations: T-ds relations, Maxwell equations, Joule-Thomson coefficient, coefficient of volume expansion, adiabatic and isothermal compressibilities, Clapeyron equation.

Ideal Gas Mixtures: Dalton's and Amagat's laws, calculations of properties, air-water vapour mixtures.

XL - LIFE SCIENCES

The syllabi of the Sections of this paper are as follows:

SECTION H. CHEMISTRY (Compulsory)

Atomic structure and periodicity: Quantum chemistry; Planck's quantum theory, wave particle duality, uncertainty principle, quantum mechanical model of hydrogen atom; electronic configuration of atoms; periodic table and periodic properties; ionization energy, election affinity, electronegativity, atomic size.

Structure and bonding: Ionic and covalent bonding M.O. and V.B. approaches for diatomic molecules, VSEPR theory and shape of molecules, hybridisation, resonance, dipole moment, structure parameters such as bond length, bond angle and bond energy, hydrogen bonding, van der Waals interactions. Ionic solids; ionic radii, lattice energy (Born-Haber Cycle).

s.p. and d Block Elements: Oxides, halides and hydrides of alkali and alkaline earth metals, B, Al, S, N, P and S, silicones, general characteristics of 3d elements, coordination complexes: valence bond and crystal field theory, color, geometry and magnetic properties.

Chemical Equilibria: Colligative properties of solutions, ionic equilibria in solution, solubility product, common ion effect, hydrolysis of salts, pH, buffer and their applications in chemical analysis.

Electrochemistry: Conductance, Kohlrausch law, Half Cell potentials, emf, Nernst equation, galvanic cells, thermodynamic aspects and their applications.

Reaction Kinetics: Rate constant, order of reaction, molecularity, activation energy, zero, first and second order kinetics, equilibrium constants (Kc, Kp and Kx) for homogeneous reactions, catalysis and elementary enzyme reactions.

Thermodynamics: First law, reversible and irreversible processes, internal energy, enthalpy, Kirchoff's equation, heat of reaction, Hess law, heat of formation, Second law, entropy, free energy, and work function. Gibbs-Helmholtz equation, Clausius-Clapeyron equation, free energy change and equilibrium constant, Troutons rule, Third law of thermodynamics.

Mechanistic Basis of Organic Reactions: Elementary treatment of SN1, SN2, E1 and E2 reactions, Hoffmann and Saytzeff rules, Addition reactions, Markonikoff rule and Kharash effect, Diels-Alder reaction, aromatic electrophilic substitution, orientation effect as exemplified by various functional groups.

Structure-Reactivity Correlations: Acids and bases, electronic and steric effects, optical and geometrical isomerism, tautomerism, concept of aromaticity

SECTION I. BIOCHEMISTRY

Organization of life. Importance of water. Cell structure and organelles. Structure and function of biomolecules: Carbohydrates, Lipids, Proteins and Nucleic acids. Biochemical separation techniques. Spectroscopic methods; UV-visible and fluorescence. Protein structure, folding and function: Myoglobin, Hemoglobin, Lysozyme, ribonuclease A, Carboxypeptidase and Chymotrypsin. Enzyme kinetics and regulation, Coenzymes.

Metabolism and bioenergitics. Generation and utilization of ATP. Photosynthesis. Major metabolic pathways and their regulation. Biological membranes. Transport across membranes. Signal transduction; hormones and neurotransmitters.

DNA replication, transcription and translation. Biochemical regulation of gene expression. Recombinant DNA technology and applications. Genomics and Proteomics.

The immune system. Active and passive immunity. Complement system. Antobody structure, function and diversity. Cells of the immune system: T, B and macrophages. T and B cell activation. Major histocompatibilty complex. T cell receptor. Immunological techniques: Immunodiffusion, immunoelectrophoresis, RIA and ELISA.

SECTION J. BIOTECHNOLOGY

Recombinant DNA technology for the production of therapeutic proteins. Micro array technology. Heterologous protein expression systems in bacteria, yeast etc.

Architecture of plant genome; plant tissue culture techniques; methods of gene transfer into plant cells; manipulation of phenotypic traits in plants; plant cell fermentations and production of secondary metabolites using suspension/ immobilized cell culture; methods for plant micro propagation; crop improvement and development of transgenic plants. Expression of animal proteins in plants.

Animal cell metabolism and regulation; cell cycle; primary cell culture; nutritional requirements for animal cell culture; techniques for the mass culture of animal cell lines; production of vaccines; growth hormones and interferons using animal cell culture; cytokines-production and therapeutic uses; hybridoma technology; vectors for gene transfer and expression in animal cells. Transgenic animals and molecular pharming.

Microbial production of industrial enzymes; methods for immobilization of enzymes; kinetics of soluble and immobilized enzymes; application of soluble and immobilized enzymes; enzyme-based sensors.

Microbial growth kinetics; batch, fed batch and continuous culture of microbial cells; media for industrial fermentations; sterilization of air and media; design features and operation of stirred tank, air-lift and fluidized bed reactors; aeration and agitation in aerobic fermentations; recovery and purification of fermentation products- filtration, centrifugation, cell disintegration, solvent extraction and chromatographic separations; industrial fermentations for the production of ethanol, citric acid, lysine, penicillin and other biomolecules; simple calculations based on material and energy balance of fermentation processes; application of microbes in the management of domestic and industrial wastes.

SECTION K. BOTANY

Anatomy: Roots, stem and leaves of land plants, meristems, vascular system, their ontogeny, structure and functions. Plant cell structure, organisation, organelles, cytoskeleton, cell wall and membranes.

Development: Cell cycle, cell division, senescence, hormonal regulation of growth; life cycle of an angiosperm, pollination, fertilization, embryogenesis, seed formation, seed storage proteins, seed dormancy and germination. Concept of cellular totipotency, organogenesis and somatic embryogenesis, somaclonal variation, embryo culture, in vitro fertilization.

Physiology and Biochemistry: Plant water relations, transport of minerals and solutes, N2 metabolism, proteins and nucleic acid, respiration, photophysiology, photosynthesis, photorespiration; biosynthesis, mechanism of action and physiological effects of plant growth regulators.

Genetics: Principles of Mendelian inheritance, linkage, recombination and genetic mapping; extrachromosomal inheritance; eukaryotic genome organization (chromatin structure) and regulation of gene expression, gene mutation, chromosome aberrations (numerical and structural), transposons.

Plant Breeding: Principles, methods - selection, hybridization, heterosis; male sterility, self and inter-specific incompatibility; haploidy; somatic cell hybridization; molecular marker-assisted selection; gene transfer methods viz. direct and vector-mediated, transgenic plants and their applications in agriculture.

Economic Botany: Economically important plants - cereals, pulses, plants yielding fiber, timber, sugar, beverages, oils, rubber, dyes, gums, drugs and narcotics - a general account.

Systematics: Systems of classification (non-phylogenetic vs. phylogenetic - outline), plant groups, molecular systematics.

Plant Pathology: Nature and classification of plant diseases, diseases of important crops caused by fungi, bacteria and viruses, and their control measures, mechanism(s) of pathogenesis and resistance, molecular detection of pathogens; plant-microbe beneficial interactions.

Ecology and Plant Geography: Ecosystems - types, dynamics, degradation, ecological succession; food chains; vegetation types of the world; pollution and global warming; speciation and extinction, conservation strategies, cryopreservation.

SECTION L. MICROBIOLOGY

Historical perspective - Discovery of the microbial world; Controversy over spontaneous generation; Role of microorganisms in transformation of organic matter and in the causation of diseases.

Methods in microbiology - Pure culture techniques; Theory and practice of sterilization;

Principles of microbial nutrition; Construction of culture media; Enrichment culture techniques for isolation of chemoautotrophs, chemoheterotrophs and photosynthetic microorganisms.

Microbial evolution, systematics and taxonomy - Evolution of earth and earliest life forms; Primitive organisms and their metabolic strategies; New approaches to bacterial taxonomic classification including ribotyping; Nomenclature.

Microbial diversity - Bacteria, archea and their broad classification; Eukaryotic microbes, yeast, fungi, slime mold and protozoa; Viruses and their classification.

Microbial growth -The definition of growth, mathematical expression of growth, growth curve, measurement of growth and growth yields; Synchronous growth; Continuous culture.

Nutrition and metabolism - Overview of metabolism; Microbial nutrition; Energy classes of microorganisms; Culture media; Energetics, modes of ATP generation; ATP generation by heterotrophs; Fermentation; Glycolysis; Respiration; The citric acid cycle; Electron transport systems; Alternate modes of energy generation; Pathways (anabolism) in the biosynthesis of amino acids, purines, pyrimidines and fatty acids.

Metabolic diversity among microorganisms - Photosynthesis in microorganisms; Role of chlorophylls, carotenoids and phycobilins; Calvin cycle; Chemolithotrophy; Hydrogen- iron- nitrite-oxidizing bacteria; Nitrate and sulfate reduction; Methanogenesis and acetogenesis.

Prokaryotic cells: structure-function - Cells walls of eubacteria (peptidoglycan) and related molecules; Outer-membrane of gram-negative bacteria; Cell wall and cell membrane synthesis; Flagella and motility; Cell inclusions like endospores, gas vesicles.

Microbial diseases and host parasite relationships - Normal microflora of skin; Oral cavity; Gastrointestinal tract; Entry of pathogens into the host; Infectious disease transmission; Respiratory infections caused by bacteria and viruses; Tuberculosis; Sexually transmitted diseases including AIDS; Diseases transmitted by animals (Rabies, plague), insects and ticks (rikettsias, Lyme disease, malaria); Food and water borne diseases; Public health and water quality; Pahtogenic fungi; Emerging and resurgent infectious diseases.

Chemotherapy/Antibiotics - Antimicrobial agents; Sulfa drugs; Antibiotics; Pencillins and cephalosporins; Broad-spectrum antibiotics; Antibiotics from prokaryotes; Antifungal antibiotics; Mode of action; Resistance to antibiotics.

Microbial genetics - Genes, mutation and mutagenesis - UV and chemical mutagnes; Types of mutations; Ames test for mutagenesis; Methods of genetic analysis. Bacterial genetic system - Transformation; Conjugation; Transduction; Recombination; Plasmids and Transposons; Bacterial genetic map with reference to E. coli. Viruses and their genetic system - Phage ? and its life cycle; RNA phages; RNA viruses; Retroviruses; Genetic systems of yeast and Neurospora; Extrachromosomal inheritance and mitochondrial genetics; Basic concept of genomics.

SECTION M. ZOOLOGY

Animal world: Animal diversity, distribution, systematic and classification of animals, the phylogenetic relationship.

Evolution: Origin of life, history of life on earth, evolutionary theories, natural selection, adaptation, speciation.

Genetics: Principles of inheritance, molecular basis of heredity, the genetic material, transmission of genetic material, mutations, cytoplasmic inheritance.

Biochemistry and Molecular Biology: Nucleic acids, proteins and other biological macromolecules. Replication, transcription and translation, regulation of gene expression, organization of genome, Kreb's cycle, glycolysis, enzyme catalysis, hormones and their action.

Cell Biology: Structure of cell, cellular organelles and their structure and function, cell cycle, cell division, cellular differentiation, chromosome and chromatin structure. Eukaryotic gene organisation and expression.

Animal Anatomy and Physiology: Comparative physiology, the respiratory system, circulatory system, digestive system, the nervous system, the excretory system, the endocrine system, the reproductive system, the skeletal system, osmoregulation.

Parasitology and Immunology: Nature of parasite, host-parasite relation, protozoan and helminthic parasites, the immune response, cellular and humoral immune response, evolution of the immune system.

Development Biology: Embryonic development, cellular differentiation, organogenesis, metamorphosis, genetic basis of development.

Ecology: The ecosystem, habitats the food chain, population dynamics, species diversity, zoogeography, biogeochemical cycles, conservation biology.

Animal Behaviour: Types of behaviours, courtship, mating and territoriality, instinct, learning and memory, social behaviour across the animal taxa, communication, pheromones, evolution of animal behaviour.

IT - INFORMATION TECHNOLOGY

ENGINEERING MATHEMATICS

Mathematical Logic: Propositional Logic; First Order Logic.

Probability: Conditional Probability; Mean, Median, Mode and Standard Deviation; Random Variables; Distributions; uniform, normal, exponential, Poisson, Binomial.

Set Theory & Algebra: Sets; Relations; Functions; Groups; Partial Orders; Lattice; Boolean Algebra.

Combinatorics: Permutations; Combinations; Counting; Summation; generating functions; recurrence relations; asymptotics.

Graph Theory: Connectivity; spanning trees; Cut vertices & edges; covering; matching; independent sets; Colouring; Planarity; Isomorphism.

Linear Algebra: Algebra of matrices, determinants, systems of linear equations, Eigen values and Eigen vectors.

Numerical Methods: LU decomposition for systems of linear equations; numerical solutions of non linear algebraic equations by Secant, Bisection and Newton-Raphson Methods; Numerical integration by trapezoidal and Simpson's rules.

Calculus: Limit, Continuity & differentiability, Mean value Theorems, Theorems of integral calculus, evaluation of definite & improper integrals, Partial derivatives, Total derivatives, maxima & minima.

FORMAL LANGUAGES AND AUTOMATA

Regular Languages: finite automata, regular expressions, regular grammar.

Context free languages: push down automata, context free grammars

COMPUTER HARDWARE

Digital Logic: Logic functions, minimization, design and synthesis of combinatorial and sequential circuits, number representation and computer arithmetic (fixed and floating point)

Computer organization: Machine instructions and addressing modes, ALU and data path, hardwired and microprogrammed control, memory interface, I/O interface (interrupt and DMA mode), serial communication interface, instruction pipelining, cache, main and secondary storage

SOFTWARE SYSTEMS

Data structures and Algorithms: the notion of abstract data types, stack, queue, list, set, string, tree, binary search tree, heap, graph, tree and graph traversals, connected components, spanning trees, shortest paths, hashing, sorting, searching, design techniques (greedy, dynamic, divide and conquer), asymptotic analysis (best, worst, average cases) of time and space, upper and lower bounds, intractability

Programming Methodology: C programming, program control (iteration, recursion, functions), scope, binding, parameter passing, elementary concepts of object oriented programming

Operating Systems (in the context of Unix): classical concepts (concurrency, synchronization, deadlock), processes, threads and interprocess communication, CPU scheduling, memory management, file systems, I/O systems, protection and security

Information Systems and Software Engineering: information gathering, requirement and feasibility analysis, data flow diagrams, process specifications, input/output design, process life cycle, planning and managing the project, design, coding, testing, implementation, maintenance.

Databases: relational model, database design, integrity constraints, normal forms, query languages (SQL), file structures (sequential, indexed), b-trees, transaction and concurrency control

Data Communication: data encoding and transmission, data link control, multiplexing, packet switching, LAN architecture, LAN systems (Ethernet, token ring), Network devices: switches, gateways, routers

Networks: ISO/OSI stack, sliding window protocols, routing protocols, TCP/UDP, application layer protocols & systems (http, smtp, dns, ftp), network security

Web technologies: three tier web based architecture; JSP, ASP, J2EE, .NET systems; html, XML

AG - AGRICULTURAL ENGINEERING

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

FARM MACHINERY AND POWER:

Sources of power on the farm-human, animal, mechanical, electrical, wind, solar and biomass; design and selection of machine elements - gears, pulleys, chains and sprockets and belts; overload safety devices used in farm machinery; measurement of force, torque, speed, displacement and acceleration on machine elements.

Soil tillage; forces acting on a tillage tool; hitch systems and hitching of tillage implements; functional requirements, principles of working, construction and operation of manual, animal and power operated equipment for tillage. sowing, planting, fertilizer application, inter-cultivation, spraying, mowing, chaff cutting, harvesting, threshing and transport; testing of agricultural machinery and equipment; calculation of performance parameters -field capacity, efficiency, application rate and losses; cost analysis of implements and tractors.

Thermodynamic principles of I.C. engines; I.C. engine cycles; engine components; fuels and combustion; lubricants and their properties; I.C. engine systems - fuel, cooling, lubrication, ignition, electrical, intake and exhaust; selection, operation, maintenance and repair of I.C. engines; power efficiencies and measurement; calculation of power, torque, fuel consumption, heat load and power losses.

Tractors and power tillers - type, selection, maintenance and repair; tractor clutches and brakes; power transmission systems - gear trains, differential, final drives and power take-off; mechanics of tractor chassis; traction theory; three point hitches- free link and restrained link operations; mechanical steering and hydraulic control systems used in tractors; human engineering and safety in tractor design; tractor tests and performance.

SOIL AND WATER CONSERVATION ENGINEERING:

Ideal and real fluids, properties of fluids; hydrostatic pressure and its measurement; hydrostatic forces on plane and curved surface; continuity equation; Bernoulli's theorem; laminar and turbulent flow in pipes, Darcy-Weisbach and Hazen-Williams equations, Moody's diagram; flow through orifices and notches; flow in open channels.

Engineering properties of soils, fundamental definitions and relationships; index properties of soils; permeability and seepage analysis; shear strength, Mohr's circle of stresses; active and passive earth pressures; stability of slopes.

Hydrological cycle; precipitation measurement, analysis of precipitation data; abstraction from precipitation; runoff; hydrograph analysis, unit hydrograph theory and application; stream flow measurement; flood routing, hydrological reservoir and channel routing.

Mechanics of soil erosion, factors affecting erosion; soil loss estimation; biological and engineering measures to control erosion, terraces and bunds; vegetative waterways; gully control structures, drop, drop inlet and chute spillways; farm ponds; earthen dams; principles of watershed management.

Water requirement of crops; consumptive use and evapo-transpiration; irrigation scheduling; irrigation efficiencies; design of prismatic and silt loaded channels; methods of irrigation water application; design and evaluation of irrigation methods; drainage coefficient; surface and subsurface drainage systems; leaching requirement and salinity control; irrigation and drainage water quality; classification of pumps; pump characteristics; pump selection; types of aquifer; evaluation of aquifer properties; well hydraulics; ground water recharge.

AGRICULTURAL PROCESSING AND FOOD ENGINEERING:

Steady state heat transfer in conduction, convection and radiation; transient heat transfer in simple geometry; condensation and boiling heat transfer; working principles of heat exchangers; diffusive and convective mass transfer; simultaneous heat and mass transfer in agricultural processing operations.

Material and energy balances in food processing systems; water activity, sorption and desorption isotherms; centrifugal separation of solids, liquids and gases; kinetics of microbial death - pasteurisation and sterilization of liquid foods; preservation of food by cooling and freezing; psychrometry - properties of air-vapour mixture; concentration and dehydration of liquid foods - evaporators, tray, drum and spray dryers.

Mechanics and energy requirement in size reduction of granular solids; particle size analysis for comminuted solids; size separation by screening; fluidisation of granular solids; cleaning and grading efficiency and effectiveness of grain cleaners; conditioning and hydrothermal treatments for grains; dehydration of food grains; processes and machines for processing of cereals, pulses and oilseeds; design considerations for grain silos.

AR - ARCHITECTURE AND PLANNING

City planning: Historical development of cities; principles of city planning; new towns; survey methods, site planning, planning regulations and building bye-laws.

Housing: Concept of shelter; housing policies and design; community planning; role of government agencies; finance and management.

Landscape Design: Principles of landscape design and site planning; history and landscape styles; landscape elements and materials; planting design.

Computer Aided Design: Application of computers in architecture and planning; understanding elements of hardware and software; computer graphics; programming languages - C and Visual Basic and usage of packages such as AutoCAD.

Environmental and Building Science: Elements of environmental science; ecological principles concerning environment; role of micro-climate in design; climatic control through design elements; thermal comfort; elements of solar architecture; principles of lighting and illumination; basic principles of architectural acoustics; air pollution, noise pollution and their control.

Visual and Urban Design: Principles of visual composition; proportion, scale, rhythm, symmetry, harmony, balance, form and colour; sense of place and space, division of space; focal point, vista, imageability, visual survey.

History of Architecture: Indian - Indus valley, Vedic, Buddhist, Indo-Aryan, Dravidian and Mughal periods; European - Egyptian, Greek, Roman, medieval and renaissance periods.

Development of Contemporary Architecture: Architectural developments and impacts on society since industrial revolution; influence of modern art on architecture; works of national and international architects; post modernism in architecture.

Building Services: Water supply, Sewerage and Drainage systems; Sanitary fittings and fixtures; principles of electrification of buildings; elevators, their standards and uses; air-conditioning systems; fire fighting systems.

Building Construction and Management: Building construction techniques, methods and details; building systems and prefabrication of building elements; principles of modular coordination; estimation, specification, valuation, professional practice; project management, PERT, CPM.

Materials and Structural Systems: Behavioural characteristics of all types of building materials e.g. mud, timber, bamboo, brick, concrete, steel, glass, FRP; principles of strength of materials; design of structural elements in wood, steel and RCC; elastic and limit state design; complex structural systems; principles of pre-stressing.

Planning Theory: Planning process; multilevel planning; comprehensive planning; central place theory; settlement pattern; land use and land utilization.

Techniques of Planning: Planning surveys; Preparation of urban and regional structure plans, development plans, action plans; site planning principles and design; statistical methods; application of remote sensing techniques in urban and regional planning.

Traffic and Transportation Planning: Principles of traffic engineering and transportation planning; methods of conducting surveys; design of roads, intersections and parking areas; hierarchy of roads and levels of services; traffic and transport management in urban areas; traffic safety and traffic laws; public transportation planning; modes of transportation.

Services and Amenities: Principles and design of water supply systems, sewerage systems, solid waste disposal systems, power supply and communication systems; Health, education, recreation and demography related standards at various levels of the settlements.

Development Administration and Management: Planning laws; development control and zoning regulations; laws relating to land acquisition; development enforcements, land ceiling; regional and urban plan preparations; planning and municipal administration; taxation, revenue resources and fiscal management; public participation and role of NGO.

CE - CIVIL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

STRUCTURAL ENGINEERING

Mechanics: Bending moments and shear forces in statically determinate beams; simple stress and strain: relationship; stress and strain in two dimensions, principal stresses, stress transformation, Mohr's circle; simple bending theory; flexural shear stress; thin-walled pressure vessels; uniform torsion.

Structural Analysis: Analysis of statically determinate trusses, arches and frames; displacements in statically determinate structures and analysis of statically indeterminate structures by force/energy methods; analysis by displacement methods (slope-deflection and moment-distribution methods); influence lines for determinate and indeterminate structures; basic concepts of matrix methods of structural analysis.

Concrete Structures: Basic working stress and limit states design concepts; analysis of ultimate load capacity and design of members subject to flexure, shear, compression and torsion (beams, columns and isolated footings); basic elements of prestressed concrete: analysis of beam sections at transfer and service loads.

Steel Structures: Analysis and design of tension and compression members, beams and beam-columns, column bases; connections - simple and eccentric, beam-column connections, plate girders and trusses; plastic analysis of beams and frames.

GEOTECHNICAL ENGINEERING

Soil Mechanics: Origin of soils; soil classification; three-phase system, fundamental definitions, relationship and inter-relationships; permeability and seepage; effective stress principle: consolidation, compaction; shear strength.

Foundation Engineering: Sub-surface investigation - scope, drilling bore holes, sampling, penetrometer tests, plate load test; earth pressure theories, effect of water table, layered soils; stability of slopes - infinite slopes, finite slopes; foundation types - foundation design requirements; shallow foundations; bearing capacity, effect of shape, water table and other factors, stress distribution, settlement analysis in sands and clays; deep foundations - pile types, dynamic and static formulae, load capacity of piles in sands and clays.

WATER RESOURCES ENGINEERING

Fluid Mechanics and Hydraulics: Hydrostatics, applications of Bernoulli equation, laminar and turbulent flow in pipes, pipe networks; concept of boundary layer and its growth; uniform flow, critical flow and gradually varied flow in channels, specific energy concept, hydraulic jump; forces on immersed bodies; flow measurement in channels; tanks and pipes; dimensional analysis and hydraulic modeling. Applications of momentum equation, potential flow, kinematics of flow; velocity triangles and specific speed of pumps and turbines.

Hydrology: Hydrologic cycle; rainfall; evaporation infiltration, unit hydrographs, flood estimation, reservoir design, reservoir and channel routing, well hydraulics.

Irrigation: Duty, delta, estimation of evapo-transpiration; crop water requirements; design of lined and unlined canals; waterways; head works, gravity dams and Ogee spillways. Designs of weirs on permeable foundation, irrigation methods.

ENVIRONMENTAL ENGINEERING

Water requirements; quality and standards, basic unit processes and operations for water treatment, distribution of water. Sewage and sewerage treatment: quantity and characteristic of waste water sewerage; primary and secondary treatment of waste water; sludge disposal; effluent discharge standards.

TRANSPORTATION ENGINEERING

Highway planning; geometric design of highways; testing and specifications of paving materials; design of flexible and rigid pavements.

CH - CHEMICAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

CHEMICAL ENGINEERING

Process Calculations and Thermodynamics: Laws of conservation of mass and energy; use of tie components; recycle, bypass and purge calculations; degree of freedom analysis.

First and Second laws of thermodynamics and their applications; equations of state and thermodynamic properties of real systems; phase equilibria; fugacity, excess properties and correlations of activity coefficients; chemical reaction equilibria.

Fluid Mechanics and Mechanical Operations: Fluid statics, Newtonian and non-Newtonian fluids, Bernoulli equation, Macroscopic friction factors, energy balance, dimensional analysis, shell balances, flow through pipeline systems, flow meters, pumps and compressors, packed and fluidized beds, elementary boundary layer theory, size reduction and size separation; free and hindered settling; centrifuge and cyclones; thickening and classification, filtration, mixing and agitation; conveying of solids.

Heat Transfer: Conduction, convection and radiation, heat transfer coefficients, steady and unsteady heat conduction, boiling, condensation and evaporation; types of heat exchangers and evaporators and their design.

Mass Transfer: Fick's law, molecular diffusion in fluids, mass transfer coefficients, film, penetration and surface renewal theories; momentum, heat and mass transfer analogies; stagewise and continuous contacting and stage efficiencies; HTU & NTU concepts design and operation of equipment for distillation, absorption, leaching, liquid-liquid extraction, crystallization, drying, humidification, dehumidification and adsorption.

Chemical Reaction Engineering: Theories of reaction rates; kinetics of homogeneous reactions, interpretation of kinetic data, single and multiple reactions in ideal reactors, non-ideal reactors; residence time; non-isothermal reactors; kinetics of heterogeneous catalytic reactions; diffusion effects in catalysis.

Instrumentation and Process Control: Measurement of process variables; sensors, transducers and their dynamics, dynamics of simple systems, dynamics such as CSTRs, transfer functions and responses of simple systems, process reaction curve, controller modes (P, PI, and PID); control valves; analysis of closed loop systems including stability, frequency response (including Bode plots) and controller tuning, cascade, feed forward control.

Plant Design and Economics: Design and sizing of chemical engineering equipment such as compressors, heat exchangers, multistage contactors; principles of process economics and cost estimation including total annualized cost, cost indexes, rate of return, payback period, discounted cash flow, optimization in Design.

Chemical Technology: Inorganic chemical industries; sulfuric acid, NaOH, fertilizers (Ammonia, Urea, SSP and TSP); natural products industries (Pulp and Paper, Sugar, Oil, and Fats); petroleum refining and petrochemicals; polymerization industries; polyethylene, polypropylene, PVC and polyester synthetic fibers.

CS - COMPUTER SCIENCE AND ENGINEERING

ENGINEERING MATHEMATICS

Mathematical Logic: Propositional Logic; First Order Logic.

Probability: Conditional Probability; Mean, Median, Mode and Standard Deviation; Random Variables; Distributions; uniform, normal, exponential, Poisson, Binomial.

Set Theory & Algebra: Sets; Relations; Functions; Groups; Partial Orders; Lattice; Boolean Algebra.

Combinatorics: Permutations; Combinations; Counting; Summation; generating functions; recurrence relations; asymptotics.

Graph Theory: Connectivity; spanning trees; Cut vertices & edges; covering; matching; independent sets; Colouring; Planarity; Isomorphism.

Linear Algebra: Algebra of matrices, determinants, systems of linear equations, Eigen values and Eigen vectors.

Numerical Methods: LU decomposition for systems of linear equations; numerical solutions of non linear algebraic equations by Secant, Bisection and Newton-Raphson Methods; Numerical integration by trapezoidal and Simpson's rules.

Calculus: Limit, Continuity & differentiability, Mean value Theorems, Theorems of integral calculus, evaluation of definite & improper integrals, Partial derivatives, Total derivatives, maxima & minima.

THEORY OF COMPUTATION

Formal Languages and Automata Theory: Regular languages and finite automata, Context free languages and Push-down automata, Recursively enumerable sets and Turing machines, Un-decidability;

Analysis of Algorithms and Computational Complexity: Asymptotic analysis (best, worst, average case) of time and space, Upper and lower bounds on the complexity of specific problems, NP-completeness.

COMPUTER HARDWARE

Digital Logic: Logic functions, Minimization, Design and synthesis of Combinational and Sequential circuits; Number representation and Computer Arithmetic (fixed and floating point);

Computer Organization: Machine instructions and addressing modes, ALU and Data-path, hardwired and micro-programmed control, Memory interface, I/O interface (Interrupt and DMA mode), Serial communication interface, Instruction pipelining, Cache, main and secondary storage.

SOFTWARE SYSTEMS

Data structures: Notion of abstract data types, Stack, Queue, List, Set, String, Tree, Binary search tree, Heap, Graph;

Programming Methodology: C programming, Program control (iteration, recursion, Functions), Scope, Binding, Parameter passing, Elementary concepts of Object oriented, Functional and Logic Programming;

Algorithms for problem solving: Tree and graph traversals, Connected components, Spanning trees, Shortest paths; Hashing, Sorting, Searching; Design techniques (Greedy, Dynamic Programming, Divide-and-conquer);

Compiler Design: Lexical analysis, Parsing, Syntax directed translation, Runtime environment, Code generation, Linking (static and dynamic); Operating Systems: Classical concepts (concurrency, synchronization, deadlock), Processes, threads and Inter-process communication, CPU scheduling, Memory management, File systems, I/O systems, Protection and security.

Databases: Relational model (ER-model, relational algebra, tuple calculus), Database design (integrity constraints, normal forms), Query languages (SQL), File structures (sequential files, indexing, B+ trees), Transactions and concurrency control;

Computer Networks: ISO/OSI stack, sliding window protocol, LAN Technologies (Ethernet, Token ring), TCP/UDP, IP, Basic concepts of switches, gateways, and routers.

CH - CHEMISTRY

PHYSICAL CHEMISTRY

Structure: Quantum theory - principles and techniques; applications to particle in a box, harmonic oscillator, rigid rotor and hydrogen atom; valence bond and molecular orbital theories and Huckel approximation, approximate techniques: variation and perturbation; symmetry, point groups; rotational, vibrational, electronic, NMR and ESR spectroscopy.

Equilibrium: First law of thermodynamics, heat, energy and work; second law of thermodynamics and entropy; third law and absolute entropy; free energy; partial molar quantities; ideal and non-ideal solutions; phase transformation: phase rule and phase diagrams- one, two, and three component systems; activity, activity coefficient, fugacity and fugacity coefficient ; chemical equilibrium, response of chemical equilibrium to temperature and pressure; colligative properties; kinetic theory of gases; thermodynamics of electrochemical cells; standard electrode potentials: applications - corrosion and energy conversion; molecular partition function (translational, rotational, vibrational and electronic).

Kinetics: Rates of chemical reactions, theories of reaction rates, collision and transition state theory; temperature dependence of chemical reactions; elementary reactions, consecutive elementary reactions; steady state approximation, kinetics of photochemical reactions and free radical polymerization, homogenous and heterogeneous catalysis.

INORGANIC CHEMISTRY

Non-Transition Elements: General characteristics, structure and reactions of simple and industrially important compounds, boranes, carboranes, silicates, silicones, diamond and graphite; hydrides, oxides and oxoacids of N, P, S and halogens; boron nitride, borazines and phosphazenes; xenon compounds. Shapes of molecules, hard-soft acid base concept.

Transition Elements: General characteristics of d and f block elements; coordination chemistry: structure and isomerism, stability, theories of metal-ligand bonding (CFT and LFT), electronic spectra and magnetic properties of transition metal complexes and lanthanides; metal carbonyls, metal-metal bonds and metal atom clusters, metallocenes; transition metal complexes with bonds to hydrogen, alkyls, alkenes, and arenes; metal carbenes; use of organometallic compounds as catalysts in organic synthesis; mechanisms of substitution and electron transfer reactions of coordination complexes. Role of metals with special reference to Na, K, Mg, Ca, Fe, Co, Zn, and Mo in biological systems.

Solids: Crystal systems and lattices, Miller planes, crystal packing, crystal defects; Bragg's Law; ionic crystals, band theory, metals and semiconductors. Spinels.

Instrumental methods of analysis: atomic absorption, UV-visible spectrometry, chromatographic and electro-analytical methods.

ORGANIC CHEMISTRY

Synthesis, reactions and mechanisms involving the following: Alkenes, alkynes, arenes, alcohols, phenols, aldehydes, ketones, carboxylic acids and their derivatives; halides, nitro compounds and amines; stereochemical and conformational effects on reactivity and specificity; reactions with diborane and peracids. Michael reaction, Robinson annulation, reactivity umpolung, acyl anion equivalents; molecular rearrangements involving electron deficient atoms.

Photochemistry: Basic principles, photochemistry of olefins, carbonyl compounds, arenes, photo oxidation and reduction.

Pericyclic reactions: Cycloadditions, electrocyclic reactions, sigmatropic reactions; Woodward-Hoffmann rules.

Heterocycles: Structural properties and reactions of furan, pyrrole, thiophene, pyridine, indole.

Biomolecules: Structure, properties and reactions of mono- and di-saccharides, physico-chemical properties of amino acids, structural features of proteins and nucleic acids.

Spectroscopy: Principles and applications of IR, UV-visible, NMR and mass spectrometry in the determination of structures of organic compounds.

EC - ELECTRONICS AND COMMUNICATION ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix Algebra, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Mean value theorems, Theorems of integral calculus, Evaluation of definite and improper integrals, Partial Derivatives, Maxima and minima, Multiple integrals, Fourier series. Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equation (linear and nonlinear), Higher order linear differential equations with constant coefficients, Method of variation of parameters, Cauchy's and Euler's equations, Initial and boundary value problems, Partial Differential Equations and variable separable method.

Complex variables: Analytic functions, Cauchy's integral theorem and integral formula, Taylor's and Laurent' series, Residue theorem, solution integrals.

Probability and Statistics: Sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Discrete and continuous distributions, Poisson, Normal and Binomial distribution, Correlation and regression analysis.

Numerical Methods: Solutions of non-linear algebraic equations, single and multi-step methods for differential equations.

Transform Theory: Fourier transform, Laplace transform, Z-transform.

ELECTRONICS & COMMUNICATION ENGINEERING

Networks: Network graphs: matrices associated with graphs; incidence, fundamental cut set and fundamental circuit matrices. Solution methods: nodal and mesh analysis. Network theorems: superposition, Thevenin and Norton's maximum power transfer, Wye-Delta transformation. Steady state sinusoidal analysis using phasors. Linear constant coefficient differential equations; time domain analysis of simple RLC circuits, Solution of network equations using Laplace transform: frequency domain analysis of RLC circuits. 2-port network parameters: driving point and transfer functions. State equations for networks.

Electronic Devices: Energy bands in silicon, intrinsic and extrinsic silicon. Carrier transport in silicon: diffusion current, drift current, mobility, resistivity. Generation and recombination of carriers. p-n junction diode, Zener diode, tunnel diode, BJT, JFET, MOS capacitor, MOSFET, LED, p-I-n and avalanche photo diode, LASERs. Device technology: integrated circuits fabrication process, oxidation, diffusion, ion implantation, photolithography, n-tub, p-tub and twin-tub CMOS process.

Analog Circuits: Equivalent circuits (large and small-signal) of diodes, BJTs, JFETs, and MOSFETs. Simple diode circuits, clipping, clamping, rectifier. Biasing and bias stability of transistor and FET amplifiers. Amplifiers: single-and multi-stage, differential, operational, feedback and power. Analysis of amplifiers; frequency response of amplifiers. Simple op-amp circuits. Filters. Sinusoidal oscillators; criterion for oscillation; single-transistor and op-amp configurations. Function generators and wave-shaping circuits. Power supplies.

Digital circuits: Boolean algebra, minimization of Boolean functions; logic gates digital IC families (DTL, TTL, ECL, MOS, CMOS). Combinational circuits: arithmetic circuits, code converters, multiplexers and decoders. Sequential circuits: latches and flip-flops, counters and shift-registers. Sample and hold circuits, ADCs, DACs. Semiconductor memories. Microprocessor(8085): architecture, programming, memory and I/O interfacing.

Signals and Systems: Definitions and properties of Laplace transform, continuous-time and discrete-time Fourier series, continuous-time and discrete-time Fourier Transform, z-transform. Sampling theorems. Linear Time-Invariant (LTI) Systems: definitions and properties; casuality, stability, impulse response, convolution, poles and zeros frequency response, group delay, phase delay. Signal transmission through LTI systems. Random signals and noise: probability, random variables, probability density function, autocorrelation, power spectral density.

Controls Systems: Basic control system components; block diagrammatic description, reduction of block diagrams. Open loop and closed loop (feedback) systems and stability analysis of these systems. Signal flow graphs and their use in determining transfer functions of systems; transient and steady state analysis of LTI control systems and frequency response. Tools and techniques for LTI control system analysis: root loci, Routh-Hurwitz criterion, Bode and Nyquist plots. Control system compensators: elements of lead and lag compensation, elements of Proportional-Integral-Derivative(PID) control. State variable representation and solution of state equation of LTI control systems.

Communications: Analog communication systems: amplitude and angle modulation and demodulation systems, spectral analysis of these operations, superheterodyne receivers; elements of hardware, realizations of analog communication systems; signal-to-noise ratio (SNR) calculations for amplitude modulation (AM) and frequency modulation (FM) for low noise conditions. Digital communication systems: pulse code modulation (PCM), differential pulse code modulation (DPCM), delta modulation (DM); digital modulation schemes-amplitude, phase and frequency shift keying schemes (ASK, PSK, FSK), matched filter receivers, bandwith consideration and probability of error calculations for these schemes.

Electromagnetics: Elements of vector calculus: divergence and curl; Gauss' and Stokes' theorems, Maxwell's equations: differential and integral forms. Wave equation, Poynting vector. Plane waves: propagation through various media; reflection and refraction; phase and group velocity; skin depth. Transmission lines: characteristic impedance; impedance transformation; Smith chart; impedance matching; pulse excitation. Waveguides: modes in rectangular waveguides; boundary conditions; cut-off frequencies; dispersion relations. Antennas: Dipole antennas; antenna arrays; radiation pattern; reciprocity theorem, antenna gain.

EE - ELECTRICAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix Algebra, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Mean value theorems, Theorems of integral calculus, Evaluation of definite and improper integrals, Partial Derivatives, Maxima and minima, Multiple integrals, Fourier series. Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equation (linear and nonlinear), Higher order linear differential equations with constant coefficients, Method of variation of parameters, Cauchy's and Euler's equations, Initial and boundary value problems, Partial Differential Equations and variable separable method.

Complex variables: Analytic functions, Cauchy's integral theorem and integral formula, Taylor's and Laurent' series, Residue theorem, solution integrals.

Probability and Statistics: Sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Discrete and continuous distributions, Poisson, Normal and Binomial distribution, Correlation and regression analysis.

Numerical Methods: Solutions of non-linear algebraic equations, single and multi-step methods for differential equations.

Transform Theory: Fourier transform, Laplace transform, Z-transform.

ELECTRICAL ENGINEERING

Electrical Circuits and Fields: Network graph, KCL, KVL, node/ cut set, mesh/ tie set analysis, transient response of d.c. and a.c. networks; sinusoidal steady-state analysis; resonance in electrical circuits; concepts of ideal voltage and current sources, network theorems, driving point, immittance and transfer functions of two port networks, elementary concepts of filters; three phase circuits; Fourier series and its application; Gauss theorem, electric field intensity and potential due to point, line, plane and spherical charge distribution, dielectrics, capacitance calculations for simple configurations; Ampere's and Biot-Savart's law, inductance calculations for simple configurations.

Electrical Machines: Single phase transformer - equivalent circuit, phasor diagram, tests, regulation and efficiency; three phase transformers - connections, parallel operation; auto transformer and three-winding transformer; principles of energy conversion, windings of rotating machines: D. C. generators and motors - characteristics, starting and speed control, armature reaction and commutation; three phase induction motors-performance characteristics, starting and speed control; single-phase induction motors; synchronous generators-performance, regulation, parallel operation; synchronous motors - starting, characteristics, applications, synchronous condensers; fractional horse power motors; permanent magnet and stepper motors.

Power Systems: Electric power generation - thermal, hydro, nuclear; transmission line parameters; steady-state performance of overhead transmission lines and cables and surge propagation; distribution systems, insulators, bundle conductors, corona and radio interference effects; per-unit quantities; bus admittance and impedance matrices; load flow; voltage control and power factor correction; economic operation; symmetrical components, analysis of symmetrical and unsymmetrical faults; principles of over current, differential and distance protections; concept of solid state relays and digital protection; circuit breakers; concept of system stability-swing curves and equal area criterion; basic concepts of HVDC transmission.

Control Systems: Principles of feedback; transfer function; block diagrams: steady-state errors; stability-Routh and Nyquist criteria; Bode plots; compensation; root loci; elementary state variable formulation; state transition matrix and response for Linear Time Invariant systems.

Electrical and Electronic Measurements: Bridges and potentiometers, PMMC, moving iron, dynamometer and induction type instruments; measurement of voltage, current, power, energy and power factor; instrument transformers; digital voltmeters and multimeters; phase, time and frequency measurement; Q-meter, oscilloscopes, potentiometric recorders, error analysis.

Analog and Digital Electronics: Characteristics of diodes, BJT, FET, SCR; amplifiers-biasing, equivalent circuit and frequency response; oscillators and feedback amplifiers, operational amplifiers- characteristics and applications; simple active filters; VCOs and timers; combinational and sequential logic circuits, multiplexer, Schmitt trigger, multivibrators, sample and hold circuits, A/D and D/A converters; microprocessors and their applications.

Power Electronics and Electric Drives: Semiconductor power devices-diodes, transistors, thyristors, triacs, GTOs, MOSFETs and IGBTs - static characteristics and principles of operation; triggering circuits; phase control rectifiers; bridge converters-fully controlled and half controlled; principles of choppers and inverters, basic concepts of adjustable speed dc and ac drives.

GG - GEOLOGY AND GEOPHYSICS

PART - I

Earth and planetary system; size, shape, internal structure and composition of the earth; atmosphere and greenhouse effect; isostasy; elements of seismology; continents and continental processes; physical oceanography; palaeomagnetism, continental drift plate tectonics, geothermal energy.

Weathering; soil formation; action of river, wind and glacier; oceans and oceanic features; earthquakes, volcanoes, orogeny and mountain building; elements of structural geology; crystallography; classification, composition and properties of minerals and rocks; engineering properties of rocks and soils, role of geology in the construction of engineering structures.

Processes of ore formation, occurrence and distribution of ores on land and on ocean floor; coal and petroleum resources in India; ground water geology including well hydraulics, geological time scale and geochronology; stratigraphic principles and stratigraphy of India; basics concepts of gravity, magnetic and electrical prospecting for ores and ground water.

PART - IIA: GEOLOGY

Crystal symmetry, forms, twinning; crystal chemistry; optical mineralogy, classification of minerals, diagnostic properties of rock minerals.

Mineralogy, structure, texture and classification of igneous, sedimentary and metamorphic rock, their origin and evolution; application of thermodynamics; structure and petrology of sedimentary rocks; sedimentary processes and environments, sedimentary facies, basin studies; basement cover relationship;

Primary and secondary structures; geometry and genesis of folds, faults, joints, unconformities, cleavage, schistosity and lineation; methods of projection. Tectonites and their significance; shear zone; superposed folding.

Morphology, classification and geological significance of important invertebrates, vertebrates, microfossils and palaeoflora; stratigraphic principles and Indian stratigraphy; geomorphic processes and agents; development and evolution of landforms; slope and drainage; processes on deep oceanic and near-shore regions; quantitative and applied geomorphology; air photo interpretation and remote sensing; chemical and optical properties of ore minerals; formation and localization of ore deposits; prospecting and exploration of economic minerals; coal and petroleum geology; origin and distribution of mineral and fuel deposits in India; ore dressing and mineral economics.

Cosmic abundance; meteorites; geochemical evolution of the earth; geochemical cycles; distribution of major, minor and trace elements; isotope geochemistry; geochemistry of waters including solution equilibria and water rock interaction.

Engineering properties of rocks and soils; rocks as construction material; geology of dams, tunnels and excavation sites; natural hazards; the fly ash problem; ground water geology and exploration; water quality; impact of human activity; Remote sensing techniques for the interpretation of landforms and resource management.

PART - II B: GEOPHYSICS

The earth as a planet; different motions of the earth; gravity filed of the earth and its shape; geochronology; isostasy, seismology and interior of the earth; variation of density, velocity, pressure, temperature, electrical and magnetic properties inside the earth; earthquakes-causes and measurements; zonation and seismic hazards; geomagnetic field, palaeomagnetism; oceanic and continental lithosphere; plate tectonics; heat flow; upper and lower atmospheric phenomena.

Theories of scalar and vector potential fields; Laplace, Maxwell and Helmholtz equations for solution of different types of boundary value problems for Cartesian, cylindrical and spherical polar coordinates; Green's theorem; Image theory; integral equations and conformal transformations in potential theory; Eikonal equation and ray theory.

'G' and 'g' units of measurement, density of rocks, gravimeters, preparation, analysis and interpretation of gravity maps; derivative maps, analytical continuation; gravity anomaly type curves; calculation of mass.

Earth's magnetic field, units of measurement, magnetic susceptibility of rocks, magnetometers, corrections, preparation of magnetic maps, magnetic anomaly type curve, analytical continuation, interpretation and application; magnetic well logging.

Conduction of electricity through rocks, electrical conductivities of metals, metallic, non-metallic and rock forming minerals, D.C. resistivity units and methods of measurement, electrode configuration for sounding and profiling, application of filter theory, interpretation of resistivity field data, application; self potential origin, classification, field measurement, interpretation of induced polarization time frequency, phase domain; IP units and methods of measurement, interpretation and application; ground-water exploration.

Origin of electromagnetic field elliptic polarization, methods of measurement for different source-receiver configuration components in EM measurements, interpretation and applications; earth's natural electromagnetic field, tellurics, magneto-tellurics; geomagnetic depth sounding principles, methods of measurement, processing of data and interpretation.

Seismic methods of prospecting: Reflection, refraction and CDP surveys; land and marine seismic sources, generation and propagation of elastic waves, velocity increasing with depth, geophones, hydrophones, recording instruments (DFS), digital formats, field layouts, seismic noises and noise profile analysis, optimum geophone grouping, noise cancellation by shot and geophone arrays, 2D and 3D seismic data acquisition and processing, CDP stacking charts, binning, filtering, dip-moveout, static and dynamic corrections, deconvolution, migration, signal processing, Fourier and Hilbert transforms, attribute analysis, bright and dim spots, seismic stratigraphy, high resolution seismics, VSP.

Principles and techniques of geophysical well-logging, SP, resistivity, induction, micro gamma ray, neutron, density, sonic, temperature, dip meter, caliper, nuclear magnetic, cement bond logging. Quantitative evaluation of formations from well logs; well hydraulics and application of geophysical methods for groundwater study; application of bore hole geophysics in ground water, mineral and oil exploration. Remote sensing techniques and application of remote sensing methods in geophysics.

IN - INSTRUMENTATION ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix Algebra, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Mean value theorems, Theorems of integral calculus, Evaluation of definite and improper integrals, Partial Derivatives, Maxima and minima, Multiple integrals, Fourier series. Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equation (linear and nonlinear), Higher order linear differential equations with constant coefficients, Method of variation of parameters, Cauchy's and Euler's equations, Initial and boundary value problems, Partial Differential Equations and variable separable method.

Complex variables: Analytic functions, Cauchy's integral theorem and integral formula, Taylor's and Laurent' series, Residue theorem, solution integrals.

Probability and Statistics: Sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Discrete and continuous distributions, Poisson, Normal and Binomial distribution, Correlation and regression analysis.

Numerical Methods: Solutions of non-linear algebraic equations, single and multi-step methods for differential equations.

Transform Theory: Fourier transform, Laplace transform, Z-transform.

INSTRUMENTATION ENGINEERING

Measurement Basics and Metrology: Static and dynamic characteristics of measurement systems. Standards and calibration. Error and uncertainty analysis, statistical analysis of data, and curve fitting. Linear and angular measurements; Measurement of straightness, flatness, roundness and roughness.

Transducers, Mechanical Measurements and Industrial Instrumentation: Transducers - elastic, resistive, inductive, capacitive, thermo-electric, piezoelectric, photoelectric, electro-mechanical, electro-chemical, and ultrasonic. Measurement of displacement, velocity (linear and rotational), acceleration, shock, vibration, force, torque, power, strain, stress, pressure, flow, temperature, humidity, viscosity, and density. energy storing elements, suspension systems and dampers.

Analog Electronics: Characteristics of diodes, BJTs, JFETs and MOSFETs; Diode circuits; Amplifiers: single and multi-stage, feedback; Frequency response; Operational amplifiers - design, characteristic, linear and non-linear applications: difference amplifiers; instrumentation amplifiers; precision rectifiers, I-to-V converters, active filters, oscillators, comparators, signal generators, wave shaping circuits.

Digital Electronics: Combinational logic circuits, minimization of Boolean functions; IC families (TTL, MOS, CMOS), arithmetic circuits, multiplexer and decoders. Sequential circuits: flip-flops, counters, shift registers. Schmitt trigger, timers, and multivibrators. Analog switches, multiplexers, S/H circuits. Analog-to-digital and digital-to-analog converters. Basics of computer organization and architecture. 8-bit microprocessor (8085), applications, memory, I/O interfacing, and microcontrollers.

Signals and Systems: Vectors and matrices; Fourier series; Fourier transforms; Ordinary differential equations. Impulse and frequency responses of first and second order systems. Laplace transform and transfer function, convolution and correlation. Amplitude and frequency modulations and demodulations. Discrete time systems, difference equations, impulse and frequency responses; Z-transforms and transfer functions; IIR and FIR filters.

Electrical and Electronic Measurements: Measurement of R, L and C; bridges and potentiometers. Measurement of voltage, current, power, power factor, and energy; Instrument transformers; Q meter, waveform analyzers. Digital volt-meters and multi-meters. Time, phase and frequency measurements; Oscilloscope. Noise and interference in instrumentation.

Control Systems & Process Control: Principles of feedback; transfer function, signal flow graphs. Stability criteria, Bode plots, root-loci, Routh and Nyquist criteria. Compensation techniques; State space analysis. System components: mechanical, hydraulic, pneumatic, electrical and electronic; Servos and synchros; Stepper motors. On-off, cascade, P, PI, PID and feed-forward controls. Controller tuning and general frequency response.

Analytical, Optical and Biomedical Instrumentation: Principles of spectrometry, UV, visible, IR mass spectrometry, X-ray methods; nuclear radiation measurements, gas, solid and semi conductor lasers and their characteristics, interferometers, basics of fibre optics, transducers in biomedical applications, cardiovascular system measurements, instrumentation for clinical laboratory.

MA - MATHEMATICS

Linear Algebra: Finite dimensional vector spaces. Linear transformations and their matrix representations, rank; systems of linear equations, eigenvalues and eigenvectors, minimal polynomial, Cayley-Hamilton theorem, diagonalisation, Hermitian, Skew-Hermitian and unitary matrices. Finite dimensional inner product spaces, self-adjoint and Normal linear operators, spectral theorem, Quadratic forms.

Complex Analysis: Analytic functions, conformal mappings, bilinear transformations, complex integration: Cauchy's integral theorem and formula, Liouville's theorem, maximum modulus principle, Taylor and Laurent's series, residue theorem and applications for evaluating real integrals.

Real Analysis: Sequences and series of functions, uniform convergence, power series, Fourier series, functions of several variables, maxima, minima, multiple integrals, line, surface and volume integrals, theorems of Green, Stokes and Gauss; metric spaces, completeness, Weierstrass approximation theorem, compactness. Lebesgue measure, measurable functions; Lebesgue integral, Fatou's lemma, dominated convergence theorem.

Ordinary Differential Equations: First order ordinary differential equations, existence and uniqueness theorems, systems of linear first order ordinary differential equations, linear ordinary differential equations of higher order with constant coefficients; linear second order ordinary differential equations with variable coefficients, method of Laplace transforms for solving ordinary differential equations, series solutions; Legendre and Bessel functions and their orthogonality, Sturm Liouville system, Greeen's functions.

Algebra: Normal subgroups and homomorphisms theorems, automorphisms. Group actions, sylow's theorems and their applications groups of order less than or equal to 20, Finite p-groups. Euclidean domains, Principal ideal domains and unique factorizations domains. Prime ideals and maximal ideals in commutative rings.

Functional Analysis: Banach spaces, Hahn-Banach theorems, open mapping and closed graph theorems, principle of uniform boundedness; Hilbert spaces, orthonormal sets, Riesz representation theorem, self-adjoint, unitary and normal linear operators on Hilbert Spaces.

Numerical Analysis: Numerical solution of algebraic and transcendental equations; bisection, secant method, Newton-Raphson method, fixed point iteration, interpolation: existence and error of polynomial interpolation, Lagrange, Newton, Hermite(osculatory)interpolations; numerical differentiation and integration, Trapezoidal and Simpson rules; Gaussian quadrature; (Gauss-Legendre and Gauss-Chebyshev), method of undetermined parameters, least square and orthonormal polynomial approximation; numerical solution of systems of linear equations: direct and iterative methods, (Jacobi Gauss-Seidel and SOR) with convergence; matrix eigenvalue problems: Jacobi and Given's methods, numerical solution of ordinary differential equations: initial value problems, Taylor series method, Runge-Kutta methods, predictor-corrector methods; convergence and stability.

Partial Differential Equations: Linear and quasilinear first order partial differential equations, method of characteristics; second order linear equations in two variables and their classification; Cauchy, Dirichlet and Neumann problems, Green's functions; solutions of Laplace, wave and diffusion equations in two variables Fourier series and transform methods of solutions of the above equations and applications to physical problems.

Mechanics: Forces in three dimensions, Poinsot central axis, virtual work, Lagrange's equations for holonomic systems, theory of small oscillations, Hamiltonian equations;

Topology: Basic concepts of topology, product topology, connectedness, compactness, countability and separation axioms, Urysohn's Lemma, Tietze extension theorem, metrization theorems, Tychonoff theorem on compactness of product spaces.

Probability and Statistics: Probability space, conditional probability, Bayes' theorem, independence, Random variables, joint and conditional distributions, standard probability distributions and their properties, expectation, conditional expectation, moments. Weak and strong law of large numbers, central limit theorem. Sampling distributions, UMVU estimators, sufficiency and consistency, maximum likelihood estimators. Testing of hypotheses, Neyman-Pearson tests, monotone likelihood ratio, likelihood ratio tests, standard parametric tests based on normal, X2 ,t, F-distributions. Linear regression and test for linearity of regression. Interval estimation.

Linear Programming: Linear programming problem and its formulation, convex sets their properties, graphical method, basic feasible solution, simplex method, big-M and two phase methods, infeasible and unbounded LPP's, alternate optima. Dual problem and duality theorems, dual simplex method and its application in post optimality analysis, interpretation of dual variables. Balanced and unbalanced transportation problems, unimodular property and u-v method for solving transportation problems. Hungarian method for solving assignment problems.

Calculus of Variations and Integral Equations: Variational problems with fixed boundaries; sufficient conditions for extremum, Linear integral equations of Fredholm and Volterra type, their iterative solutions. Fredholm alternative.

ME - MECHANICAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

APPLIED MECHANICS AND DESIGN

Engineering Mechanics: Equivalent force systems, free-body concepts, equations of equilibrium, trusses and frames, virtual work and minimum potential energy. Kinematics and dynamics of particles and rigid bodies, impulse and momentum (linear and angular), energy methods, central force motion.

Strength of Materials: Stress and strain, stress-strain relationship and elastic constants, Mohr's circle for plane stress and plane strain, shear force and bending moment diagrams, bending and shear stresses, deflection of beams, torsion of circular shafts, thin and thick cylinders, Euler's theory of columns, strain energy methods, thermal stresses.

Theory of Machines: Displacement, velocity and acceleration, analysis of plane mechanisms, dynamic analysis of slider-crank mechanism, planar cams and followers, gear tooth profiles, kinematics of gears, governors and flywheels, balancing of reciprocating and rotating masses.

Vibrations: Free and forced vibration of single degree freedom systems, effect of damping, vibration isolation, resonance, critical speed of rotors.

Design of Machine Elements: Design for static and dynamic loading, failure theories, fatigue strength; design of bolted, riveted and welded joints; design of shafts and keys; design of spur gears, rolling and sliding contact bearings; brakes and clutches; belt, rope and chain drives.

FLUID MECHANICS AND THERMAL SCIENCES

Fluid Mechanics: Fluid properties, fluid statics, manometry, buoyancy; control-volume analysis of mass, momentum and energy; fluid acceleration; differential equations of continuity and momentum; Bernoulli's equation; viscous flow of incompressible fluids; boundary layer; elementary turbulent flow; flow through pipes, head losses in pipes, bends etc.

Heat-Transfer: Modes of heat transfer; one dimensional heat conduction, resistance concept, electrical analogy, unsteady heat conduction, fins; dimensionless parameters in free and forced convective heat transfer, various correlations for heat transfer in flow over flat plates and through pipes; thermal boundary layer; effect of turbulence; radiative heat transfer, black and grey surfaces, shape factors, network analysis; heat exchanger performance, LMTD and NTU methods.

Thermodynamics: Zeroth, First and Second laws of thermodynamics; thermodynamic system and processes; irreversibility and availability; behaviour of ideal and real gases, properties of pure substances, calculation of work and heat in ideal processes; analysis of thermodynamic cycles related to energy conversion; Carnot, Rankine, Otto, Diesel, Brayton and vapour compression cycles.

Power Plant Engineering: Steam generators; steam power cycles; steam turbines; impulse and reaction principles, velocity diagrams, pressure and velocity compounding; reheating and reheat factor; condensers and feed heaters.

I.C. Engines: Requirements and suitability of fuels in IC engines, fuel ratings, fuel-air mixture requirements; normal combustion in SI and CI engines; engine performance calculations.

Refrigeration and air-conditioning: Refrigerant compressors, expansion devices, condensers and evaporators; properties of moist air, psychrometric chart, basic psychometric processes.

Turbomachinery: Components of gas turbines; compression processes, centrifugal and axial flow compressors; axial flow turbines, elementary theory; hydraulic turbines; Euler-turbine equation; specific speed, Pelton-wheel, Francis and Kaplan turbines; centrifugal pumps.

MANUFACTURING AND INDUSTRIAL ENGINEERING

Engineering Materials: Structure and properties of engineering materials and their applications, heat treatment.

Metal Casting: Casting processes (expendable and non-expendable) -pattern, moulds and cores, heating and pouring, solidification and cooling, gating design, design considerations, defects.

Forming Processes: Stress-strain diagrams for ductile and brittle material, Plastic deformation and yield criteria, fundamentals of hot and cold working processes, Bulk metal forming processes (forging, rolling, extrusion, drawing), sheet metal working processes (punching, blanking, bending, deep drawing, coining, spinning, load estimation using homogeneous deformation methods, defects). processing of powder metals- atomization, compaction, sintering, secondary and finishing operations. forming and shaping of plastics- extrusion, injection moulding.

Joining Processes: Physics of welding, fusion and non-fusion welding processes, brazing and soldering, adhesive bonding, design considerations in welding, weld quality defects.

Machining and Machine Tool Operations: Mechanics of machining, single and multi-point cutting tools, tool geometry and materials, tool life and wear, cutting fluids, machinability, economics of machining, non-traditional machining processes.

Metrology and Inspection: Limits, fits and tolerances, linear and angular measurements, comparators, gauge design, interferometry, form and finish measurement, measurement of screw threads, alignment and testing methods.

Tool Engineering: Principles of work holding, design of jigs and fixtures.

Computer Integrated Manufacturing: Basic concepts of CAD, CAM and their integration tools.

Manufacturing Analysis: Part-print analysis, tolerance analysis in manufacturing and assembly, time and cost analysis.

Work-Study: Method study, work measurement, time study, work sampling, job evaluation, merit rating.

Production Planning and Control: Forecasting models, aggregate production planning, master scheduling, materials requirements planning.

Inventory Control: Deterministic and probabilistic models, safety stock inventory control systems.

Operations Research: Linear programming, simplex and duplex method, transportation, assignment, network flow models, simple queuing models, PERT and CPM

MN - MINING ENGINEERING

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

MINING ENGINEERING

Mechanics: Equivalent force systems, equations of equilibrium, two dimensional frames and trusses, free body diagrams, friction forces, particle kinematics and dynamics.

Mine Development, Geomechanics and Strata Control: Drivages for underground mine development, drilling methods and machines, explosives, blasting devices and practices, shaft sinking. Physico-mechanical properties of rocks, rock mass classification, ground control instrumentation and stress measurement techniques, theories of rock failure, ground vibrations, stress distribution around mine openings, subsidence, design of supports in roadways and workings, stability of open pits, slopes.

Mining Methods and Machinery: Surface mining - layout, development, loading, transportation and mechanization, continuous surface mining systems. Underground coal mining - bord and pillar system, longwall mining, thick seam mining methods. Underground metal mining: different stoping methods, stope mechanization, ore handling systems, mine filling.

Generation and transmission of mechanical, hydraulic, and pneumatic power. Materials handling - haulages, conveyors, ropeways, face and development machinery, hoisting systems, and pumps.

Ventilation, Underground Hazards and Surface Environment: Underground atmosphere, heat load sources and thermal environment, air cooling, mechanics of air flow distribution, natural and mechanical ventilation, mine fans and their usage, auxiliary ventilation. Subsurface hazards from fires, explosions, gases, dust, and inundation, rescue apparatus and practices, safety in mines, accident analysis, noise, mine lighting. Air and water pollution: causes, dispersion, quality standards, and control.

Surveying, Mine Planning and Systems Engineering: Fundamentals of engineering surveying, Levels and levelling, Theodolite, tacheometry, triangulation, contouring, errors and adjustments, correlation, underground surveying, curves, photogrammetry, field astronomy, GPS fundamentals. Principles of planning - Sampling methods and practices, reserve estimation techniques, basics of geostatistics, optimization of facility location, cash flow concepts and mine valuation, open pit design. Work study, concepts of reliability, reliability of series and parallel systems. Linear programming, transportation and assignment problems, queueing, network analysis, inventory control.

MT - METALLURGICAL ENGINEERING

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

METALLURGICAL ENGINEERING

Thermodynamics and Rate Processes: Laws of thermodynamics, activity, equilibrium constant, applications to metallurgical systems, solutions, phase equilibria, basic kinetic laws, order of reactions, rate constants and rate limiting steps principles of electro chemistry, aqueous, corrosion and protection of metals, oxidation and high temperature corrosion - characterization and control; momentum transfer - concepts of viscosity, shell balances, Bernoulli's equation; heat transfer - conduction, convection and heat transfer coefficient relations, radiation, mass transfer - diffusion and Fick's laws.

Extractive Metallurgy: Flotation, gravity and other methods of mineral processing; agglomeration, pyro-hydro-and electro-metallurgical processes; material and energy balances; principles and processes for the extraction of non-ferrous metals - aluminium, copper, zinc, lead, magnesium, nickel, titanium and other rare metals; iron and steel making - principles, blast furnace, direct reduction processes, primary and secondary steel making, deoxidation and inclusion in steel; ingot and continuous casting; stainless steel making, design of furnaces; fuels and refractories.

Physical Metallurgy: Crystal structure and bonding characteristics of metals, alloys, ceramics and polymers; solid solutions; solidification; phase transformation and binary phase diagrams; principles of heat treatment of steels, aluminum alloys and cast irons; recovery, recrystallization and grain growth; industrially important ferrous and non-ferrous alloys; elements of X-ray and electron diffraction; principles of scanning and transmission electron microscopy; elements of ceramics, composites and electronic materials; electronic basis of thermal, optical, electrical and magnetic properties of materials.

Mechanical Metallurgy: Elements of elasticity and plasticity; defects in crystals; elements of dislocation theory - types of dislocations, slip and twinning, stress fields of dislocations, dislocation interactions and reactions, methods of seeing dislocations; strengthening mechanisms; tensile, fatigue and creep behaviour; superplasticity; fracture - Griffith theory, ductile to brittle transition, fracture toughness; failure analysis; mechanical testing - tension, compression, torsion, hardness, impact, creep, fatigue, fracture toughness and formability tests.

Manufacturing Processes: Metal casting - patterns, moulds, melting, gating, feeding and casting processes, defects and castings, hot and cold working of metals; Metal forming - fundamentals of metal forming, rolling wire drawing, extrusion, forming, sheet metal forming processes, defects in forming; Metal joining - soldering, brazing and welding, common welding processes, welding metallurgy, problems associated with welding of steels and aluminium alloys, defects in welding, powder metallurgy; NDT methods - ultrasonic, radiography, eddy current, acoustic emission and magnetic.

PH - PHYSICS

Mathematical Physics: Linear vector space, matrices; vector calculus; linear differential equations; elements of complex analysis; Laplace transforms, Fourier analysis, elementary ideas about tensors.

Classical Mechanics: Conservation laws; central forces; collisions and scattering in laboratory and centre of mass reference frames; mechanics of system of particles; rigid body dynamics; moment of inertia tensor; noninertial frames and pseudo forces; variational principle; Lagrange's and Hamilton's formalisms; equation of motion, cyclic coordinates, Poisson bracket; periodic motion, small oscillations, normal modes; wave equation and wave propagation; special theory of relativity - Lorentz transformations, relativistic kinematics, mass-energy equivalence.

Electromagnetic Theory: Laplace and Poisson equations; conductors and dielectrics; boundary value problems; Ampere's and Biot-Savart's laws; Faraday's law; Maxwell's equations; scalar and vector potentials; Coulomb and Lorentz gauges; boundary conditions at interfaces; electromagnetic waves; interference, diffraction and polarization; radiation from moving charges.

Quantum Mechanics: Physical basis of quantum mechanics; uncertainty principle; Schrodinger equation; one and three dimensional potential problems; Particle in a box, harmonic oscillator, hydrogen atom; linear vectors and operators in Hilbert space; angular momentum and spin; addition of angular momentum; time independent perturbation theory; elementary scattering theory.

Atomic and Molecular Physics: Spectra of one-and many-electron atoms; LS and jj coupling; hyperfine structure; Zeeman and Stark effects; electric dipole transitions and selection rules; X-ray spectra; rotational and vibrational spectra of diatomic molecules; electronic transition in diatomic molecules, Franck-Condon principle; Raman effect; NMR and ESR; lasers.

Thermodynamics and Statistical Physics: Laws of thermodynamics; macrostates, phase space; probability ensembles; partition function, free energy, calculation of thermodynamic quantities; classical and quantum statistics; degenerate Fermi gas; black body radiation and Planck's distribution law; Bose-Einstein condensation; first and second order phase transitions, critical point.

Solid State Physics: Elements of crystallography; diffraction methods for structure determination; bonding in solids; elastic properties of solids; defects in crystals; lattice vibrations and thermal properties of solids; free electron theory; band theory of solids; metals, semiconductors and insulators; transport properties; optical, dielectric and magnetic properties of solids; elements of superconductivity.

Nuclear and Particle Physics: Rutheford scattering; basic properties of nuclei; radioactive decay; nuclear forces; two nucleon problem; nuclear reactions; conservation laws; fission and fusion; nuclear models; particle accelerators, detectors; elementary particles; photons, baryons, mesons and leptons; Quark model.

Electronics: Network analysis; semiconductor devices; bipolar transistors; FETs; power supplies, amplifier, oscillators; operational amplifiers; elements of digital electronics; logic circuits.

PI - PRODUCTION AND INDUSTRIAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

GENERAL ENGINEERING:

Engineering Materials: Structure and properties of engineering materials and their applications; effect of strain, strain rate and temperature on mechanical properties of metals and alloys; heat treatment of metals and alloys.

Applied Mechanics: Engineering mechanics - equivalent force systems, free body concepts, equations of equilibrium, virtual work and minimum potential energy; strength of materials-stress, strain and their relationship, Mohr's circle, deflection of beams, bending and shear stress, Euler's theory of columns.

Theory of Machines and Design: Analysis of planar mechanisms, plane cams and followers; governers and fly wheels; design of elements-failure theories; design of bolted, riveted and welded joints; design of shafts, keys, belt drives, brakes and clutches.

Thermal Engineering: Fluid machines - fluid statics, Bernoulli's equation, flow through pipes, equations of continuity and momentum; Thermodynamics - zeroth, First and Second laws of thermodynamics, thermodynamic system and processes, calculation of work and heat for systems and control volumes; Heat transfer - fundamentals of conduction, convection and radiation.

PRODUCTION ENGINEERING

Metal Casting: Casting processes; patterns-materials; allowances; moulds and cores - materials, making and testing; melting and founding of cast iron, steels and nonferrous metals and alloys; solidification; design of casting, gating and risering; casting defects and inspection.

Metal working: Stress-strain in elastic and plastic deformation; deformation mechanisms; hot and cold working-forging, rolling, extrusion, wire and tube drawing; sheet metal working; analysis of rolling, forging, extrusion and wire /rod drawing; metal working defects, high energy rate forming processes-explosive, magnetic, electro and electrohydraulic.

Metal Joining Processes: Welding processes - gas shielded metal arc, TIG, MIG, submerged arc, electroslag, thermit, resistance, pressure and forge welding; thermal cutting; other joining processes - soldering, brazing, braze welding; welding codes, welding symbols, design of welded joints, defects and inspection; introduction to modern welding processes - friction, ultrasonic, explosive, electron beam, laser and plasma.

Machining and Machine Tool Operations: Machining processes-turning, drilling, boring, milling, shaping, planing, sawing, gear cutting, thread production, broaching, grinding, lapping, honing super finishing; mechanics of cutting- Merchant's analysis, geometry of cutting tools, cutting forces, power requirements; selection of process parameters; tool materials, tool wear and tool life, cutting fluids, machinability; nontraditional machining processes and hybrid processes- EDM, CHM, ECM, USM, LBM, EBM, AJM, PAM AND WJM; economics of machining.

Metrology and Inspection: Limits and fits, linear and angular measurements by mechanical and optical methods, comparators; design of limit gauges; interferometry; measurement of straightness, flatness, roundness, squareness and symmetry; surface finish measurement; inspection of screw threads and gears; alignment testing.

Powder Metallurgy and Processing of Plastics: Production of powders, compaction, sintering; Polymers and composites; injection, compression and blow molding, extrusion, calendaring and thermoforming; molding of composites.

Tool Engineering: Work-holding-location and clamping; principles and methods; design of jigs and fixtures; design of press working tools, forging dies.

Manufacturing Analysis: Sources of errors in manufacturing; process capability; part-print analysis; tolerance analysis in manufacturing and assembly; process planning; parameter selection and comparison of production alternatives; time and cost analysis; Issues in choosing manufacturing technologies and strategies.

Computer Integrated Manufacturing: Basic concepts of CAD, CAM, CAPP, group technology, NC, CNC, DNC, FMS, Robotics and CIM.

INDUSTRIAL ENGINEERING

Product Design and Development: Principles of good product design, component and tolerance design; efficiency, quality and cost considerations; product life cycle; standardization, simplification, diversification, value analysis, concurrent engineering.

Engineering Economy and Costing: Financial statements; elementary cost accounting, methods of depreciation; break-even analysis, techniques for evaluation of capital investments.

Work System Design: Taylor's scientific management, Gilbreths's contributions; productivity concepts and measurements; method study, micro-motion study, principles of motion economy; human factors engineering, ergonomics; work measurement - time study, PMTS, work sampling; job evaluation, merit rating, wage administration, incentive systems; business process reengineering.

Logistics and Facility Design: Facility location factors, evaluation of alternatives, types of plant layout, evaluation; computer aided layout; assembly line balancing; material handling systems; supply chain management.

Production Planning and Inventory Control: Inventory Function costs, classifications - deterministic and probabilistic models; quantity discount; safety stock; inventory control system; Forecasting techniques - causal and time series models, moving average, exponential smoothing; trend and seasonality; aggregate production planning; master scheduling; bill of materials and material requirement planning; order control and flow control, routing, scheduling and priority dispatching; JIT; Kanban PULL systems; bottleneck scheduling and theory of constraints.

Operation Research: Linear programming - problem formulation, simplex method, duality and sensitivity analysis; transportation; assignment; network flow models, constrained optimization and Lagrange multipliers; simple queuing models; dynamic programming; simulation; PERT and CPM, time-cost trade-off, resource leveling.

Quality Control: Taguchi method; design of experiments; quality costs, statistical quality assurance, process control charts, acceptance sampling, zero defects; quality circles, total quality management.

Reliability and Maintenance: Reliability, availability and maintainability; probabilistic failure and repair times; system reliability; preventive maintenance and replacement, TPM.

Management Information System: Value of information; information storage and retrieval system - database and data structures; interactive systems; knowledge based systems.

Intellectual Property System: Definition of intellectual property, importance of IPR; TRIPS, and its implications, WIPO and Global IP structure, and IPS in India; patent, copyright, industrial design and trademark; meanings, rules and procedures, terms, infringements and remedies.

PY - PHARMACEUTICAL SCIENCES

Natural Products: Pharmacognosy & Phytochemistry - Chemistry, tests, isolation, characterization and estimation of phytopharmaceuticals belonging to the group of Alkaloids, Glycosides, Terpenoids, Steroids, Bioflavanoids, Purines, Guggul lipids. Pharmacognosy of crude drugs which contain the above constituents. Standardisation of raw materials and herbal products. WHO guide lines. Quantitative microscopy including modern techniques used for evaluation. Biotechnological principles and techniques for plant development Tissue culture.

Pharmacology: General pharmacological principles including Toxicology. Drug interaction. Pharmacology of drugs acting on Central nervous system, Cardiovascular system, Autonomic nervous system, Gastro intestinal system and Respiratory system. Pharmacology of Autocoids, Hormones, Chemotherapeutic agents including anticancer drugs. Bioassays. Immuno Pharmacology.

Medicinal Chemistry: Structure, nomenclature, classification, synthesis, SAR and metabolism of the following category of drugs which are official in Indian Pharmacopoeia and British Pharmacopoeia Hypnotics and Sedatives, Analgesics, NSAIDS, Neuroleptics, Antidepressants, Anxiolytics, Anticonvulsants, Antihistaminics, Local anaesthetics, Cardio Vascular drugs - Antianginal agents Vasodilators, Adrenergic & cholinergic drugs, Cardiotonic agents, Diuretics, Antihypertensive drugs, Hypoglycemic agents, Antilipedmic agents, Coagulants, Anticoagulants, Antiplatelet agents. Chemotherapeutic agents - Antibiotics, Antibacterials, Sulphadrugs. Antiproliozoal drugs, Antiviral, Antitubercular, Antimalarial, Anticancer, Antiamoebic drugs. Diagnostic agents. Preparation and storage and uses of official Radiopharmaceuticals. Vitamins and Hormones.

Pharmaceutics: Development, manufacturing standards, labeling, packing as per the pharmacopoeal requirements, Storage of different dosage forms and new drug delivery systems. Biopharmaceutics and Pharmacokinetics and their importance in formulation. Formulation and preparation of cosmetics - lipstick, shampoo, creams, nail preparations and dentifrices. Pharmaceutical calculations.

Pharmaceutical Jurisprudence: Legal aspects of manufacture, storage, sale of drugs. D and C act and rules. Pharmacy act.

Pharmaceutical Analysis: Principles, instrumentation and applications of the following. Absorption spectroscopy (UV, visible & IR), Fluorimetry, Flame photometry, Potentiometry, Conductometry and Plarography. Pharmacopoeial assays. Principles of NMR, ESR, Mass spectroscopy, X-ray diffraction analysis and different chromatographic methods.

Biochemistry and Clinical Pharmacy: Biochemical role of hormones, Vitamins, Enzymes, Nucleic acids. Bioenergetics. General principles of immunology. Immunological techniques. Adverse drug interaction.

Microbiology: Principles and methods of microbiological assays of the Pharmacopoeia. Methods of preparation of official sera and vaccines. Serological and diagnostic tests. Applications of microorganisms in Bio Conversions and in Pharmaceutical industry.

TF - TEXTILE ENGINEERING AND FIBRE SCIENCE

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

TEXTILE ENGINEERING & FIBRE SCIENCE

Textile Fibres: Classification of textile fibres according to their nature and origin; general characteristics of textile fibres-their chemical and physical structures and their properties; essential characteristics of fibre forming polymers; uses of natural and man-made fibres; physical and chemical methods of fibre and blend identification and blend analysis.

Melt Spinning processes with special reference to polyamide and polyester fibres; wet and dry spinning of viscose and acrylic fibres; post spinning operations-drawing, heat setting, texturing- false twist and air-jet, tow-to-top conversion. Methods of investigating fibre structure e.g. X-ray diffraction, birefringence, optical and electron microscopy, I.R. absorption, thermal methods; structure and morphology and principal natural and man-made fibres, mechanical properties of fibres, moisture sorption in fibres; fibre structure and property correlation.

Textile Testing: Sampling techniques, sample size and sampling errors; measurement of fibre length, fineness, crimp, strength and reflectance; measurement of cotton fibre maturity ad trash content; HVI and AFIS for fibre testing. Measurement of yarn count, twist and hairiness; tensile testing of fibres, yarn and fabrics; evenness testing of slivers, rovings and yarns; testing equipment for measurement test methods of fabric properties like thickness, compressibility, air permeability, drape, crease recovery, tear strength bursting strength and abrasion resistance. Correlation analysis, significance tests and analysis of variance; frequency distributions and control charts.

Yarn Manufacture and Yarn Structure: Modern methods of opening, cleaning and blending of fibrous materials; the technology of carding with particular reference to modern developments; causes of irregularity introduced by drafting, the development of modern drafting systems; principles and techniques of preparing material for combing; recent development in combers; functions and synchronization of various mechanisms concerned with roving production; forces acting on yarn and traveller, ring and traveller designs; causes of end breakages; properties of doubles yarns; new methods of yarn production such as rotor spinning, air jet spinning and friction spinning.

Yarn diameter; specific volume, packing coefficient; twist-strength relationship; fibre orientation in yarn; fibre migration.

Fabric Manufacture and Fabric Structure: Principles of cheese and cone winding processes and machines; random and precision winding; package faults and their remedies; yarn clearers and tensioners; different systems of yarn splicing; features of modern cone winding machines; different types of warping creels; features of modern beam and sectional warping machines; different sizing systems, sizing of spun and filament yarns, modern sizing machines; principles of pirn winding processes and machines; primary and secondary motions of loom, effect of their settings and timings on fabric formation, fabric appearance and weaving performance; dobby and jacquard shedding; mechanics of weft insertion with shuttle; warp and weft stop motions, warp protection, weft replenishment; functional principles of weft insertion systems of shuttleless weaving machines, principles of multiphase and circular looms. Principles of weft and warp knitting; basic weft and warp knitted structures; classification, production and areas of application of nonwoven fabrics.

Basic woven fabric constructions and their derivatives; crepe, cord, terry, gauze, lino and double cloth constructions.

Peirce's equations for fabric geometry; thickness, cover and maximum sett of woven fabrics

Textile Chemical Processing: Preparatory processes for natural-and and their blends; mercerization of cotton; machines for yarn and fabric mercerization.

Dyeing and printing of natural- and synthetic- fibre fabrics and their blends with different dye classes; dyeing and printing machines; styles of printing; fastness properties of dyed and printed textile materials.

Finishing of textile materials, wash and wear, durable press, soil release, water repellent, flame retardant and antistatic finishes; shrink-resistance finish for wool; heat setting of synthetic-fibre fabrics, finishing machines; energy efficient processes; pollution control.

XE - ENGINERING SCIENCES

The syllabi of the sections of this paper are as follows:

SECTION A. ENGINEERING MATHEMATICS (Compulsory)

Linear Algebra : Determinates, algebra of matrices, rank, inverse, system of linear equations, symmetric, skew-symmetric and orthogonal matrices. Hermitian, skew-hermitian and unitary matrices. eigenvalues and eigenvectors, diagonalisation of matrices, Cayley-Hamiltonian, quadratic forms.

Calculus : Functions of single variables, limit, continuity and differentiability, Mean value theorems, Intermediate forms and L'Hospital rule, Maxima and minima, Taylor's series, Fundamental and mean value-theorems of integral calculus. Evaluation of definite and improper integrals, Beta and Gamma functions, Functions of two variables, limit, continuity, partial derivatives, Euler's theorem for homogeneous functions, total derivatives, maxima and minima, Lagrange method of multipliers, double and triple integrals and their applications, sequence and series, tests for convergence, power series, Fourier Series, Fourier integrals.

Complex variable: Analytic functions, Cauchy's integral theorem and integral formula without proof. Taylor's and Laurent' series, Residue theorem (without proof) with application to the evaluation of real integarls.

Vector Calculus: Gradient, divergence and curl, vector identities, directional derivatives, line, surface and volume integrals, Stokes, Gauss and Green's theorems (without proofs) with applications.

Ordinary Differential Equations: First order equation (linear and nonlinear), higher order linear differential equations with constant coefficients, method of variation of paramaters, Cauchy's and Euler's equations, initial and boundary value problems, power series solutions, Legendre polynomials and Bessel's functions of the first kind.

Partial Differential Equations: Variables separable method, solutions of one dimensional heat, wave and Laplace equations.

Probability and Statistics: Definitions of probability and simple theorems, conditional probability, mean, mode and standard deviation, random variables, discrete and continuous distributions, Poisson, normal and Binomial distribution, correlation and regression

Numerical Methods: L-U decomposition for systems of linear equations,Newton-Raphson method, numerical integration(trapezoidal and Simpson's rule), numerical methods for first order differential equation (Euler method)

SECTION B. COMPUTATIONAL SCIENCE

Numerical Methods: Truncation errors, round off errors and their propagation; Interpolation; Lagrange, Newton's forward, backward and divided difference formulas, least square curve fitting, solution of non-linear equations of one variables using bisection, false position, secant and Newton Raphson methods; Rate of convergence of these methods, general iterative methods. Simple and multiple roots of polynomials. Solutions of system of linear algebraic equations using Gauss elimination methods, Jacobi and Gauss-Seidel iterative methods and their rate of convergence; ill conditioned and well conditioned system. eigen values and eigen vectors using power methods. Numerical integration using trapezoidal, Simpson's rule and other quadrature formulas. Numerical Differentiation. Solution of boundary value problems. Solution of initial value problems of ordinary differential equations using Euler's method, predictor corrector and Runge Kutta method.

Programming : Elementary concepts and terminology of a computer system and system software, Fortran77 and C programming.

Fortran : Program organization, arithmetic statements, transfer of control, Do loops, subscripted variables, functions and subroutines.

C language : Basic data types and declarations, flow of control- iterative statement, conditional statement, unconditional branching, arrays, functions and procedures.

SECTION C. ELECTRICAL SCIENCES

Electric Circuits: Ideal voltage and current sources; RLC circuits, steady state and transient analysis of DC circuits, network theorems; alternating currents and voltages, single-phase AC circuits, resonance; three-phase circuits.

Magnetic circuits: Mmf and flux, and their relationship with voltage and current; transformer, equivalent circuit of a practical transformer, three-phase transformer connections.

Electrical machines: Principle of operation, characteristics, efficiency and regulation of DC and synchronous machines; equivalent circuit and performance of three-phase and single-phase induction motors.

Electronic Circuits: Characteristics of p-n junction diodes, zener diodes, bipolar junction transistors (BJT) and junction field effect transistors (JFET); MOSFET's structure, characteristics, and operations; rectifiers, filters, and regulated power supplies; biasing circuits, different configurations of transistor amplifiers, class A, B and C of power amplifiers; linear applications of operational amplifiers; oscillators; tuned and phase shift types.

Digital circuits: Number systems, Boolean algebra; logic gates, combinational circuits, flip-flops (RS, JK, D and T) counters.

Measuring instruments: Moving coil, moving iron, and dynamometer type instruments; shunts, instrument transformers, cathode ray oscilloscopes; D/A and A/D converters.

SECTION D. FLUID MECHANICS

Fluid Properties: Relation between stress and strain rate for Newtonian fluids

Hydrostatics, buoyancy, manometry

Concept of local and convective accelerations; control volume analysis for mass, momentum and energy conservation.

Differential equations of continuity and momentum (Euler's equation of motion); concept of fluid rotation, stream function, potential function; Bernoulli's equation and its applications.

Qualitative ideas of boundary layers and its separation; streamlined and bluff bodies; drag and lift forces.

Fully-developed pipe flow; laminar and turbulent flows; friction factor; Darcy Weisbach relation; Moody's friction chart; losses in pipe fittings; flow measurements using venturimeter and orifice plates.

Dimensional analysis; similitude and concept of dynamic similarity; importance of dimensionless numbers in model studies.

SECTION E. MATERIALS SCIENCE

Atomic structure and bonding in materials: metals, ceramics and polymers.

Structure of materials: Crystal systems, unit cells and space lattice; determination of structures of simple crystals by X-ray diffraction; Miller indices for planes and directions. Packing geometry in metallic, ionic and covalent solids.

Concept of amorphous, single and polycrystalline structures and their effects on properties of materials.

Imperfections in crystalline solids and their role in influencing various properties.

Fick´s laws of diffusion and applications of diffusion in sintering, doping of semiconductors and surface hardening of metals.

Alloys: solid solution and solubility limit. Binary phase diagram, intermediate phases and intermetallic compounds; iron-iron carbide phase diagram. Phase transformation in steels. Cold and hot working of metals, recovery, recrystallization and grain growth.

Properties and applications of ferrous and nonferrous alloys.

Structure, properties, processing and applications of traditional and advanced ceramics.

Polymers: classification, polymerization, structure and properties, additives for polymer products, processing and application.

Composites: properties and application of various composites.

Corrosion and environmental degradation of materials (metals, ceramics and polymers).

Mechanical properties of materials: Stress-strain diagrams of metallic, ceramic and polymeric materials, modulus of elasticity, yield strength, plastic deformation and toughness, tensile strength and elongation at break; viscoelasticity, hardness, impact strength. ductile and brittle fracture. creep and fatigue properties of materials.

Heat capacity, thermal conductivity, thermal expansion of materials.

Concept of energy band diagram for materials; conductors, semiconductors and insulators in terms of energy bands. Electrical conductivity, effect of temperature on conductivity in materials, intrinsic and extrinsic semiconductors, dielectric properties of materials.

Refraction, reflection, absorption and transmission of electromagnetic radiation in solids.

Origin of magnetism in metallic and ceramic materials, paramagnetism, diamagnetism, antiferromagnetism, ferromagnetism, ferrimagnetism in materials and magnetic hysteresis.

Advanced materials: Smart materials exhibiting ferroelectric, piezoelectric, optoelectronic, semiconducting behaviour; lasers and optical fibers; photoconductivity and superconductivity in materials.

SECTION F. SOLID MECHANICS

Equivalent force systems; free-body diagrams; equilibrium equations; analysis of determinate and indeterminate trusses and frames; friction.

Simple relative motion of particles; force as function of position, time and speed; force acting on a body in motion; laws of motion; law of conservation of energy; law of conservation of momentum

Stresses and strains; principal stresses and strains; Mohr's circle; generalized Hooke's Law; equilibrium equations; compatibility conditions; yield criteria.

Axial, shear and bending moment diagrams; axial, shear and bending stresses; deflection (for symmetric bending); torsion in circular shafts; thin cylinders; energy methods (Castigliano's Theorems); Euler buckling.

SECTION G. THERMODYNAMICS

Basic Concepts: Continuum, macroscopic approach, thermodynamic system (closed and open or control volume); thermodynamic properties and equilibrium; state of a system, state diagram, path and process; different modes of work; Zeroth law of thermodynamics; concept of temperature; heat.

First Law of Thermodynamics: Energy, enthalpy, specific heats, first law applied to systems and control volumes, steady and unsteady flow analysis.

Second Law of Thermodynamics: Kelvin-Planck and Clausius statements, reversible and irreversible processes, Carnot theorems, thermodynamic temperature scale, Clausius inequality and concept of entropy, principle of increase of entropy; availability and irreversibility.

Properties of Pure Substances: Thermodynamic properties of pure substances in solid, liquid and vapour phases, P-V-T behaviour of simple compressible substances, phase rule, thermodynamic property tables and charts, ideal and real gases, equations of state, compressibility chart.

Thermodynamic Relations: T-ds relations, Maxwell equations, Joule-Thomson coefficient, coefficient of volume expansion, adiabatic and isothermal compressibilities, Clapeyron equation.

Ideal Gas Mixtures: Dalton's and Amagat's laws, calculations of properties, air-water vapour mixtures.

XL - LIFE SCIENCES

The syllabi of the Sections of this paper are as follows:

SECTION H. CHEMISTRY (Compulsory)

Atomic structure and periodicity: Quantum chemistry; Planck's quantum theory, wave particle duality, uncertainty principle, quantum mechanical model of hydrogen atom; electronic configuration of atoms; periodic table and periodic properties; ionization energy, election affinity, electronegativity, atomic size.

Structure and bonding: Ionic and covalent bonding M.O. and V.B. approaches for diatomic molecules, VSEPR theory and shape of molecules, hybridisation, resonance, dipole moment, structure parameters such as bond length, bond angle and bond energy, hydrogen bonding, van der Waals interactions. Ionic solids; ionic radii, lattice energy (Born-Haber Cycle).

s.p. and d Block Elements: Oxides, halides and hydrides of alkali and alkaline earth metals, B, Al, S, N, P and S, silicones, general characteristics of 3d elements, coordination complexes: valence bond and crystal field theory, color, geometry and magnetic properties.

Chemical Equilibria: Colligative properties of solutions, ionic equilibria in solution, solubility product, common ion effect, hydrolysis of salts, pH, buffer and their applications in chemical analysis.

Electrochemistry: Conductance, Kohlrausch law, Half Cell potentials, emf, Nernst equation, galvanic cells, thermodynamic aspects and their applications.

Reaction Kinetics: Rate constant, order of reaction, molecularity, activation energy, zero, first and second order kinetics, equilibrium constants (Kc, Kp and Kx) for homogeneous reactions, catalysis and elementary enzyme reactions.

Thermodynamics: First law, reversible and irreversible processes, internal energy, enthalpy, Kirchoff's equation, heat of reaction, Hess law, heat of formation, Second law, entropy, free energy, and work function. Gibbs-Helmholtz equation, Clausius-Clapeyron equation, free energy change and equilibrium constant, Troutons rule, Third law of thermodynamics.

Mechanistic Basis of Organic Reactions: Elementary treatment of SN1, SN2, E1 and E2 reactions, Hoffmann and Saytzeff rules, Addition reactions, Markonikoff rule and Kharash effect, Diels-Alder reaction, aromatic electrophilic substitution, orientation effect as exemplified by various functional groups.

Structure-Reactivity Correlations: Acids and bases, electronic and steric effects, optical and geometrical isomerism, tautomerism, concept of aromaticity

SECTION I. BIOCHEMISTRY

Organization of life. Importance of water. Cell structure and organelles. Structure and function of biomolecules: Carbohydrates, Lipids, Proteins and Nucleic acids. Biochemical separation techniques. Spectroscopic methods; UV-visible and fluorescence. Protein structure, folding and function: Myoglobin, Hemoglobin, Lysozyme, ribonuclease A, Carboxypeptidase and Chymotrypsin. Enzyme kinetics and regulation, Coenzymes.

Metabolism and bioenergitics. Generation and utilization of ATP. Photosynthesis. Major metabolic pathways and their regulation. Biological membranes. Transport across membranes. Signal transduction; hormones and neurotransmitters.

DNA replication, transcription and translation. Biochemical regulation of gene expression. Recombinant DNA technology and applications. Genomics and Proteomics.

The immune system. Active and passive immunity. Complement system. Antobody structure, function and diversity. Cells of the immune system: T, B and macrophages. T and B cell activation. Major histocompatibilty complex. T cell receptor. Immunological techniques: Immunodiffusion, immunoelectrophoresis, RIA and ELISA.

SECTION J. BIOTECHNOLOGY

Recombinant DNA technology for the production of therapeutic proteins. Micro array technology. Heterologous protein expression systems in bacteria, yeast etc.

Architecture of plant genome; plant tissue culture techniques; methods of gene transfer into plant cells; manipulation of phenotypic traits in plants; plant cell fermentations and production of secondary metabolites using suspension/ immobilized cell culture; methods for plant micro propagation; crop improvement and development of transgenic plants. Expression of animal proteins in plants.

Animal cell metabolism and regulation; cell cycle; primary cell culture; nutritional requirements for animal cell culture; techniques for the mass culture of animal cell lines; production of vaccines; growth hormones and interferons using animal cell culture; cytokines-production and therapeutic uses; hybridoma technology; vectors for gene transfer and expression in animal cells. Transgenic animals and molecular pharming.

Microbial production of industrial enzymes; methods for immobilization of enzymes; kinetics of soluble and immobilized enzymes; application of soluble and immobilized enzymes; enzyme-based sensors.

Microbial growth kinetics; batch, fed batch and continuous culture of microbial cells; media for industrial fermentations; sterilization of air and media; design features and operation of stirred tank, air-lift and fluidized bed reactors; aeration and agitation in aerobic fermentations; recovery and purification of fermentation products- filtration, centrifugation, cell disintegration, solvent extraction and chromatographic separations; industrial fermentations for the production of ethanol, citric acid, lysine, penicillin and other biomolecules; simple calculations based on material and energy balance of fermentation processes; application of microbes in the management of domestic and industrial wastes.

SECTION K. BOTANY

Anatomy: Roots, stem and leaves of land plants, meristems, vascular system, their ontogeny, structure and functions. Plant cell structure, organisation, organelles, cytoskeleton, cell wall and membranes.

Development: Cell cycle, cell division, senescence, hormonal regulation of growth; life cycle of an angiosperm, pollination, fertilization, embryogenesis, seed formation, seed storage proteins, seed dormancy and germination. Concept of cellular totipotency, organogenesis and somatic embryogenesis, somaclonal variation, embryo culture, in vitro fertilization.

Physiology and Biochemistry: Plant water relations, transport of minerals and solutes, N2 metabolism, proteins and nucleic acid, respiration, photophysiology, photosynthesis, photorespiration; biosynthesis, mechanism of action and physiological effects of plant growth regulators.

Genetics: Principles of Mendelian inheritance, linkage, recombination and genetic mapping; extrachromosomal inheritance; eukaryotic genome organization (chromatin structure) and regulation of gene expression, gene mutation, chromosome aberrations (numerical and structural), transposons.

Plant Breeding: Principles, methods - selection, hybridization, heterosis; male sterility, self and inter-specific incompatibility; haploidy; somatic cell hybridization; molecular marker-assisted selection; gene transfer methods viz. direct and vector-mediated, transgenic plants and their applications in agriculture.

Economic Botany: Economically important plants - cereals, pulses, plants yielding fiber, timber, sugar, beverages, oils, rubber, dyes, gums, drugs and narcotics - a general account.

Systematics: Systems of classification (non-phylogenetic vs. phylogenetic - outline), plant groups, molecular systematics.

Plant Pathology: Nature and classification of plant diseases, diseases of important crops caused by fungi, bacteria and viruses, and their control measures, mechanism(s) of pathogenesis and resistance, molecular detection of pathogens; plant-microbe beneficial interactions.

Ecology and Plant Geography: Ecosystems - types, dynamics, degradation, ecological succession; food chains; vegetation types of the world; pollution and global warming; speciation and extinction, conservation strategies, cryopreservation.

SECTION L. MICROBIOLOGY

Historical perspective - Discovery of the microbial world; Controversy over spontaneous generation; Role of microorganisms in transformation of organic matter and in the causation of diseases.

Methods in microbiology - Pure culture techniques; Theory and practice of sterilization; Principles of microbial nutrition; Construction of culture media; Enrichment culture techniques for isolation of chemoautotrophs, chemoheterotrophs and photosynthetic microorganisms.

Microbial evolution, systematics and taxonomy - Evolution of earth and earliest life forms; Primitive organisms and their metabolic strategies; New approaches to bacterial taxonomic classification including ribotyping; Nomenclature.

Microbial diversity - Bacteria, archea and their broad classification; Eukaryotic microbes, yeast, fungi, slime mold and protozoa; Viruses and their classification.

Microbial growth -The definition of growth, mathematical expression of growth, growth curve, measurement of growth and growth yields; Synchronous growth; Continuous culture.

Nutrition and metabolism - Overview of metabolism; Microbial nutrition; Energy classes of microorganisms; Culture media; Energetics, modes of ATP generation; ATP generation by heterotrophs; Fermentation; Glycolysis; Respiration; The citric acid cycle; Electron transport systems; Alternate modes of energy generation; Pathways (anabolism) in the biosynthesis of amino acids, purines, pyrimidines and fatty acids.

Metabolic diversity among microorganisms - Photosynthesis in microorganisms; Role of chlorophylls, carotenoids and phycobilins; Calvin cycle; Chemolithotrophy; Hydrogen- iron-nitrite-oxidizing bacteria; Nitrate and sulfate reduction; Methanogenesis and acetogenesis.

Prokaryotic cells: structure-function - Cells walls of eubacteria (peptidoglycan) and related molecules; Outer-membrane of gram-negative bacteria; Cell wall and cell membrane synthesis; Flagella and motility; Cell inclusions like endospores, gas vesicles.

Microbial diseases and host parasite relationships - Normal microflora of skin; Oral cavity; Gastrointestinal tract; Entry of pathogens into the host; Infectious disease transmission; Respiratory infections caused by bacteria and viruses; Tuberculosis; Sexually transmitted diseases including AIDS; Diseases transmitted by animals (Rabies, plague), insects and ticks (rikettsias, Lyme disease, malaria); Food and water borne diseases; Public health and water quality; Pahtogenic fungi; Emerging and resurgent infectious diseases.

Chemotherapy/Antibiotics - Antimicrobial agents; Sulfa drugs; Antibiotics; Pencillins and cephalosporins; Broad-spectrum antibiotics; Antibiotics from prokaryotes; Antifungal antibiotics; Mode of action; Resistance to antibiotics.

Microbial genetics - Genes, mutation and mutagenesis - UV and chemical mutagnes; Types of mutations; Ames test for mutagenesis; Methods of genetic analysis. Bacterial genetic system - Transformation; Conjugation; Transduction; Recombination; Plasmids and Transposons; Bacterial genetic map with reference to E. coli. Viruses and their genetic system - Phage ? and its life cycle; RNA phages; RNA viruses; Retroviruses; Genetic systems of yeast and Neurospora; Extrachromosomal inheritance and mitochondrial genetics; Basic concept of genomics.

SECTION M. ZOOLOGY

Animal world: Animal diversity, distribution, systematic and classification of animals, the phylogenetic relationship.

Evolution: Origin of life, history of life on earth, evolutionary theories, natural selection, adaptation, speciation.

Genetics: Principles of inheritance, molecular basis of heredity, the genetic material, transmission of genetic material, mutations, cytoplasmic inheritance.

Biochemistry and Molecular Biology: Nucleic acids, proteins and other biological macromolecules. Replication, transcription and translation, regulation of gene expression, organization of genome, Kreb's cycle, glycolysis, enzyme catalysis, hormones and their action.

Cell Biology: Structure of cell, cellular organelles and their structure and function, cell cycle, cell division, cellular differentiation, chromosome and chromatin structure. Eukaryotic gene organisation and expression.

Animal Anatomy and Physiology: Comparative physiology, the respiratory system, circulatory system, digestive system, the nervous system, the excretory system, the endocrine system, the reproductive system, the skeletal system, osmoregulation.

Parasitology and Immunology: Nature of parasite, host-parasite relation, protozoan and helminthic parasites, the immune response, cellular and humoral immune response, evolution of the immune system.

Development Biology: Embryonic development, cellular differentiation, organogenesis, metamorphosis, genetic basis of development.

Ecology: The ecosystem, habitats the food chain, population dynamics, species diversity, zoogeography, biogeochemical cycles, conservation biology.

Animal Behaviour: Types of behaviours, courtship, mating and territoriality, instinct, learning and memory, social behaviour across the animal taxa, communication, pheromones, evolution of animal behaviour.

IT - INFORMATION TECHNOLOGY

ENGINEERING MATHEMATICS

Mathematical Logic: Propositional Logic; First Order Logic.

Probability: Conditional Probability; Mean, Median, Mode and Standard Deviation; Random Variables; Distributions; uniform, normal, exponential, Poisson, Binomial.

Set Theory & Algebra: Sets; Relations; Functions; Groups; Partial Orders; Lattice; Boolean Algebra.

Combinatorics: Permutations; Combinations; Counting; Summation; generating functions; recurrence relations; asymptotics.

Graph Theory: Connectivity; spanning trees; Cut vertices & edges; covering; matching; independent sets; Colouring; Planarity; Isomorphism.

Linear Algebra: Algebra of matrices, determinants, systems of linear equations, Eigen values and Eigen vectors.

Numerical Methods: LU decomposition for systems of linear equations; numerical solutions of non linear algebraic equations by Secant, Bisection and Newton-Raphson Methods; Numerical integration by trapezoidal and Simpson's rules.

Calculus: Limit, Continuity & differentiability, Mean value Theorems, Theorems of integral calculus, evaluation of definite & improper integrals, Partial derivatives, Total derivatives, maxima & minima.

FORMAL LANGUAGES AND AUTOMATA

Regular Languages: finite automata, regular expressions, regular grammar.

Context free languages: push down automata, context free grammars

COMPUTER HARDWARE

Digital Logic: Logic functions, minimization, design and synthesis of combinatorial and sequential circuits, number representation and computer arithmetic (fixed and floating point)

Computer organization: Machine instructions and addressing modes, ALU and data path, hardwired and microprogrammed control, memory interface, I/O interface (interrupt and DMA mode), serial communication interface, instruction pipelining, cache, main and secondary storage

SOFTWARE SYSTEMS

Data structures and Algorithms: the notion of abstract data types, stack, queue, list, set, string, tree, binary search tree, heap, graph, tree and graph traversals, connected components, spanning trees, shortest paths, hashing, sorting, searching, design techniques (greedy, dynamic, divide and conquer), asymptotic analysis (best, worst, average cases) of time and space, upper and lower bounds, intractability

Programming Methodology: C programming, program control (iteration, recursion, functions), scope, binding, parameter passing, elementary concepts of object oriented programming

Operating Systems (in the context of Unix): classical concepts (concurrency, synchronization, deadlock), processes, threads and interprocess communication, CPU scheduling, memory management, file systems, I/O systems, protection and security

Information Systems and Software Engineering: information gathering, requirement and feasibility analysis, data flow diagrams, process specifications, input/output design, process life cycle, planning and managing the project, design, coding, testing, implementation, maintenance.

Databases: relational model, database design, integrity constraints, normal forms, query languages (SQL), file structures (sequential, indexed), b-trees, transaction and concurrency control

Data Communication: data encoding and transmission, data link control, multiplexing, packet switching, LAN architecture, LAN systems (Ethernet, token ring), Network devices: switches, gateways, routers

Networks: ISO/OSI stack, sliding window protocols, routing protocols, TCP/UDP, application layer protocols & systems (http, smtp, dns, ftp), network security

Web technologies: three tier web based architecture; JSP, ASP, J2EE, .NET systems; html, XML

AG - AGRICULTURAL ENGINEERING

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

FARM MACHINERY AND POWER:

Sources of power on the farm-human, animal, mechanical, electrical, wind, solar and biomass; design and selection of machine elements - gears, pulleys, chains and sprockets and belts; overload safety devices used in farm machinery; measurement of force, torque, speed, displacement and acceleration on machine elements.

Soil tillage; forces acting on a tillage tool; hitch systems and hitching of tillage implements; functional requirements, principles of working, construction and operation of manual, animal and power operated equipment for tillage. sowing, planting, fertilizer application, inter-cultivation, spraying, mowing, chaff cutting, harvesting, threshing and transport; testing of agricultural machinery and equipment; calculation of performance parameters -field capacity, efficiency, application rate and losses; cost analysis of implements and tractors.

Thermodynamic principles of I.C. engines; I.C. engine cycles; engine components; fuels and combustion; lubricants and their properties; I.C. engine systems - fuel, cooling, lubrication, ignition, electrical, intake and exhaust; selection, operation, maintenance and repair of I.C. engines; power efficiencies and measurement; calculation of power, torque, fuel consumption, heat load and power losses.

Tractors and power tillers - type, selection, maintenance and repair; tractor clutches and brakes; power transmission systems - gear trains, differential, final drives and power take-off; mechanics of tractor chassis; traction theory; three point hitches- free link and restrained link operations; mechanical steering and hydraulic control systems used in tractors; human engineering and safety in tractor design; tractor tests and performance.

SOIL AND WATER CONSERVATION ENGINEERING:

Ideal and real fluids, properties of fluids; hydrostatic pressure and its measurement; hydrostatic forces on plane and curved surface; continuity equation; Bernoulli's theorem; laminar and turbulent flow in pipes, Darcy-Weisbach and Hazen-Williams equations, Moody's diagram; flow through orifices and notches; flow in open channels.

Engineering properties of soils, fundamental definitions and relationships; index properties of soils; permeability and seepage analysis; shear strength, Mohr's circle of stresses; active and passive earth pressures; stability of slopes.

Hydrological cycle; precipitation measurement, analysis of precipitation data; abstraction from precipitation; runoff; hydrograph analysis, unit hydrograph theory and application; stream flow measurement; flood routing, hydrological reservoir and channel routing.

Mechanics of soil erosion, factors affecting erosion; soil loss estimation; biological and engineering measures to control erosion, terraces and bunds; vegetative waterways; gully control structures, drop, drop inlet and chute spillways; farm ponds; earthen dams; principles of watershed management.

Water requirement of crops; consumptive use and evapo-transpiration; irrigation scheduling; irrigation efficiencies; design of prismatic and silt loaded channels; methods of irrigation water application; design and evaluation of irrigation methods; drainage coefficient; surface and subsurface drainage systems; leaching requirement and salinity control; irrigation and drainage water quality; classification of pumps; pump characteristics; pump selection; types of aquifer; evaluation of aquifer properties; well hydraulics; ground water recharge.

AGRICULTURAL PROCESSING AND FOOD ENGINEERING:

Steady state heat transfer in conduction, convection and radiation; transient heat transfer in simple geometry; condensation and boiling heat transfer; working principles of heat exchangers; diffusive and convective mass transfer; simultaneous heat and mass transfer in agricultural processing operations.

Material and energy balances in food processing systems; water activity, sorption and desorption isotherms; centrifugal separation of solids, liquids and gases; kinetics of microbial death - pasteurisation and sterilization of liquid foods; preservation of food by cooling and freezing; psychrometry - properties of air-vapour mixture; concentration and dehydration of liquid foods - evaporators, tray, drum and spray dryers.

Mechanics and energy requirement in size reduction of granular solids; particle size analysis for comminuted solids; size separation by screening; fluidisation of granular solids; cleaning and grading efficiency and effectiveness of grain cleaners; conditioning and hydrothermal treatments for grains; dehydration of food grains; processes and machines for processing of cereals, pulses and oilseeds; design considerations for grain silos.

AR - ARCHITECTURE AND PLANNING

City planning: Historical development of cities; principles of city planning; new towns; survey methods, site planning, planning regulations and building bye-laws.

Housing: Concept of shelter; housing policies and design; community planning; role of government agencies; finance and management.

Landscape Design: Principles of landscape design and site planning; history and landscape styles; landscape elements and materials; planting design.

Computer Aided Design: Application of computers in architecture and planning; understanding elements of hardware and software; computer graphics; programming languages - C and Visual Basic and usage of packages such as AutoCAD.

Environmental and Building Science: Elements of environmental science; ecological principles concerning environment; role of micro-climate in design; climatic control through design elements; thermal comfort; elements of solar architecture; principles of lighting and illumination; basic principles of architectural acoustics; air pollution, noise pollution and their control.

Visual and Urban Design: Principles of visual composition; proportion, scale, rhythm, symmetry, harmony, balance, form and colour; sense of place and space, division of space; focal point, vista, imageability, visual survey.

History of Architecture: Indian - Indus valley, Vedic, Buddhist, Indo-Aryan, Dravidian and Mughal periods; European - Egyptian, Greek, Roman, medieval and renaissance periods.

Development of Contemporary Architecture: Architectural developments and impacts on society since industrial revolution; influence of modern art on architecture; works of national and international architects; post modernism in architecture.

Building Services: Water supply, Sewerage and Drainage systems; Sanitary fittings and fixtures; principles of electrification of buildings; elevators, their standards and uses; air-conditioning systems; fire fighting systems.

Building Construction and Management: Building construction techniques, methods and details; building systems and prefabrication of building elements; principles of modular coordination; estimation, specification, valuation, professional practice; project management, PERT, CPM.

Materials and Structural Systems: Behavioural characteristics of all types of building materials e.g. mud, timber, bamboo, brick, concrete, steel, glass, FRP; principles of strength of materials; design of structural elements in wood, steel and RCC; elastic and limit state design; complex structural systems; principles of pre-stressing.

Planning Theory: Planning process; multilevel planning; comprehensive planning; central place theory; settlement pattern; land use and land utilization.

Techniques of Planning: Planning surveys; Preparation of urban and regional structure plans, development plans, action plans; site planning principles and design; statistical methods; application of remote sensing techniques in urban and regional planning.

Traffic and Transportation Planning: Principles of traffic engineering and transportation planning; methods of conducting surveys; design of roads, intersections and parking areas; hierarchy of roads and levels of services; traffic and transport management in urban areas; traffic safety and traffic laws; public transportation planning; modes of transportation.

Services and Amenities: Principles and design of water supply systems, sewerage systems, solid waste disposal systems, power supply and communication systems; Health, education, recreation and demography related standards at various levels of the settlements.

Development Administration and Management: Planning laws; development control and zoning regulations; laws relating to land acquisition; development enforcements, land ceiling; regional and urban plan preparations; planning and municipal administration; taxation, revenue resources and fiscal management; public participation and role of NGO.

CE - CIVIL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

STRUCTURAL ENGINEERING

Mechanics: Bending moments and shear forces in statically determinate beams; simple stress and strain: relationship; stress and strain in two dimensions, principal stresses, stress transformation, Mohr's circle; simple bending theory; flexural shear stress; thin-walled pressure vessels; uniform torsion.

Structural Analysis: Analysis of statically determinate trusses, arches and frames; displacements in statically determinate structures and analysis of statically indeterminate structures by force/energy methods; analysis by displacement methods (slope-deflection and moment-distribution methods); influence lines for determinate and indeterminate structures; basic concepts of matrix methods of structural analysis.

Concrete Structures: Basic working stress and limit states design concepts; analysis of ultimate load capacity and design of members subject to flexure, shear, compression and torsion (beams, columns and isolated footings); basic elements of prestressed concrete: analysis of beam sections at transfer and service loads.

Steel Structures: Analysis and design of tension and compression members, beams and beam-columns, column bases; connections - simple and eccentric, beam-column connections, plate girders and trusses; plastic analysis of beams and frames.

GEOTECHNICAL ENGINEERING

Soil Mechanics: Origin of soils; soil classification; three-phase system, fundamental definitions, relationship and inter-relationships; permeability and seepage; effective stress principle: consolidation, compaction; shear strength.

Foundation Engineering: Sub-surface investigation - scope, drilling bore holes, sampling, penetrometer tests, plate load test; earth pressure theories, effect of water table, layered soils; stability of slopes - infinite slopes, finite slopes; foundation types - foundation design requirements; shallow foundations; bearing capacity, effect of shape, water table and other factors, stress distribution, settlement analysis in sands and clays; deep foundations - pile types, dynamic and static formulae, load capacity of piles in sands and clays.

WATER RESOURCES ENGINEERING

Fluid Mechanics and Hydraulics: Hydrostatics, applications of Bernoulli equation, laminar and turbulent flow in pipes, pipe networks; concept of boundary layer and its growth; uniform flow, critical flow and gradually varied flow in channels, specific energy concept, hydraulic jump; forces on immersed bodies; flow measurement in channels; tanks and pipes; dimensional analysis and hydraulic modeling. Applications of momentum equation, potential flow, kinematics of flow; velocity triangles and specific speed of pumps and turbines.

Hydrology: Hydrologic cycle; rainfall; evaporation infiltration, unit hydrographs, flood estimation, reservoir design, reservoir and channel routing, well hydraulics.

Irrigation: Duty, delta, estimation of evapo-transpiration; crop water requirements; design of lined and unlined canals; waterways; head works, gravity dams and Ogee spillways. Designs of weirs on permeable foundation, irrigation methods.

ENVIRONMENTAL ENGINEERING

Water requirements; quality and standards, basic unit processes and operations for water treatment, distribution of water. Sewage and sewerage treatment: quantity and characteristic of waste water sewerage; primary and secondary treatment of waste water; sludge disposal; effluent discharge standards.

TRANSPORTATION ENGINEERING

Highway planning; geometric design of highways; testing and specifications of paving materials; design of flexible and rigid pavements.

CH - CHEMICAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

CHEMICAL ENGINEERING

Process Calculations and Thermodynamics: Laws of conservation of mass and energy; use of tie components; recycle, bypass and purge calculations; degree of freedom analysis.

First and Second laws of thermodynamics and their applications; equations of state and thermodynamic properties of real systems; phase equilibria; fugacity, excess properties and correlations of activity coefficients; chemical reaction equilibria.

Fluid Mechanics and Mechanical Operations: Fluid statics, Newtonian and non-Newtonian fluids, Bernoulli equation, Macroscopic friction factors, energy balance, dimensional analysis, shell balances, flow through pipeline systems, flow meters, pumps and compressors, packed and fluidized beds, elementary boundary layer theory, size reduction and size separation; free and hindered settling; centrifuge and cyclones; thickening and classification, filtration, mixing and agitation; conveying of solids.

Heat Transfer: Conduction, convection and radiation, heat transfer coefficients, steady and unsteady heat conduction, boiling, condensation and evaporation; types of heat exchangers and evaporators and their design.

Mass Transfer: Fick's law, molecular diffusion in fluids, mass transfer coefficients, film, penetration and surface renewal theories; momentum, heat and mass transfer analogies; stagewise and continuous contacting and stage efficiencies; HTU & NTU concepts design and operation of equipment for distillation, absorption, leaching, liquid-liquid extraction, crystallization, drying, humidification, dehumidification and adsorption.

Chemical Reaction Engineering: Theories of reaction rates; kinetics of homogeneous reactions, interpretation of kinetic data, single and multiple reactions in ideal reactors, non-ideal reactors; residence time; non-isothermal reactors; kinetics of heterogeneous catalytic reactions; diffusion effects in catalysis.

Instrumentation and Process Control: Measurement of process variables; sensors, transducers and their dynamics, dynamics of simple systems, dynamics such as CSTRs, transfer functions and responses of simple systems, process reaction curve, controller modes (P, PI, and PID); control valves; analysis of closed loop systems including stability, frequency response (including Bode plots) and controller tuning, cascade, feed forward control.

Plant Design and Economics: Design and sizing of chemical engineering equipment such as compressors, heat exchangers, multistage contactors; principles of process economics and cost estimation including total annualized cost, cost indexes, rate of return, payback period, discounted cash flow, optimization in Design.

Chemical Technology: Inorganic chemical industries; sulfuric acid, NaOH, fertilizers (Ammonia, Urea, SSP and TSP); natural products industries (Pulp and Paper, Sugar, Oil, and Fats); petroleum refining and petrochemicals; polymerization industries; polyethylene, polypropylene, PVC and polyester synthetic fibers.

CS - COMPUTER SCIENCE AND ENGINEERING

ENGINEERING MATHEMATICS

Mathematical Logic: Propositional Logic; First Order Logic.

Probability: Conditional Probability; Mean, Median, Mode and Standard Deviation; Random Variables; Distributions; uniform, normal, exponential, Poisson, Binomial.

Set Theory & Algebra: Sets; Relations; Functions; Groups; Partial Orders; Lattice; Boolean Algebra.

Combinatorics: Permutations; Combinations; Counting; Summation; generating functions; recurrence relations; asymptotics.

Graph Theory: Connectivity; spanning trees; Cut vertices & edges; covering; matching; independent sets; Colouring; Planarity; Isomorphism.

Linear Algebra: Algebra of matrices, determinants, systems of linear equations, Eigen values and Eigen vectors.

Numerical Methods: LU decomposition for systems of linear equations; numerical solutions of non linear algebraic equations by Secant, Bisection and Newton-Raphson Methods; Numerical integration by trapezoidal and Simpson's rules.

Calculus: Limit, Continuity & differentiability, Mean value Theorems, Theorems of integral calculus, evaluation of definite & improper integrals, Partial derivatives, Total derivatives, maxima & minima.

THEORY OF COMPUTATION

Formal Languages and Automata Theory: Regular languages and finite automata, Context free languages and Push-down automata, Recursively enumerable sets and Turing machines, Un-decidability;

Analysis of Algorithms and Computational Complexity: Asymptotic analysis (best, worst, average case) of time and space, Upper and lower bounds on the complexity of specific problems, NP-completeness.

COMPUTER HARDWARE

Digital Logic: Logic functions, Minimization, Design and synthesis of Combinational and Sequential circuits; Number representation and Computer Arithmetic (fixed and floating point);

Computer Organization: Machine instructions and addressing modes, ALU and Data-path, hardwired and micro-programmed control, Memory interface, I/O interface (Interrupt and DMA mode), Serial communication interface, Instruction pipelining, Cache, main and secondary storage.

SOFTWARE SYSTEMS

Data structures: Notion of abstract data types, Stack, Queue, List, Set, String, Tree, Binary search tree, Heap, Graph;

Programming Methodology: C programming, Program control (iteration, recursion, Functions), Scope, Binding, Parameter passing, Elementary concepts of Object oriented, Functional and Logic Programming;

Algorithms for problem solving: Tree and graph traversals, Connected components, Spanning trees, Shortest paths; Hashing, Sorting, Searching; Design techniques (Greedy, Dynamic Programming, Divide-and-conquer);

Compiler Design: Lexical analysis, Parsing, Syntax directed translation, Runtime environment, Code generation, Linking (static and dynamic); Operating Systems: Classical concepts (concurrency, synchronization, deadlock), Processes, threads and Inter-process communication, CPU scheduling, Memory management, File systems, I/O systems, Protection and security.

Databases: Relational model (ER-model, relational algebra, tuple calculus), Database design (integrity constraints, normal forms), Query languages (SQL), File structures (sequential files, indexing, B+ trees), Transactions and concurrency control;

Computer Networks: ISO/OSI stack, sliding window protocol, LAN Technologies (Ethernet, Token ring), TCP/UDP, IP, Basic concepts of switches, gateways, and routers.

CH - CHEMISTRY

PHYSICAL CHEMISTRY

Structure: Quantum theory - principles and techniques; applications to particle in a box, harmonic oscillator, rigid rotor and hydrogen atom; valence bond and molecular orbital theories and Huckel approximation, approximate techniques: variation and perturbation; symmetry, point groups; rotational, vibrational, electronic, NMR and ESR spectroscopy.

Equilibrium: First law of thermodynamics, heat, energy and work; second law of thermodynamics and entropy; third law and absolute entropy; free energy; partial molar quantities; ideal and non-ideal solutions; phase transformation: phase rule and phase diagrams- one, two, and three component systems; activity, activity coefficient, fugacity and fugacity coefficient ; chemical equilibrium, response of chemical equilibrium to temperature and pressure; colligative properties; kinetic theory of gases; thermodynamics of electrochemical cells; standard electrode potentials: applications - corrosion and energy conversion; molecular partition function (translational, rotational, vibrational and electronic).

Kinetics: Rates of chemical reactions, theories of reaction rates, collision and transition state theory; temperature dependence of chemical reactions; elementary reactions, consecutive elementary reactions; steady state approximation, kinetics of photochemical reactions and free radical polymerization, homogenous and heterogeneous catalysis.

INORGANIC CHEMISTRY

Non-Transition Elements: General characteristics, structure and reactions of simple and industrially important compounds, boranes, carboranes, silicates, silicones, diamond and graphite; hydrides, oxides and oxoacids of N, P, S and halogens; boron nitride, borazines and phosphazenes; xenon compounds. Shapes of molecules, hard-soft acid base concept.

Transition Elements: General characteristics of d and f block elements; coordination chemistry: structure and isomerism, stability, theories of metal-ligand bonding (CFT and LFT), electronic spectra and magnetic properties of transition metal complexes and lanthanides;

metal carbonyls, metal-metal bonds and metal atom clusters, metallocenes; transition metal complexes with bonds to hydrogen, alkyls, alkenes, and arenes; metal carbenes; use of organometallic compounds as catalysts in organic synthesis; mechanisms of substitution and electron transfer reactions of coordination complexes. Role of metals with special reference to Na, K, Mg, Ca, Fe, Co, Zn, and Mo in biological systems.

Solids: Crystal systems and lattices, Miller planes, crystal packing, crystal defects; Bragg's Law; ionic crystals, band theory, metals and semiconductors. Spinels.

Instrumental methods of analysis: atomic absorption, UV-visible spectrometry, chromatographic and electro-analytical methods.

ORGANIC CHEMISTRY

Synthesis, reactions and mechanisms involving the following: Alkenes, alkynes, arenes, alcohols, phenols, aldehydes, ketones, carboxylic acids and their derivatives; halides, nitro compounds and amines; stereochemical and conformational effects on reactivity and specificity; reactions with diborane and peracids. Michael reaction, Robinson annulation, reactivity umpolung, acyl anion equivalents; molecular rearrangements involving electron deficient atoms.

Photochemistry: Basic principles, photochemistry of olefins, carbonyl compounds, arenes, photo oxidation and reduction.

Pericyclic reactions: Cycloadditions, electrocyclic reactions, sigmatropic reactions; Woodward-Hoffmann rules.

Heterocycles: Structural properties and reactions of furan, pyrrole, thiophene, pyridine, indole.

Biomolecules: Structure, properties and reactions of mono- and di-saccharides, physico-chemical properties of amino acids, structural features of proteins and nucleic acids.

Spectroscopy: Principles and applications of IR, UV-visible, NMR and mass spectrometry in the determination of structures of organic compounds.

EC - ELECTRONICS AND COMMUNICATION ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix Algebra, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Mean value theorems, Theorems of integral calculus, Evaluation of definite and improper integrals, Partial Derivatives, Maxima and minima, Multiple integrals, Fourier series. Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equation (linear and nonlinear), Higher order linear differential equations with constant coefficients, Method of variation of parameters, Cauchy's and Euler's equations, Initial and boundary value problems, Partial Differential Equations and variable separable method.

Complex variables: Analytic functions, Cauchy's integral theorem and integral formula, Taylor's and Laurent' series, Residue theorem, solution integrals.

Probability and Statistics: Sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Discrete and continuous distributions, Poisson, Normal and Binomial distribution, Correlation and regression analysis.

Numerical Methods: Solutions of non-linear algebraic equations, single and multi-step

methods for differential equations.

Transform Theory: Fourier transform, Laplace transform, Z-transform.

ELECTRONICS & COMMUNICATION ENGINEERING

Networks: Network graphs: matrices associated with graphs; incidence, fundamental cut set and fundamental circuit matrices. Solution methods: nodal and mesh analysis. Network theorems: superposition, Thevenin and Norton's maximum power transfer, Wye-Delta transformation. Steady state sinusoidal analysis using phasors. Linear constant coefficient differential equations; time domain analysis of simple RLC circuits, Solution of network equations using Laplace transform: frequency domain analysis of RLC circuits. 2-port network parameters: driving point and transfer functions. State equations for networks.

Electronic Devices: Energy bands in silicon, intrinsic and extrinsic silicon. Carrier transport in silicon: diffusion current, drift current, mobility, resistivity. Generation and recombination of carriers. p-n junction diode, Zener diode, tunnel diode, BJT, JFET, MOS capacitor, MOSFET, LED, p-I-n and avalanche photo diode, LASERs. Device technology: integrated circuits fabrication process, oxidation, diffusion, ion implantation, photolithography, n-tub, p-tub and twin-tub CMOS process.

Analog Circuits: Equivalent circuits (large and small-signal) of diodes, BJTs, JFETs, and MOSFETs. Simple diode circuits, clipping, clamping, rectifier. Biasing and bias stability of transistor and FET amplifiers. Amplifiers: single-and multi-stage, differential, operational, feedback and power. Analysis of amplifiers; frequency response of amplifiers. Simple op-amp circuits. Filters. Sinusoidal oscillators; criterion for oscillation; single-transistor and op-amp configurations. Function generators and wave-shaping circuits. Power supplies.

Digital circuits: Boolean algebra, minimization of Boolean functions; logic gates digital IC families (DTL, TTL, ECL, MOS, CMOS). Combinational circuits: arithmetic circuits, code converters, multiplexers and decoders. Sequential circuits: latches and flip-flops, counters and shift-registers. Sample and hold circuits, ADCs, DACs. Semiconductor memories. Microprocessor(8085): architecture, programming, memory and I/O interfacing.

Signals and Systems: Definitions and properties of Laplace transform, continuous-time and discrete-time Fourier series, continuous-time and discrete-time Fourier Transform, z-transform. Sampling theorems. Linear Time-Invariant (LTI) Systems: definitions and properties; casuality, stability, impulse response, convolution, poles and zeros frequency response, group delay, phase delay. Signal transmission through LTI systems. Random signals and noise: probability, random variables, probability density function, autocorrelation, power spectral density.

Controls Systems: Basic control system components; block diagrammatic description, reduction of block diagrams. Open loop and closed loop (feedback) systems and stability analysis of these systems. Signal flow graphs and their use in determining transfer functions of systems; transient and steady state analysis of LTI control systems and frequency response. Tools and techniques for LTI control system analysis: root loci, Routh-Hurwitz criterion, Bode and Nyquist plots. Control system compensators: elements of lead and lag compensation, elements of Proportional-Integral-Derivative(PID) control. State variable representation and solution of state equation of LTI control systems.

Communications: Analog communication systems: amplitude and angle modulation and demodulation systems, spectral analysis of these operations, superheterodyne receivers; elements of hardware, realizations of analog communication systems; signal-to-noise ratio (SNR) calculations for amplitude modulation (AM) and frequency modulation (FM) for low noise conditions. Digital communication systems: pulse code modulation (PCM), differential pulse code modulation (DPCM), delta modulation (DM); digital modulation schemes-amplitude, phase and frequency shift keying schemes (ASK, PSK, FSK), matched filter receivers, bandwith consideration and probability of error calculations for these schemes.

Electromagnetics: Elements of vector calculus: divergence and curl; Gauss' and Stokes' theorems, Maxwell's equations: differential and integral forms. Wave equation, Poynting vector. Plane waves: propagation through various media; reflection and refraction; phase and group velocity; skin depth. Transmission lines: characteristic impedance; impedance transformation; Smith chart; impedance matching; pulse excitation. Waveguides: modes in rectangular waveguides; boundary conditions; cut-off frequencies; dispersion relations. Antennas: Dipole antennas; antenna arrays; radiation pattern; reciprocity theorem, antenna gain.

EE - ELECTRICAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix Algebra, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Mean value theorems, Theorems of integral calculus, Evaluation of definite and improper integrals, Partial Derivatives, Maxima and minima, Multiple integrals, Fourier series. Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equation (linear and nonlinear), Higher order linear differential equations with constant coefficients, Method of variation of parameters, Cauchy's and Euler's equations, Initial and boundary value problems, Partial Differential Equations and variable separable method.

Complex variables: Analytic functions, Cauchy's integral theorem and integral formula, Taylor's and Laurent' series, Residue theorem, solution integrals.

Probability and Statistics: Sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Discrete and continuous distributions, Poisson, Normal and Binomial distribution, Correlation and regression analysis.

Numerical Methods: Solutions of non-linear algebraic equations, single and multi-step methods for differential equations.

Transform Theory: Fourier transform, Laplace transform, Z-transform.

ELECTRICAL ENGINEERING

Electrical Circuits and Fields: Network graph, KCL, KVL, node/ cut set, mesh/ tie set analysis, transient response of d.c. and a.c. networks; sinusoidal steady-state analysis; resonance in electrical circuits; concepts of ideal voltage and current sources, network theorems, driving point, immittance and transfer functions of two port networks, elementary concepts of filters; three phase circuits; Fourier series and its application; Gauss theorem, electric field intensity and potential due to point, line, plane and spherical charge distribution, dielectrics, capacitance calculations for simple configurations; Ampere's and Biot-Savart's law, inductance calculations for simple configurations.

Electrical Machines: Single phase transformer - equivalent circuit, phasor diagram, tests, regulation and efficiency; three phase transformers - connections, parallel operation; auto transformer and three-winding transformer; principles of energy conversion, windings of rotating machines: D. C. generators and motors - characteristics, starting and speed control, armature reaction and commutation; three phase induction motors-performance characteristics, starting and speed control; single-phase induction motors; synchronous generators-performance, regulation, parallel operation; synchronous motors - starting, characteristics, applications, synchronous condensers; fractional horse power motors; permanent magnet and stepper motors.

Power Systems: Electric power generation - thermal, hydro, nuclear; transmission line parameters; steady-state performance of overhead transmission lines and cables and surge propagation; distribution systems, insulators, bundle conductors, corona and radio interference effects; per-unit quantities; bus admittance and impedance matrices; load flow; voltage control and power factor correction; economic operation; symmetrical components, analysis of symmetrical and unsymmetrical faults; principles of over current, differential and distance protections; concept of solid state relays and digital protection; circuit breakers; concept of system stability-swing curves and equal area criterion; basic concepts of HVDC transmission.

Control Systems: Principles of feedback; transfer function; block diagrams: steady-state errors; stability-Routh and Nyquist criteria; Bode plots; compensation; root loci; elementary state variable formulation; state transition matrix and response for Linear Time Invariant systems.

Electrical and Electronic Measurements: Bridges and potentiometers, PMMC, moving iron, dynamometer and induction type instruments; measurement of voltage, current, power, energy and power factor; instrument transformers; digital voltmeters and multimeters; phase, time and frequency measurement; Q-meter, oscilloscopes, potentiometric recorders, error analysis.

Analog and Digital Electronics: Characteristics of diodes, BJT, FET, SCR; amplifiers-biasing, equivalent circuit and frequency response; oscillators and feedback amplifiers, operational amplifiers- characteristics and applications; simple active filters; VCOs and timers; combinational and sequential logic circuits, multiplexer, Schmitt trigger, multivibrators, sample and hold circuits, A/D and D/A converters; microprocessors and their applications.

Power Electronics and Electric Drives: Semiconductor power devices-diodes, transistors, thyristors, triacs, GTOs, MOSFETs and IGBTs - static characteristics and principles of operation; triggering circuits; phase control rectifiers; bridge converters-fully controlled and half controlled; principles of choppers and inverters, basic concepts of adjustable speed dc and ac drives.

GG - GEOLOGY AND GEOPHYSICS

PART - I

Earth and planetary system; size, shape, internal structure and composition of the earth; atmosphere and greenhouse effect; isostasy; elements of seismology; continents and continental processes; physical oceanography; palaeomagnetism, continental drift plate tectonics, geothermal energy.

Weathering; soil formation; action of river, wind and glacier; oceans and oceanic features; earthquakes, volcanoes, orogeny and mountain building; elements of structural geology; crystallography; classification, composition and properties of minerals and rocks; engineering properties of rocks and soils, role of geology in the construction of engineering structures.

Processes of ore formation, occurrence and distribution of ores on land and on ocean floor; coal and petroleum resources in India; ground water geology including well hydraulics, geological time scale and geochronology; stratigraphic principles and stratigraphy of India; basics concepts of gravity, magnetic and electrical prospecting for ores and ground water.

PART - IIA: GEOLOGY

Crystal symmetry, forms, twinning; crystal chemistry; optical mineralogy, classification of minerals, diagnostic properties of rock minerals.

Mineralogy, structure, texture and classification of igneous, sedimentary and metamorphic rock, their origin and evolution; application of thermodynamics; structure and petrology of sedimentary rocks; sedimentary processes and environments, sedimentary facies, basin studies; basement cover relationship;

Primary and secondary structures; geometry and genesis of folds, faults, joints, unconformities, cleavage, schistosity and lineation; methods of projection. Tectonites and their significance; shear zone; superposed folding.

Morphology, classification and geological significance of important invertebrates, vertebrates, microfossils and palaeoflora; stratigraphic principles and Indian stratigraphy; geomorphic processes and agents; development and evolution of landforms; slope and drainage; processes on deep oceanic and near-shore regions; quantitative and applied geomorphology; air photo interpretation and remote sensing; chemical and optical properties of ore minerals; formation and localization of ore deposits; prospecting and exploration of economic minerals; coal and petroleum geology; origin and distribution of mineral and fuel deposits in India; ore dressing and mineral economics.

Cosmic abundance; meteorites; geochemical evolution of the earth; geochemical cycles; distribution of major, minor and trace elements; isotope geochemistry; geochemistry of waters including solution equilibria and water rock interaction.

Engineering properties of rocks and soils; rocks as construction material; geology of dams, tunnels and excavation sites; natural hazards; the fly ash problem; ground water geology and exploration; water quality; impact of human activity; Remote sensing techniques for the interpretation of landforms and resource management.

PART - II B: GEOPHYSICS

The earth as a planet; different motions of the earth; gravity filed of the earth and its shape; geochronology; isostasy, seismology and interior of the earth; variation of density, velocity, pressure, temperature, electrical and magnetic properties inside the earth; earthquakes-causes and measurements; zonation and seismic hazards; geomagnetic field, palaeomagnetism; oceanic and continental lithosphere; plate tectonics; heat flow; upper and lower atmospheric phenomena.

Theories of scalar and vector potential fields; Laplace, Maxwell and Helmholtz equations for solution of different types of boundary value problems for Cartesian, cylindrical and spherical polar coordinates; Green's theorem; Image theory; integral equations and conformal transformations in potential theory; Eikonal equation and ray theory.

'G' and 'g' units of measurement, density of rocks, gravimeters, preparation, analysis and interpretation of gravity maps; derivative maps, analytical continuation; gravity anomaly type curves; calculation of mass.

Earth's magnetic field, units of measurement, magnetic susceptibility of rocks, magnetometers, corrections, preparation of magnetic maps, magnetic anomaly type curve, analytical continuation, interpretation and application; magnetic well logging.

Conduction of electricity through rocks, electrical conductivities of metals, metallic, non-metallic and rock forming minerals, D.C. resistivity units and methods of measurement, electrode configuration for sounding and profiling, application of filter theory, interpretation of resistivity field data, application; self potential origin, classification, field measurement, interpretation of induced polarization time frequency, phase domain; IP units and methods of measurement, interpretation and application; ground-water exploration.

Origin of electromagnetic field elliptic polarization, methods of measurement for different source-receiver configuration components in EM measurements, interpretation and applications; earth's natural electromagnetic field, tellurics, magneto-tellurics; geomagnetic depth sounding principles, methods of measurement, processing of data and interpretation.

Seismic methods of prospecting: Reflection, refraction and CDP surveys; land and marine seismic sources, generation and propagation of elastic waves, velocity increasing with depth, geophones, hydrophones, recording instruments (DFS), digital formats, field layouts, seismic noises and noise profile analysis, optimum geophone grouping, noise cancellation by shot and geophone arrays, 2D and 3D seismic data acquisition and processing, CDP stacking charts, binning, filtering, dip-moveout, static and dynamic corrections, deconvolution, migration, signal processing, Fourier and Hilbert transforms, attribute analysis, bright and dim spots, seismic stratigraphy, high resolution seismics, VSP.

Principles and techniques of geophysical well-logging, SP, resistivity, induction, micro gamma ray, neutron, density, sonic, temperature, dip meter, caliper, nuclear magnetic, cement bond logging. Quantitative evaluation of formations from well logs; well hydraulics and application of geophysical methods for groundwater study; application of bore hole geophysics in ground water, mineral and oil exploration. Remote sensing techniques and application of remote sensing methods in geophysics.

IN - INSTRUMENTATION ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix Algebra, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Mean value theorems, Theorems of integral calculus, Evaluation of definite and improper integrals, Partial Derivatives, Maxima and minima, Multiple integrals, Fourier series. Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equation (linear and nonlinear), Higher order linear differential equations with constant coefficients, Method of variation of parameters, Cauchy's and Euler's equations, Initial and boundary value problems, Partial Differential Equations and variable separable method.

Complex variables: Analytic functions, Cauchy's integral theorem and integral formula, Taylor's and Laurent' series, Residue theorem, solution integrals.

Probability and Statistics: Sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Discrete and continuous distributions, Poisson, Normal and Binomial distribution, Correlation and regression analysis.

Numerical Methods: Solutions of non-linear algebraic equations, single and multi-step methods for differential equations.

Transform Theory: Fourier transform, Laplace transform, Z-transform.

INSTRUMENTATION ENGINEERING

Measurement Basics and Metrology: Static and dynamic characteristics of measurement systems. Standards and calibration. Error and uncertainty analysis, statistical analysis of data, and curve fitting. Linear and angular measurements; Measurement of straightness, flatness, roundness and roughness.

Transducers, Mechanical Measurements and Industrial Instrumentation: Transducers - elastic, resistive, inductive, capacitive, thermo-electric, piezoelectric, photoelectric, electro-mechanical, electro-chemical, and ultrasonic. Measurement of displacement, velocity (linear and rotational), acceleration, shock, vibration, force, torque, power, strain, stress, pressure, flow, temperature, humidity, viscosity, and density. energy storing elements, suspension systems and dampers.

Analog Electronics: Characteristics of diodes, BJTs, JFETs and MOSFETs; Diode circuits;

Amplifiers: single and multi-stage, feedback; Frequency response; Operational amplifiers - design, characteristic, linear and non-linear applications: difference amplifiers; instrumentation amplifiers; precision rectifiers, I-to-V converters, active filters, oscillators, comparators, signal generators, wave shaping circuits.

Digital Electronics: Combinational logic circuits, minimization of Boolean functions; IC families (TTL, MOS, CMOS), arithmetic circuits, multiplexer and decoders. Sequential circuits: flip-flops, counters, shift registers. Schmitt trigger, timers, and multivibrators. Analog switches, multiplexers, S/H circuits. Analog-to-digital and digital-to-analog converters. Basics of computer organization and architecture. 8-bit microprocessor (8085), applications, memory, I/O interfacing, and microcontrollers.

Signals and Systems: Vectors and matrices; Fourier series; Fourier transforms; Ordinary differential equations. Impulse and frequency responses of first and second order systems. Laplace transform and transfer function, convolution and correlation. Amplitude and frequency modulations and demodulations. Discrete time systems, difference equations, impulse and frequency responses; Z-transforms and transfer functions; IIR and FIR filters.

Electrical and Electronic Measurements: Measurement of R, L and C; bridges and potentiometers. Measurement of voltage, current, power, power factor, and energy; Instrument transformers; Q meter, waveform analyzers. Digital volt-meters and multi-meters. Time, phase and frequency measurements; Oscilloscope. Noise and interference in instrumentation.

Control Systems & Process Control: Principles of feedback; transfer function, signal flow graphs. Stability criteria, Bode plots, root-loci, Routh and Nyquist criteria. Compensation techniques; State space analysis. System components: mechanical, hydraulic, pneumatic, electrical and electronic; Servos and synchros; Stepper motors. On-off, cascade, P, PI, PID and feed-forward controls. Controller tuning and general frequency response.

Analytical, Optical and Biomedical Instrumentation: Principles of spectrometry, UV, visible, IR mass spectrometry, X-ray methods; nuclear radiation measurements, gas, solid and semi conductor lasers and their characteristics, interferometers, basics of fibre optics, transducers in biomedical applications, cardiovascular system measurements, instrumentation for clinical laboratory.

MA - MATHEMATICS

Linear Algebra: Finite dimensional vector spaces. Linear transformations and their matrix representations, rank; systems of linear equations, eigenvalues and eigenvectors, minimal polynomial, Cayley-Hamilton theorem, diagonalisation, Hermitian, Skew-Hermitian and unitary matrices. Finite dimensional inner product spaces, self-adjoint and Normal linear operators, spectral theorem, Quadratic forms.

Complex Analysis: Analytic functions, conformal mappings, bilinear transformations, complex integration: Cauchy's integral theorem and formula, Liouville's theorem, maximum modulus principle, Taylor and Laurent's series, residue theorem and applications for evaluating real integrals.

Real Analysis: Sequences and series of functions, uniform convergence, power series, Fourier series, functions of several variables, maxima, minima, multiple integrals, line, surface and volume integrals, theorems of Green, Stokes and Gauss; metric spaces, completeness, Weierstrass approximation theorem, compactness. Lebesgue measure, measurable functions; Lebesgue integral, Fatou's lemma, dominated convergence theorem.

Ordinary Differential Equations: First order ordinary differential equations, existence and uniqueness theorems, systems of linear first order ordinary differential equations, linear ordinary differential equations of higher order with constant coefficients; linear second order ordinary differential equations with variable coefficients, method of Laplace transforms for solving ordinary differential equations, series solutions; Legendre and Bessel functions and their orthogonality, Sturm Liouville system, Greeen's functions.

Algebra: Normal subgroups and homomorphisms theorems, automorphisms. Group actions, sylow's theorems and their applications groups of order less than or equal to 20, Finite p-groups. Euclidean domains, Principal ideal domains and unique factorizations domains. Prime ideals and maximal ideals in commutative rings.

Functional Analysis: Banach spaces, Hahn-Banach theorems, open mapping and closed graph theorems, principle of uniform boundedness; Hilbert spaces, orthonormal sets, Riesz representation theorem, self-adjoint, unitary and normal linear operators on Hilbert Spaces.

Numerical Analysis: Numerical solution of algebraic and transcendental equations; bisection, secant method, Newton-Raphson method, fixed point iteration, interpolation: existence and error of polynomial interpolation, Lagrange, Newton, Hermite(osculatory)interpolations; numerical differentiation and integration, Trapezoidal and Simpson rules; Gaussian quadrature; (Gauss-Legendre and Gauss-Chebyshev), method of undetermined parameters, least square and orthonormal polynomial approximation; numerical solution of systems of linear equations: direct and iterative methods, (Jacobi Gauss-Seidel and SOR) with convergence; matrix eigenvalue problems: Jacobi and Given's methods, numerical solution of ordinary differential equations: initial value problems, Taylor series method, Runge-Kutta methods, predictor-corrector methods; convergence and stability.

Partial Differential Equations: Linear and quasilinear first order partial differential equations, method of characteristics; second order linear equations in two variables and their classification; Cauchy, Dirichlet and Neumann problems, Green's functions; solutions of Laplace, wave and diffusion equations in two variables Fourier series and transform methods of solutions of the above equations and applications to physical problems.

Mechanics: Forces in three dimensions, Poinsot central axis, virtual work, Lagrange's equations for holonomic systems, theory of small oscillations, Hamiltonian equations;

Topology: Basic concepts of topology, product topology, connectedness, compactness, countability and separation axioms, Urysohn's Lemma, Tietze extension theorem, metrization theorems, Tychonoff theorem on compactness of product spaces.

Probability and Statistics: Probability space, conditional probability, Bayes' theorem, independence, Random variables, joint and conditional distributions, standard probability distributions and their properties, expectation, conditional expectation, moments. Weak and strong law of large numbers, central limit theorem. Sampling distributions, UMVU estimators, sufficiency and consistency, maximum likelihood estimators. Testing of hypotheses, Neyman-Pearson tests, monotone likelihood ratio, likelihood ratio tests, standard parametric tests based on normal, X2 ,t, F-distributions. Linear regression and test for linearity of regression. Interval estimation.

Linear Programming: Linear programming problem and its formulation, convex sets their properties, graphical method, basic feasible solution, simplex method, big-M and two phase methods, infeasible and unbounded LPP's, alternate optima. Dual problem and duality theorems, dual simplex method and its application in post optimality analysis, interpretation of dual variables. Balanced and unbalanced transportation problems, unimodular property and u-v method for solving transportation problems. Hungarian method for solving assignment problems.

Calculus of Variations and Integral Equations: Variational problems with fixed boundaries; sufficient conditions for extremum, Linear integral equations of Fredholm and Volterra type, their iterative solutions. Fredholm alternative.

ME - MECHANICAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

APPLIED MECHANICS AND DESIGN

Engineering Mechanics: Equivalent force systems, free-body concepts, equations of equilibrium, trusses and frames, virtual work and minimum potential energy. Kinematics and dynamics of particles and rigid bodies, impulse and momentum (linear and angular), energy methods, central force motion.

Strength of Materials: Stress and strain, stress-strain relationship and elastic constants, Mohr's circle for plane stress and plane strain, shear force and bending moment diagrams, bending and shear stresses, deflection of beams, torsion of circular shafts, thin and thick cylinders, Euler's theory of columns, strain energy methods, thermal stresses.

Theory of Machines: Displacement, velocity and acceleration, analysis of plane mechanisms, dynamic analysis of slider-crank mechanism, planar cams and followers, gear tooth profiles, kinematics of gears, governors and flywheels, balancing of reciprocating and rotating masses.

Vibrations: Free and forced vibration of single degree freedom systems, effect of damping, vibration isolation, resonance, critical speed of rotors.

Design of Machine Elements: Design for static and dynamic loading, failure theories, fatigue strength; design of bolted, riveted and welded joints; design of shafts and keys; design of spur gears, rolling and sliding contact bearings; brakes and clutches; belt, rope and chain drives.

FLUID MECHANICS AND THERMAL SCIENCES

Fluid Mechanics: Fluid properties, fluid statics, manometry, buoyancy; control-volume analysis of mass, momentum and energy; fluid acceleration; differential equations of continuity and momentum; Bernoulli's equation; viscous flow of incompressible fluids; boundary layer; elementary turbulent flow; flow through pipes, head losses in pipes, bends etc.

Heat-Transfer: Modes of heat transfer; one dimensional heat conduction, resistance concept, electrical analogy, unsteady heat conduction, fins; dimensionless parameters in free and forced convective heat transfer, various correlations for heat transfer in flow over flat plates and through pipes; thermal boundary layer; effect of turbulence; radiative heat transfer, black and grey surfaces, shape factors, network analysis; heat exchanger performance, LMTD and NTU methods.

Thermodynamics: Zeroth, First and Second laws of thermodynamics; thermodynamic system and processes; irreversibility and availability; behaviour of ideal and real gases, properties of pure substances, calculation of work and heat in ideal processes; analysis of thermodynamic cycles related to energy conversion; Carnot, Rankine, Otto, Diesel, Brayton and vapour compression cycles.

Power Plant Engineering: Steam generators; steam power cycles; steam turbines; impulse and reaction principles, velocity diagrams, pressure and velocity compounding; reheating and reheat factor; condensers and feed heaters.

I.C. Engines: Requirements and suitability of fuels in IC engines, fuel ratings, fuel-air mixture requirements; normal combustion in SI and CI engines; engine performance calculations.

Refrigeration and air-conditioning: Refrigerant compressors, expansion devices, condensers and evaporators; properties of moist air, psychrometric chart, basic psychometric processes.

Turbomachinery: Components of gas turbines; compression processes, centrifugal and axial flow compressors; axial flow turbines, elementary theory; hydraulic turbines; Euler-turbine equation; specific speed, Pelton-wheel, Francis and Kaplan turbines; centrifugal pumps.

MANUFACTURING AND INDUSTRIAL ENGINEERING

Engineering Materials: Structure and properties of engineering materials and their applications, heat treatment.

Metal Casting: Casting processes (expendable and non-expendable) -pattern, moulds and cores, heating and pouring, solidification and cooling, gating design, design considerations, defects.

Forming Processes: Stress-strain diagrams for ductile and brittle material, Plastic deformation and yield criteria, fundamentals of hot and cold working processes, Bulk metal forming processes (forging, rolling, extrusion, drawing), sheet metal working processes (punching, blanking, bending, deep drawing, coining, spinning, load estimation using homogeneous deformation methods, defects). processing of powder metals- atomization, compaction, sintering, secondary and finishing operations. forming and shaping of plastics- extrusion, injection moulding.

Joining Processes: Physics of welding, fusion and non-fusion welding processes, brazing and soldering, adhesive bonding, design considerations in welding, weld quality defects.

Machining and Machine Tool Operations: Mechanics of machining, single and multi-point cutting tools, tool geometry and materials, tool life and wear, cutting fluids, machinability, economics of machining, non-traditional machining processes.

Metrology and Inspection: Limits, fits and tolerances, linear and angular measurements, comparators, gauge design, interferometry, form and finish measurement, measurement of screw threads, alignment and testing methods.

Tool Engineering: Principles of work holding, design of jigs and fixtures.

Computer Integrated Manufacturing: Basic concepts of CAD, CAM and their integration tools.

Manufacturing Analysis: Part-print analysis, tolerance analysis in manufacturing and assembly, time and cost analysis.

Work-Study: Method study, work measurement, time study, work sampling, job evaluation, merit rating.

Production Planning and Control: Forecasting models, aggregate production planning, master scheduling, materials requirements planning.

Inventory Control: Deterministic and probabilistic models, safety stock inventory control systems.

Operations Research: Linear programming, simplex and duplex method, transportation, assignment, network flow models, simple queuing models, PERT and CPM

MN - MINING ENGINEERING

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

MINING ENGINEERING

Mechanics: Equivalent force systems, equations of equilibrium, two dimensional frames and trusses, free body diagrams, friction forces, particle kinematics and dynamics.

Mine Development, Geomechanics and Strata Control: Drivages for underground mine development, drilling methods and machines, explosives, blasting devices and practices, shaft sinking. Physico-mechanical properties of rocks, rock mass classification, ground control instrumentation and stress measurement techniques, theories of rock failure, ground vibrations, stress distribution around mine openings, subsidence, design of supports in roadways and workings, stability of open pits, slopes.

Mining Methods and Machinery: Surface mining - layout, development, loading, transportation and mechanization, continuous surface mining systems. Underground coal mining - bord and pillar system, longwall mining, thick seam mining methods. Underground metal mining: different stoping methods, stope mechanization, ore handling systems, mine filling. Generation and transmission of mechanical, hydraulic, and pneumatic power. Materials handling - haulages, conveyors, ropeways, face and development machinery, hoisting systems, and pumps.

Ventilation, Underground Hazards and Surface Environment: Underground atmosphere, heat load sources and thermal environment, air cooling, mechanics of air flow distribution, natural and mechanical ventilation, mine fans and their usage, auxiliary ventilation. Subsurface hazards from fires, explosions, gases, dust, and inundation, rescue apparatus and practices, safety in mines, accident analysis, noise, mine lighting. Air and water pollution: causes, dispersion, quality standards, and control.

Surveying, Mine Planning and Systems Engineering: Fundamentals of engineering surveying, Levels and levelling, Theodolite, tacheometry, triangulation, contouring, errors and adjustments, correlation, underground surveying, curves, photogrammetry, field astronomy, GPS fundamentals. Principles of planning - Sampling methods and practices, reserve estimation techniques, basics of geostatistics, optimization of facility location, cash flow concepts and mine valuation, open pit design. Work study, concepts of reliability, reliability of series and parallel systems. Linear programming, transportation and assignment problems, queueing, network analysis, inventory control.

MT - METALLURGICAL ENGINEERING

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

METALLURGICAL ENGINEERING

Thermodynamics and Rate Processes: Laws of thermodynamics, activity, equilibrium constant, applications to metallurgical systems, solutions, phase equilibria, basic kinetic laws, order of reactions, rate constants and rate limiting steps principles of electro chemistry, aqueous, corrosion and protection of metals, oxidation and high temperature corrosion - characterization and control; momentum transfer - concepts of viscosity, shell balances, Bernoulli's equation; heat transfer - conduction, convection and heat transfer coefficient relations, radiation, mass transfer - diffusion and Fick's laws.

Extractive Metallurgy: Flotation, gravity and other methods of mineral processing; agglomeration, pyro-hydro-and electro-metallurgical processes; material and energy balances; principles and processes for the extraction of non-ferrous metals - aluminium, copper, zinc, lead, magnesium, nickel, titanium and other rare metals; iron and steel making - principles, blast furnace, direct reduction processes, primary and secondary steel making, deoxidation and inclusion in steel; ingot and continuous casting; stainless steel making, design of furnaces; fuels and refractories.

Physical Metallurgy: Crystal structure and bonding characteristics of metals, alloys, ceramics and polymers; solid solutions; solidification; phase transformation and binary phase diagrams; principles of heat treatment of steels, aluminum alloys and cast irons; recovery, recrystallization and grain growth; industrially important ferrous and non-ferrous alloys; elements of X-ray and electron diffraction; principles of scanning and transmission electron microscopy; elements of ceramics, composites and electronic materials; electronic basis of thermal, optical, electrical and magnetic properties of materials.

Mechanical Metallurgy: Elements of elasticity and plasticity; defects in crystals; elements of dislocation theory - types of dislocations, slip and twinning, stress fields of dislocations, dislocation interactions and reactions, methods of seeing dislocations; strengthening mechanisms; tensile, fatigue and creep behaviour; superplasticity; fracture - Griffith theory, ductile to brittle transition, fracture toughness; failure analysis; mechanical testing - tension, compression, torsion, hardness, impact, creep, fatigue, fracture toughness and formability tests.

Manufacturing Processes: Metal casting - patterns, moulds, melting, gating, feeding and casting processes, defects and castings, hot and cold working of metals; Metal forming - fundamentals of metal forming, rolling wire drawing, extrusion, forming, sheet metal forming processes, defects in forming; Metal joining - soldering, brazing and welding, common welding processes, welding metallurgy, problems associated with welding of steels and aluminium alloys, defects in welding, powder metallurgy; NDT methods - ultrasonic, radiography, eddy current, acoustic emission and magnetic.

PH - PHYSICS

Mathematical Physics: Linear vector space, matrices; vector calculus; linear differential equations; elements of complex analysis; Laplace transforms, Fourier analysis, elementary ideas about tensors.

Classical Mechanics: Conservation laws; central forces; collisions and scattering in laboratory and centre of mass reference frames; mechanics of system of particles; rigid body dynamics; moment of inertia tensor; noninertial frames and pseudo forces; variational principle; Lagrange's and Hamilton's formalisms; equation of motion, cyclic coordinates, Poisson bracket; periodic motion, small oscillations, normal modes; wave equation and wave propagation; special theory of relativity - Lorentz transformations, relativistic kinematics, mass-energy equivalence.

Electromagnetic Theory: Laplace and Poisson equations; conductors and dielectrics; boundary value problems; Ampere's and Biot-Savart's laws; Faraday's law; Maxwell's equations; scalar and vector potentials; Coulomb and Lorentz gauges; boundary conditions at interfaces; electromagnetic waves; interference, diffraction and polarization; radiation from moving charges.

Quantum Mechanics: Physical basis of quantum mechanics; uncertainty principle; Schrodinger equation; one and three dimensional potential problems; Particle in a box, harmonic oscillator, hydrogen atom; linear vectors and operators in Hilbert space; angular momentum and spin; addition of angular momentum; time independent perturbation theory; elementary scattering theory.

Atomic and Molecular Physics: Spectra of one-and many-electron atoms; LS and jj coupling; hyperfine structure; Zeeman and Stark effects; electric dipole transitions and selection rules; X-ray spectra; rotational and vibrational spectra of diatomic molecules; electronic transition in diatomic molecules, Franck-Condon principle; Raman effect; NMR and ESR; lasers.

Thermodynamics and Statistical Physics: Laws of thermodynamics; macrostates, phase space; probability ensembles; partition function, free energy, calculation of thermodynamic quantities; classical and quantum statistics; degenerate Fermi gas; black body radiation and Planck's distribution law; Bose-Einstein condensation; first and second order phase transitions, critical point.

Solid State Physics: Elements of crystallography; diffraction methods for structure determination; bonding in solids; elastic properties of solids; defects in crystals; lattice vibrations and thermal properties of solids; free electron theory; band theory of solids;

metals, semiconductors and insulators; transport properties; optical, dielectric and magnetic properties of solids; elements of superconductivity.

Nuclear and Particle Physics: Rutheford scattering; basic properties of nuclei; radioactive decay; nuclear forces; two nucleon problem; nuclear reactions; conservation laws; fission and fusion; nuclear models; particle accelerators, detectors; elementary particles; photons, baryons, mesons and leptons; Quark model.

Electronics: Network analysis; semiconductor devices; bipolar transistors; FETs; power supplies, amplifier, oscillators; operational amplifiers; elements of digital electronics; logic circuits.

PI - PRODUCTION AND INDUSTRIAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

GENERAL ENGINEERING:

Engineering Materials: Structure and properties of engineering materials and their applications; effect of strain, strain rate and temperature on mechanical properties of metals and alloys; heat treatment of metals and alloys.

Applied Mechanics: Engineering mechanics - equivalent force systems, free body concepts, equations of equilibrium, virtual work and minimum potential energy; strength of materials-stress, strain and their relationship, Mohr's circle, deflection of beams, bending and shear stress, Euler's theory of columns.

Theory of Machines and Design: Analysis of planar mechanisms, plane cams and followers; governers and fly wheels; design of elements-failure theories; design of bolted, riveted and welded joints; design of shafts, keys, belt drives, brakes and clutches.

Thermal Engineering: Fluid machines - fluid statics, Bernoulli's equation, flow through pipes, equations of continuity and momentum; Thermodynamics - zeroth, First and Second laws of thermodynamics, thermodynamic system and processes, calculation of work and heat for systems and control volumes; Heat transfer - fundamentals of conduction, convection and radiation.

PRODUCTION ENGINEERING

Metal Casting: Casting processes; patterns-materials; allowances; moulds and cores - materials, making and testing; melting and founding of cast iron, steels and nonferrous metals and alloys; solidification; design of casting, gating and risering; casting defects and inspection.

Metal working: Stress-strain in elastic and plastic deformation; deformation mechanisms; hot and cold working-forging, rolling, extrusion, wire and tube drawing; sheet metal working; analysis of rolling, forging, extrusion and wire /rod drawing; metal working defects, high energy rate forming processes-explosive, magnetic, electro and electrohydraulic.

Metal Joining Processes: Welding processes - gas shielded metal arc, TIG, MIG, submerged arc, electroslag, thermit, resistance, pressure and forge welding; thermal cutting; other joining processes - soldering, brazing, braze welding; welding codes, welding symbols, design of welded joints, defects and inspection; introduction to modern welding processes - friction, ultrasonic, explosive, electron beam, laser and plasma.

Machining and Machine Tool Operations: Machining processes-turning, drilling, boring, milling, shaping, planing, sawing, gear cutting, thread production, broaching, grinding, lapping, honing super finishing; mechanics of cutting- Merchant's analysis, geometry of cutting tools, cutting forces, power requirements; selection of process parameters; tool materials, tool wear and tool life, cutting fluids, machinability; nontraditional machining processes and hybrid processes- EDM, CHM, ECM, USM, LBM, EBM, AJM, PAM AND WJM; economics of machining.

Metrology and Inspection: Limits and fits, linear and angular measurements by mechanical and optical methods, comparators; design of limit gauges; interferometry; measurement of straightness, flatness, roundness, squareness and symmetry; surface finish measurement; inspection of screw threads and gears; alignment testing.

Powder Metallurgy and Processing of Plastics: Production of powders, compaction, sintering; Polymers and composites; injection, compression and blow molding, extrusion, calendaring and thermoforming; molding of composites.

Tool Engineering: Work-holding-location and clamping; principles and methods; design of jigs and fixtures; design of press working tools, forging dies.

Manufacturing Analysis: Sources of errors in manufacturing; process capability; part-print analysis; tolerance analysis in manufacturing and assembly; process planning; parameter selection and comparison of production alternatives; time and cost analysis; Issues in choosing manufacturing technologies and strategies.

Computer Integrated Manufacturing: Basic concepts of CAD, CAM, CAPP, group technology, NC, CNC, DNC, FMS, Robotics and CIM.

INDUSTRIAL ENGINEERING

Product Design and Development: Principles of good product design, component and tolerance design; efficiency, quality and cost considerations; product life cycle; standardization, simplification, diversification, value analysis, concurrent engineering.

Engineering Economy and Costing: Financial statements; elementary cost accounting, methods of depreciation; break-even analysis, techniques for evaluation of capital investments.

Work System Design: Taylor's scientific management, Gilbreths's contributions; productivity concepts and measurements; method study, micro-motion study, principles of motion economy; human factors engineering, ergonomics; work measurement - time study, PMTS, work sampling; job evaluation, merit rating, wage administration, incentive systems; business process reengineering.

Logistics and Facility Design: Facility location factors, evaluation of alternatives, types of plant layout, evaluation; computer aided layout; assembly line balancing; material handling systems; supply chain management.

Production Planning and Inventory Control: Inventory Function costs, classifications - deterministic and probabilistic models; quantity discount; safety stock; inventory control system; Forecasting techniques - causal and time series models, moving average, exponential smoothing; trend and seasonality; aggregate production planning; master scheduling; bill of materials and material requirement planning; order control and flow control, routing, scheduling and priority dispatching; JIT; Kanban PULL systems; bottleneck scheduling and theory of constraints.

Operation Research: Linear programming - problem formulation, simplex method, duality and sensitivity analysis; transportation; assignment; network flow models, constrained optimization and Lagrange multipliers; simple queuing models; dynamic programming; simulation; PERT and CPM, time-cost trade-off, resource leveling.

Quality Control: Taguchi method; design of experiments; quality costs, statistical quality assurance, process control charts, acceptance sampling, zero defects; quality circles, total quality management.

Reliability and Maintenance: Reliability, availability and maintainability; probabilistic failure and repair times; system reliability; preventive maintenance and replacement, TPM.

Management Information System: Value of information; information storage and retrieval system - database and data structures; interactive systems; knowledge based systems.

Intellectual Property System: Definition of intellectual property, importance of IPR; TRIPS, and its implications, WIPO and Global IP structure, and IPS in India; patent, copyright, industrial design and trademark; meanings, rules and procedures, terms, infringements and remedies.

PY - PHARMACEUTICAL SCIENCES

Natural Products: Pharmacognosy & Phytochemistry - Chemistry, tests, isolation, characterization and estimation of phytopharmaceuticals belonging to the group of Alkaloids, Glycosides, Terpenoids, Steroids, Bioflavanoids, Purines, Guggul lipids. Pharmacognosy of crude drugs which contain the above constituents. Standardisation of raw materials and herbal products. WHO guide lines. Quantitative microscopy including modern techniques used for evaluation. Biotechnological principles and techniques for plant development Tissue culture.

Pharmacology: General pharmacological principles including Toxicology. Drug interaction. Pharmacology of drugs acting on Central nervous system, Cardiovascular system, Autonomic nervous system, Gastro intestinal system and Respiratory system. Pharmacology of Autocoids, Hormones, Chemotherapeutic agents including anticancer drugs. Bioassays. Immuno Pharmacology.

Medicinal Chemistry: Structure, nomenclature, classification, synthesis, SAR and metabolism of the following category of drugs which are official in Indian Pharmacopoeia and British Pharmacopoeia Hypnotics and Sedatives, Analgesics, NSAIDS, Neuroleptics, Antidepressants, Anxiolytics, Anticonvulsants, Antihistaminics, Local anaesthetics, Cardio Vascular drugs - Antianginal agents Vasodilators, Adrenergic & cholinergic drugs, Cardiotonic agents, Diuretics, Antihypertensive drugs, Hypoglycemic agents, Antilipedmic agents, Coagulants, Anticoagulants, Antiplatelet agents. Chemotherapeutic agents - Antibiotics, Antibacterials, Sulphadrugs. Antiproliozoal drugs, Antiviral, Antitubercular, Antimalarial, Anticancer, Antiamoebic drugs. Diagnostic agents. Preparation and storage and uses of official Radiopharmaceuticals. Vitamins and Hormones.

Pharmaceutics: Development, manufacturing standards, labeling, packing as per the pharmacopoeal requirements, Storage of different dosage forms and new drug delivery systems. Biopharmaceutics and Pharmacokinetics and their importance in formulation. Formulation and preparation of cosmetics - lipstick, shampoo, creams, nail preparations and dentifrices. Pharmaceutical calculations.

Pharmaceutical Jurisprudence: Legal aspects of manufacture, storage, sale of drugs. D and C act and rules. Pharmacy act.

Pharmaceutical Analysis: Principles, instrumentation and applications of the following. Absorption spectroscopy (UV, visible & IR), Fluorimetry, Flame photometry, Potentiometry, Conductometry and Plarography. Pharmacopoeial assays. Principles of NMR, ESR, Mass spectroscopy, X-ray diffraction analysis and different chromatographic methods.

Biochemistry and Clinical Pharmacy: Biochemical role of hormones, Vitamins, Enzymes, Nucleic acids. Bioenergetics. General principles of immunology. Immunological techniques. Adverse drug interaction.

Microbiology: Principles and methods of microbiological assays of the Pharmacopoeia. Methods of preparation of official sera and vaccines. Serological and diagnostic tests. Applications of microorganisms in Bio Conversions and in Pharmaceutical industry.

TF - TEXTILE ENGINEERING AND FIBRE SCIENCE

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

TEXTILE ENGINEERING & FIBRE SCIENCE

Textile Fibres: Classification of textile fibres according to their nature and origin; general characteristics of textile fibres-their chemical and physical structures and their properties; essential characteristics of fibre forming polymers; uses of natural and man-made fibres; physical and chemical methods of fibre and blend identification and blend analysis.

Melt Spinning processes with special reference to polyamide and polyester fibres; wet and dry spinning of viscose and acrylic fibres; post spinning operations-drawing, heat setting, texturing- false twist and air-jet, tow-to-top conversion. Methods of investigating fibre structure e.g. X-ray diffraction, birefringence, optical and electron microscopy, I.R. absorption, thermal methods; structure and morphology and principal natural and man-made fibres, mechanical properties of fibres, moisture sorption in fibres; fibre structure and property correlation.

Textile Testing: Sampling techniques, sample size and sampling errors; measurement of fibre length, fineness, crimp, strength and reflectance; measurement of cotton fibre maturity ad trash content; HVI and AFIS for fibre testing. Measurement of yarn count, twist and hairiness; tensile testing of fibres, yarn and fabrics; evenness testing of slivers, rovings and yarns; testing equipment for measurement test methods of fabric properties like thickness, compressibility, air permeability, drape, crease recovery, tear strength bursting strength and abrasion resistance. Correlation analysis, significance tests and analysis of variance; frequency distributions and control charts.

Yarn Manufacture and Yarn Structure: Modern methods of opening, cleaning and blending of fibrous materials; the technology of carding with particular reference to modern developments; causes of irregularity introduced by drafting, the development of modern drafting systems; principles and techniques of preparing material for combing; recent development in combers; functions and synchronization of various mechanisms concerned with roving production; forces acting on yarn and traveller, ring and traveller designs; causes of end breakages; properties of doubles yarns; new methods of yarn production such as rotor spinning, air jet spinning and friction spinning.

Yarn diameter; specific volume, packing coefficient; twist-strength relationship; fibre orientation in yarn; fibre migration.

Fabric Manufacture and Fabric Structure: Principles of cheese and cone winding processes and machines; random and precision winding; package faults and their remedies; yarn clearers and tensioners; different systems of yarn splicing; features of modern cone winding machines; different types of warping creels; features of modern beam and sectional warping machines; different sizing systems, sizing of spun and filament yarns, modern sizing machines; principles of pirn winding processes and machines; primary and secondary motions of loom, effect of their settings and timings on fabric formation, fabric appearance and weaving performance; dobby and jacquard shedding; mechanics of weft insertion with shuttle; warp and weft stop motions, warp protection, weft replenishment; functional principles of weft insertion systems of shuttleless weaving machines, principles of multiphase and circular looms. Principles of weft and warp knitting; basic weft and warp knitted structures; classification, production and areas of application of nonwoven fabrics.

Basic woven fabric constructions and their derivatives; crepe, cord, terry, gauze, lino and double cloth constructions.

Peirce's equations for fabric geometry; thickness, cover and maximum sett of woven fabrics

Textile Chemical Processing: Preparatory processes for natural-and and their blends; mercerization of cotton; machines for yarn and fabric mercerization.

Dyeing and printing of natural- and synthetic- fibre fabrics and their blends with different dye classes; dyeing and printing machines; styles of printing; fastness properties of dyed and printed textile materials.

Finishing of textile materials, wash and wear, durable press, soil release, water repellent, flame retardant and antistatic finishes; shrink-resistance finish for wool; heat setting of synthetic-fibre fabrics, finishing machines; energy efficient processes; pollution control.

XE - ENGINERING SCIENCES

The syllabi of the sections of this paper are as follows:

SECTION A. ENGINEERING MATHEMATICS (Compulsory)

Linear Algebra : Determinates, algebra of matrices, rank, inverse, system of linear equations, symmetric, skew-symmetric and orthogonal matrices. Hermitian, skew-hermitian and unitary matrices. eigenvalues and eigenvectors, diagonalisation of matrices, Cayley-Hamiltonian, quadratic forms.

Calculus : Functions of single variables, limit, continuity and differentiability, Mean value theorems, Intermediate forms and L'Hospital rule, Maxima and minima, Taylor's series, Fundamental and mean value-theorems of integral calculus. Evaluation of definite and improper integrals, Beta and Gamma functions, Functions of two variables, limit, continuity, partial derivatives, Euler's theorem for homogeneous functions, total derivatives, maxima and minima, Lagrange method of multipliers, double and triple integrals and their applications, sequence and series, tests for convergence, power series, Fourier Series, Fourier integrals.

Complex variable: Analytic functions, Cauchy's integral theorem and integral formula without proof. Taylor's and Laurent' series, Residue theorem (without proof) with application to the evaluation of real integarls.

Vector Calculus: Gradient, divergence and curl, vector identities, directional derivatives, line, surface and volume integrals, Stokes, Gauss and Green's theorems (without proofs) with applications.

Ordinary Differential Equations: First order equation (linear and nonlinear), higher order linear differential equations with constant coefficients, method of variation of paramaters, Cauchy's and Euler's equations, initial and boundary value problems, power series solutions, Legendre polynomials and Bessel's functions of the first kind.

Partial Differential Equations: Variables separable method, solutions of one dimensional heat, wave and Laplace equations.

Probability and Statistics: Definitions of probability and simple theorems, conditional probability, mean, mode and standard deviation, random variables, discrete and continuous distributions, Poisson, normal and Binomial distribution, correlation and regression

Numerical Methods: L-U decomposition for systems of linear equations,Newton-Raphson method, numerical integration(trapezoidal and Simpson's rule), numerical methods for first order differential equation (Euler method)

SECTION B. COMPUTATIONAL SCIENCE

Numerical Methods: Truncation errors, round off errors and their propagation; Interpolation; Lagrange, Newton's forward, backward and divided difference formulas, least square curve fitting, solution of non-linear equations of one variables using bisection, false position, secant and Newton Raphson methods; Rate of convergence of these methods, general iterative methods. Simple and multiple roots of polynomials. Solutions of system of linear algebraic equations using Gauss elimination methods, Jacobi and Gauss-Seidel iterative methods and their rate of convergence; ill conditioned and well conditioned system. eigen values and eigen vectors using power methods. Numerical integration using trapezoidal, Simpson's rule and other quadrature formulas. Numerical Differentiation. Solution of boundary value problems. Solution of initial value problems of ordinary differential equations using Euler's method, predictor corrector and Runge Kutta method.

Programming : Elementary concepts and terminology of a computer system and system software, Fortran77 and C programming.

Fortran : Program organization, arithmetic statements, transfer of control, Do loops, subscripted variables, functions and subroutines.

C language : Basic data types and declarations, flow of control- iterative statement, conditional statement, unconditional branching, arrays, functions and procedures.

SECTION C. ELECTRICAL SCIENCES

Electric Circuits: Ideal voltage and current sources; RLC circuits, steady state and transient analysis of DC circuits, network theorems; alternating currents and voltages, single-phase AC circuits, resonance; three-phase circuits.

Magnetic circuits: Mmf and flux, and their relationship with voltage and current; transformer, equivalent circuit of a practical transformer, three-phase transformer connections.

Electrical machines: Principle of operation, characteristics, efficiency and regulation of DC and synchronous machines; equivalent circuit and performance of three-phase and single-phase induction motors.

Electronic Circuits: Characteristics of p-n junction diodes, zener diodes, bipolar junction transistors (BJT) and junction field effect transistors (JFET); MOSFET's structure, characteristics, and operations; rectifiers, filters, and regulated power supplies; biasing circuits, different configurations of transistor amplifiers, class A, B and C of power amplifiers; linear applications of operational amplifiers; oscillators; tuned and phase shift types.

Digital circuits: Number systems, Boolean algebra; logic gates, combinational circuits, flip-flops (RS, JK, D and T) counters.

Measuring instruments: Moving coil, moving iron, and dynamometer type instruments; shunts, instrument transformers, cathode ray oscilloscopes; D/A and A/D converters.

SECTION D. FLUID MECHANICS

Fluid Properties: Relation between stress and strain rate for Newtonian fluids

Hydrostatics, buoyancy, manometry

Concept of local and convective accelerations; control volume analysis for mass, momentum and energy conservation.

Differential equations of continuity and momentum (Euler's equation of motion); concept of fluid rotation, stream function, potential function; Bernoulli's equation and its applications.

Qualitative ideas of boundary layers and its separation; streamlined and bluff bodies; drag and lift forces.

Fully-developed pipe flow; laminar and turbulent flows; friction factor; Darcy Weisbach relation; Moody's friction chart; losses in pipe fittings; flow measurements using venturimeter and orifice plates.

Dimensional analysis; similitude and concept of dynamic similarity; importance of dimensionless numbers in model studies.

SECTION E. MATERIALS SCIENCE

Atomic structure and bonding in materials: metals, ceramics and polymers.

Structure of materials: Crystal systems, unit cells and space lattice; determination of structures of simple crystals by X-ray diffraction; Miller indices for planes and directions. Packing geometry in metallic, ionic and covalent solids.

Concept of amorphous, single and polycrystalline structures and their effects on properties of materials.

Imperfections in crystalline solids and their role in influencing various properties.

Fick´s laws of diffusion and applications of diffusion in sintering, doping of semiconductors and surface hardening of metals.

Alloys: solid solution and solubility limit. Binary phase diagram, intermediate phases and intermetallic compounds; iron-iron carbide phase diagram. Phase transformation in steels. Cold and hot working of metals, recovery, recrystallization and grain growth.

Properties and applications of ferrous and nonferrous alloys.

Structure, properties, processing and applications of traditional and advanced ceramics.

Polymers: classification, polymerization, structure and properties, additives for polymer products, processing and application.

Composites: properties and application of various composites.

Corrosion and environmental degradation of materials (metals, ceramics and polymers).

Mechanical properties of materials: Stress-strain diagrams of metallic, ceramic and polymeric materials, modulus of elasticity, yield strength, plastic deformation and toughness, tensile strength and elongation at break; viscoelasticity, hardness, impact strength. ductile and brittle fracture. creep and fatigue properties of materials.

Heat capacity, thermal conductivity, thermal expansion of materials.

Concept of energy band diagram for materials; conductors, semiconductors and insulators in terms of energy bands. Electrical conductivity, effect of temperature on conductivity in materials, intrinsic and extrinsic semiconductors, dielectric properties of materials.

Refraction, reflection, absorption and transmission of electromagnetic radiation in solids.

Origin of magnetism in metallic and ceramic materials, paramagnetism, diamagnetism, antiferromagnetism, ferromagnetism, ferrimagnetism in materials and magnetic hysteresis.

Advanced materials: Smart materials exhibiting ferroelectric, piezoelectric, optoelectronic, semiconducting behaviour; lasers and optical fibers; photoconductivity and superconductivity in materials.

SECTION F. SOLID MECHANICS

Equivalent force systems; free-body diagrams; equilibrium equations; analysis of determinate and indeterminate trusses and frames; friction.

Simple relative motion of particles; force as function of position, time and speed; force acting on a body in motion; laws of motion; law of conservation of energy; law of conservation of momentum

Stresses and strains; principal stresses and strains; Mohr's circle; generalized Hooke's Law; equilibrium equations; compatibility conditions; yield criteria.

Axial, shear and bending moment diagrams; axial, shear and bending stresses; deflection (for symmetric bending); torsion in circular shafts; thin cylinders; energy methods (Castigliano's Theorems); Euler buckling.

SECTION G. THERMODYNAMICS

Basic Concepts: Continuum, macroscopic approach, thermodynamic system (closed and open or control volume); thermodynamic properties and equilibrium; state of a system, state diagram, path and process; different modes of work; Zeroth law of thermodynamics; concept of temperature; heat.

First Law of Thermodynamics: Energy, enthalpy, specific heats, first law applied to systems and control volumes, steady and unsteady flow analysis.

Second Law of Thermodynamics: Kelvin-Planck and Clausius statements, reversible and irreversible processes, Carnot theorems, thermodynamic temperature scale, Clausius inequality and concept of entropy, principle of increase of entropy; availability and irreversibility.

Properties of Pure Substances: Thermodynamic properties of pure substances in solid, liquid and vapour phases, P-V-T behaviour of simple compressible substances, phase rule, thermodynamic property tables and charts, ideal and real gases, equations of state, compressibility chart.

Thermodynamic Relations: T-ds relations, Maxwell equations, Joule-Thomson coefficient, coefficient of volume expansion, adiabatic and isothermal compressibilities, Clapeyron equation.

Ideal Gas Mixtures: Dalton's and Amagat's laws, calculations of properties, air-water vapour mixtures.

XL - LIFE SCIENCES

The syllabi of the Sections of this paper are as follows:

SECTION H. CHEMISTRY (Compulsory)

Atomic structure and periodicity: Quantum chemistry; Planck's quantum theory, wave particle duality, uncertainty principle, quantum mechanical model of hydrogen atom; electronic configuration of atoms; periodic table and periodic properties; ionization energy, election affinity, electronegativity, atomic size.

Structure and bonding: Ionic and covalent bonding M.O. and V.B. approaches for diatomic molecules, VSEPR theory and shape of molecules, hybridisation, resonance, dipole moment, structure parameters such as bond length, bond angle and bond energy, hydrogen bonding, van der Waals interactions. Ionic solids; ionic radii, lattice energy (Born-Haber Cycle).

s.p. and d Block Elements: Oxides, halides and hydrides of alkali and alkaline earth metals, B, Al, S, N, P and S, silicones, general characteristics of 3d elements, coordination complexes: valence bond and crystal field theory, color, geometry and magnetic properties.

Chemical Equilibria: Colligative properties of solutions, ionic equilibria in solution, solubility product, common ion effect, hydrolysis of salts, pH, buffer and their applications in chemical analysis.

Electrochemistry: Conductance, Kohlrausch law, Half Cell potentials, emf, Nernst equation, galvanic cells, thermodynamic aspects and their applications.

Reaction Kinetics: Rate constant, order of reaction, molecularity, activation energy, zero, first and second order kinetics, equilibrium constants (Kc, Kp and Kx) for homogeneous reactions, catalysis and elementary enzyme reactions.

Thermodynamics: First law, reversible and irreversible processes, internal energy, enthalpy, Kirchoff's equation, heat of reaction, Hess law, heat of formation, Second law, entropy, free energy, and work function. Gibbs-Helmholtz equation, Clausius-Clapeyron equation, free energy change and equilibrium constant, Troutons rule, Third law of thermodynamics.

Mechanistic Basis of Organic Reactions: Elementary treatment of SN1, SN2, E1 and E2 reactions, Hoffmann and Saytzeff rules, Addition reactions, Markonikoff rule and Kharash effect, Diels-Alder reaction, aromatic electrophilic substitution, orientation effect as exemplified by various functional groups.

Structure-Reactivity Correlations: Acids and bases, electronic and steric effects, optical and geometrical isomerism, tautomerism, concept of aromaticity

SECTION I. BIOCHEMISTRY

Organization of life. Importance of water. Cell structure and organelles. Structure and function of biomolecules: Carbohydrates, Lipids, Proteins and Nucleic acids. Biochemical separation techniques. Spectroscopic methods; UV-visible and fluorescence. Protein structure, folding and function: Myoglobin, Hemoglobin, Lysozyme, ribonuclease A, Carboxypeptidase and Chymotrypsin. Enzyme kinetics and regulation, Coenzymes.

Metabolism and bioenergitics. Generation and utilization of ATP. Photosynthesis. Major metabolic pathways and their regulation. Biological membranes. Transport across membranes. Signal transduction; hormones and neurotransmitters.

DNA replication, transcription and translation. Biochemical regulation of gene expression. Recombinant DNA technology and applications. Genomics and Proteomics.

The immune system. Active and passive immunity. Complement system. Antobody structure, function and diversity. Cells of the immune system: T, B and macrophages. T and B cell activation. Major histocompatibilty complex. T cell receptor. Immunological techniques: Immunodiffusion, immunoelectrophoresis, RIA and ELISA.

SECTION J. BIOTECHNOLOGY

Recombinant DNA technology for the production of therapeutic proteins. Micro array technology. Heterologous protein expression systems in bacteria, yeast etc.

Architecture of plant genome; plant tissue culture techniques; methods of gene transfer into plant cells; manipulation of phenotypic traits in plants; plant cell fermentations and production of secondary metabolites using suspension/ immobilized cell culture; methods for plant micro propagation; crop improvement and development of transgenic plants. Expression of animal proteins in plants.

Animal cell metabolism and regulation; cell cycle; primary cell culture; nutritional requirements for animal cell culture; techniques for the mass culture of animal cell lines; production of vaccines; growth hormones and interferons using animal cell culture; cytokines-production and therapeutic uses; hybridoma technology; vectors for gene transfer and expression in animal cells. Transgenic animals and molecular pharming.

Microbial production of industrial enzymes; methods for immobilization of enzymes; kinetics of soluble and immobilized enzymes; application of soluble and immobilized enzymes; enzyme-based sensors.

Microbial growth kinetics; batch, fed batch and continuous culture of microbial cells; media for industrial fermentations; sterilization of air and media; design features and operation of stirred tank, air-lift and fluidized bed reactors; aeration and agitation in aerobic fermentations; recovery and purification of fermentation products- filtration, centrifugation, cell disintegration, solvent extraction and chromatographic separations; industrial fermentations for the production of ethanol, citric acid, lysine, penicillin and other biomolecules; simple calculations based on material and energy balance of fermentation processes; application of microbes in the management of domestic and industrial wastes.

SECTION K. BOTANY

Anatomy: Roots, stem and leaves of land plants, meristems, vascular system, their ontogeny, structure and functions. Plant cell structure, organisation, organelles, cytoskeleton, cell wall and membranes.

Development: Cell cycle, cell division, senescence, hormonal regulation of growth; life cycle of an angiosperm, pollination, fertilization, embryogenesis, seed formation, seed storage proteins, seed dormancy and germination. Concept of cellular totipotency, organogenesis and somatic embryogenesis, somaclonal variation, embryo culture, in vitro fertilization.

Physiology and Biochemistry: Plant water relations, transport of minerals and solutes, N2 metabolism, proteins and nucleic acid, respiration, photophysiology, photosynthesis, photorespiration; biosynthesis, mechanism of action and physiological effects of plant growth regulators.

Genetics: Principles of Mendelian inheritance, linkage, recombination and genetic mapping; extrachromosomal inheritance; eukaryotic genome organization (chromatin structure) and regulation of gene expression, gene mutation, chromosome aberrations (numerical and structural), transposons.

Plant Breeding: Principles, methods - selection, hybridization, heterosis; male sterility, self and inter-specific incompatibility; haploidy; somatic cell hybridization; molecular marker-assisted selection; gene transfer methods viz. direct and vector-mediated, transgenic plants and their applications in agriculture.

Economic Botany: Economically important plants - cereals, pulses, plants yielding fiber, timber, sugar, beverages, oils, rubber, dyes, gums, drugs and narcotics - a general account.

Systematics: Systems of classification (non-phylogenetic vs. phylogenetic - outline), plant groups, molecular systematics.

Plant Pathology: Nature and classification of plant diseases, diseases of important crops caused by fungi, bacteria and viruses, and their control measures, mechanism(s) of pathogenesis and resistance, molecular detection of pathogens; plant-microbe beneficial interactions.

Ecology and Plant Geography: Ecosystems - types, dynamics, degradation, ecological succession; food chains; vegetation types of the world; pollution and global warming; speciation and extinction, conservation strategies, cryopreservation.

SECTION L. MICROBIOLOGY

Historical perspective - Discovery of the microbial world; Controversy over spontaneous generation; Role of microorganisms in transformation of organic matter and in the causation of diseases.

Methods in microbiology - Pure culture techniques; Theory and practice of sterilization; Principles of microbial nutrition; Construction of culture media; Enrichment culture techniques for isolation of chemoautotrophs, chemoheterotrophs and photosynthetic microorganisms.

Microbial evolution, systematics and taxonomy - Evolution of earth and earliest life forms; Primitive organisms and their metabolic strategies; New approaches to bacterial taxonomic classification including ribotyping; Nomenclature.

Microbial diversity - Bacteria, archea and their broad classification; Eukaryotic microbes, yeast, fungi, slime mold and protozoa; Viruses and their classification.

Microbial growth -The definition of growth, mathematical expression of growth, growth curve, measurement of growth and growth yields; Synchronous growth; Continuous culture.

Nutrition and metabolism - Overview of metabolism; Microbial nutrition; Energy classes of microorganisms; Culture media; Energetics, modes of ATP generation; ATP generation by heterotrophs; Fermentation; Glycolysis; Respiration; The citric acid cycle; Electron transport systems; Alternate modes of energy generation; Pathways (anabolism) in the biosynthesis of amino acids, purines, pyrimidines and fatty acids.

Metabolic diversity among microorganisms - Photosynthesis in microorganisms; Role of chlorophylls, carotenoids and phycobilins; Calvin cycle; Chemolithotrophy; Hydrogen- iron- nitrite-oxidizing bacteria; Nitrate and sulfate reduction; Methanogenesis and acetogenesis.

Prokaryotic cells: structure-function - Cells walls of eubacteria (peptidoglycan) and related molecules; Outer-membrane of gram-negative bacteria; Cell wall and cell membrane synthesis; Flagella and motility; Cell inclusions like endospores, gas vesicles.

Microbial diseases and host parasite relationships - Normal microflora of skin; Oral cavity; Gastrointestinal tract; Entry of pathogens into the host; Infectious disease transmission; Respiratory infections caused by bacteria and viruses; Tuberculosis; Sexually transmitted diseases including AIDS; Diseases transmitted by animals (Rabies, plague), insects and ticks (rikettsias, Lyme disease, malaria); Food and water borne diseases; Public health and water quality; Pahtogenic fungi; Emerging and resurgent infectious diseases.

Chemotherapy/Antibiotics - Antimicrobial agents; Sulfa drugs; Antibiotics; Pencillins and cephalosporins; Broad-spectrum antibiotics; Antibiotics from prokaryotes; Antifungal antibiotics; Mode of action; Resistance to antibiotics.

Microbial genetics - Genes, mutation and mutagenesis - UV and chemical mutagnes; Types of mutations; Ames test for mutagenesis; Methods of genetic analysis. Bacterial genetic system - Transformation; Conjugation; Transduction; Recombination; Plasmids and Transposons; Bacterial genetic map with reference to E. coli. Viruses and their genetic system - Phage ? and its life cycle; RNA phages; RNA viruses; Retroviruses; Genetic systems of yeast and Neurospora; Extrachromosomal inheritance and mitochondrial genetics; Basic concept of genomics.

SECTION M. ZOOLOGY

Animal world: Animal diversity, distribution, systematic and classification of animals, the phylogenetic relationship.

Evolution: Origin of life, history of life on earth, evolutionary theories, natural selection, adaptation, speciation.

Genetics: Principles of inheritance, molecular basis of heredity, the genetic material, transmission of genetic material, mutations, cytoplasmic inheritance.

Biochemistry and Molecular Biology: Nucleic acids, proteins and other biological macromolecules. Replication, transcription and translation, regulation of gene expression, organization of genome, Kreb's cycle, glycolysis, enzyme catalysis, hormones and their action.

Cell Biology: Structure of cell, cellular organelles and their structure and function, cell cycle, cell division, cellular differentiation, chromosome and chromatin structure. Eukaryotic gene organisation and expression.

Animal Anatomy and Physiology: Comparative physiology, the respiratory system, circulatory system, digestive system, the nervous system, the excretory system, the endocrine system, the reproductive system, the skeletal system, osmoregulation.

Parasitology and Immunology: Nature of parasite, host-parasite relation, protozoan and helminthic parasites, the immune response, cellular and humoral immune response, evolution of the immune system.

Development Biology: Embryonic development, cellular differentiation, organogenesis, metamorphosis, genetic basis of development.

Ecology: The ecosystem, habitats the food chain, population dynamics, species diversity, zoogeography, biogeochemical cycles, conservation biology.

Animal Behaviour: Types of behaviours, courtship, mating and territoriality, instinct, learning and memory, social behaviour across the animal taxa, communication, pheromones, evolution of animal behaviour.

IT - INFORMATION TECHNOLOGY

ENGINEERING MATHEMATICS

Mathematical Logic: Propositional Logic; First Order Logic.

Probability: Conditional Probability; Mean, Median, Mode and Standard Deviation; Random Variables; Distributions; uniform, normal, exponential, Poisson, Binomial.

Set Theory & Algebra: Sets; Relations; Functions; Groups; Partial Orders; Lattice; Boolean Algebra.

Combinatorics: Permutations; Combinations; Counting; Summation; generating functions; recurrence relations; asymptotics.

Graph Theory: Connectivity; spanning trees; Cut vertices & edges; covering; matching; independent sets; Colouring; Planarity; Isomorphism.

Linear Algebra: Algebra of matrices, determinants, systems of linear equations, Eigen values and Eigen vectors.

Numerical Methods: LU decomposition for systems of linear equations; numerical solutions of non linear algebraic equations by Secant, Bisection and Newton-Raphson Methods; Numerical integration by trapezoidal and Simpson's rules.

Calculus: Limit, Continuity & differentiability, Mean value Theorems, Theorems of integral calculus, evaluation of definite & improper integrals, Partial derivatives, Total derivatives, maxima & minima.

FORMAL LANGUAGES AND AUTOMATA

Regular Languages: finite automata, regular expressions, regular grammar.

Context free languages: push down automata, context free grammars

COMPUTER HARDWARE

Digital Logic: Logic functions, minimization, design and synthesis of combinatorial and sequential circuits, number representation and computer arithmetic (fixed and floating point)

Computer organization: Machine instructions and addressing modes, ALU and data path, hardwired and microprogrammed control, memory interface, I/O interface (interrupt and DMA mode), serial communication interface, instruction pipelining, cache, main and secondary storage

SOFTWARE SYSTEMS

Data structures and Algorithms: the notion of abstract data types, stack, queue, list, set, string, tree, binary search tree, heap, graph, tree and graph traversals, connected components, spanning trees, shortest paths, hashing, sorting, searching, design techniques (greedy, dynamic, divide and conquer), asymptotic analysis (best, worst, average cases) of time and space, upper and lower bounds, intractability

Programming Methodology: C programming, program control (iteration, recursion, functions), scope, binding, parameter passing, elementary concepts of object oriented programming

Operating Systems (in the context of Unix): classical concepts (concurrency, synchronization, deadlock), processes, threads and interprocess communication, CPU scheduling, memory management, file systems, I/O systems, protection and security

Information Systems and Software Engineering: information gathering, requirement and feasibility analysis, data flow diagrams, process specifications, input/output design, process life cycle, planning and managing the project, design, coding, testing, implementation, maintenance.

Databases: relational model, database design, integrity constraints, normal forms, query languages (SQL), file structures (sequential, indexed), b-trees, transaction and concurrency control

Data Communication: data encoding and transmission, data link control, multiplexing, packet switching, LAN architecture, LAN systems (Ethernet, token ring), Network devices: switches, gateways, routers

Networks: ISO/OSI stack, sliding window protocols, routing protocols, TCP/UDP, application layer protocols & systems (http, smtp, dns, ftp), network security

Web technologies: three tier web based architecture; JSP, ASP, J2EE, .NET systems; html, XML

AG - AGRICULTURAL ENGINEERING

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

FARM MACHINERY AND POWER:

Sources of power on the farm-human, animal, mechanical, electrical, wind, solar and biomass; design and selection of machine elements - gears, pulleys, chains and sprockets and belts; overload safety devices used in farm machinery; measurement of force, torque, speed, displacement and acceleration on machine elements.

Soil tillage; forces acting on a tillage tool; hitch systems and hitching of tillage implements; functional requirements, principles of working, construction and operation of manual, animal and power operated equipment for tillage. sowing, planting, fertilizer application, inter-cultivation, spraying, mowing, chaff cutting, harvesting, threshing and transport; testing of agricultural machinery and equipment; calculation of performance parameters -field capacity, efficiency, application rate and losses; cost analysis of implements and tractors.

Thermodynamic principles of I.C. engines; I.C. engine cycles; engine components; fuels and combustion; lubricants and their properties; I.C. engine systems - fuel, cooling, lubrication, ignition, electrical, intake and exhaust; selection, operation, maintenance and repair of I.C. engines; power efficiencies and measurement; calculation of power, torque, fuel consumption, heat load and power losses.

Tractors and power tillers - type, selection, maintenance and repair; tractor clutches and brakes; power transmission systems - gear trains, differential, final drives and power take-off; mechanics of tractor chassis; traction theory; three point hitches- free link and restrained link operations; mechanical steering and hydraulic control systems used in tractors; human engineering and safety in tractor design; tractor tests and performance.

SOIL AND WATER CONSERVATION ENGINEERING:

Ideal and real fluids, properties of fluids; hydrostatic pressure and its measurement; hydrostatic forces on plane and curved surface; continuity equation; Bernoulli's theorem; laminar and turbulent flow in pipes, Darcy-Weisbach and Hazen-Williams equations, Moody's diagram; flow through orifices and notches; flow in open channels.

Engineering properties of soils, fundamental definitions and relationships; index properties of soils; permeability and seepage analysis; shear strength, Mohr's circle of stresses; active and passive earth pressures; stability of slopes.

Hydrological cycle; precipitation measurement, analysis of precipitation data; abstraction from precipitation; runoff; hydrograph analysis, unit hydrograph theory and application; stream flow measurement; flood routing, hydrological reservoir and channel routing.

Mechanics of soil erosion, factors affecting erosion; soil loss estimation; biological and engineering measures to control erosion, terraces and bunds; vegetative waterways; gully control structures, drop, drop inlet and chute spillways; farm ponds; earthen dams; principles of watershed management.

Water requirement of crops; consumptive use and evapo-transpiration; irrigation scheduling; irrigation efficiencies; design of prismatic and silt loaded channels; methods of irrigation water application; design and evaluation of irrigation methods; drainage coefficient; surface and subsurface drainage systems; leaching requirement and salinity control; irrigation and drainage water quality; classification of pumps; pump characteristics; pump selection; types of aquifer; evaluation of aquifer properties; well hydraulics; ground water recharge.

AGRICULTURAL PROCESSING AND FOOD ENGINEERING:

Steady state heat transfer in conduction, convection and radiation; transient heat transfer in simple geometry; condensation and boiling heat transfer; working principles of heat exchangers; diffusive and convective mass transfer; simultaneous heat and mass transfer in agricultural processing operations.

Material and energy balances in food processing systems; water activity, sorption and desorption isotherms; centrifugal separation of solids, liquids and gases; kinetics of microbial death - pasteurisation and sterilization of liquid foods; preservation of food by cooling and freezing; psychrometry - properties of air-vapour mixture; concentration and dehydration of liquid foods - evaporators, tray, drum and spray dryers.

Mechanics and energy requirement in size reduction of granular solids; particle size analysis for comminuted solids; size separation by screening; fluidisation of granular solids; cleaning and grading efficiency and effectiveness of grain cleaners; conditioning and hydrothermal treatments for grains; dehydration of food grains; processes and machines for processing of cereals, pulses and oilseeds; design considerations for grain silos.

AR - ARCHITECTURE AND PLANNING

City planning: Historical development of cities; principles of city planning; new towns; survey methods, site planning, planning regulations and building bye-laws.

Housing: Concept of shelter; housing policies and design; community planning; role of government agencies; finance and management.

Landscape Design: Principles of landscape design and site planning; history and landscape styles; landscape elements and materials; planting design.

Computer Aided Design: Application of computers in architecture and planning; understanding elements of hardware and software; computer graphics; programming languages - C and Visual Basic and usage of packages such as AutoCAD.

Environmental and Building Science: Elements of environmental science; ecological principles concerning environment; role of micro-climate in design; climatic control through design elements; thermal comfort; elements of solar architecture; principles of lighting and illumination; basic principles of architectural acoustics; air pollution, noise pollution and their control.

Visual and Urban Design: Principles of visual composition; proportion, scale, rhythm, symmetry, harmony, balance, form and colour; sense of place and space, division of space; focal point, vista, imageability, visual survey.

History of Architecture: Indian - Indus valley, Vedic, Buddhist, Indo-Aryan, Dravidian and Mughal periods; European - Egyptian, Greek, Roman, medieval and renaissance periods.

Development of Contemporary Architecture: Architectural developments and impacts on society since industrial revolution; influence of modern art on architecture; works of national and international architects; post modernism in architecture.

Building Services: Water supply, Sewerage and Drainage systems; Sanitary fittings and fixtures; principles of electrification of buildings; elevators, their standards and uses; air-conditioning systems; fire fighting systems.

Building Construction and Management: Building construction techniques, methods and details; building systems and prefabrication of building elements; principles of modular coordination; estimation, specification, valuation, professional practice; project management, PERT, CPM.

Materials and Structural Systems: Behavioural characteristics of all types of building materials e.g. mud, timber, bamboo, brick, concrete, steel, glass, FRP; principles of strength of materials; design of structural elements in wood, steel and RCC; elastic and limit state design; complex structural systems; principles of pre-stressing.

Planning Theory: Planning process; multilevel planning; comprehensive planning; central place theory; settlement pattern; land use and land utilization.

Techniques of Planning: Planning surveys; Preparation of urban and regional structure plans, development plans, action plans; site planning principles and design; statistical methods; application of remote sensing techniques in urban and regional planning.

Traffic and Transportation Planning: Principles of traffic engineering and transportation planning; methods of conducting surveys; design of roads, intersections and parking areas; hierarchy of roads and levels of services; traffic and transport management in urban areas; traffic safety and traffic laws; public transportation planning; modes of transportation.

Services and Amenities: Principles and design of water supply systems, sewerage systems, solid waste disposal systems, power supply and communication systems; Health, education, recreation and demography related standards at various levels of the settlements.

Development Administration and Management: Planning laws; development control and zoning regulations; laws relating to land acquisition; development enforcements, land ceiling; regional and urban plan preparations; planning and municipal administration; taxation, revenue resources and fiscal management; public participation and role of NGO.

CE - CIVIL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

STRUCTURAL ENGINEERING

Mechanics: Bending moments and shear forces in statically determinate beams; simple stress and strain: relationship; stress and strain in two dimensions, principal stresses, stress transformation, Mohr's circle; simple bending theory; flexural shear stress; thin-walled pressure vessels; uniform torsion.

Structural Analysis: Analysis of statically determinate trusses, arches and frames; displacements in statically determinate structures and analysis of statically indeterminate structures by force/energy methods; analysis by displacement methods (slope-deflection and moment-distribution methods); influence lines for determinate and indeterminate structures; basic concepts of matrix methods of structural analysis.

Concrete Structures: Basic working stress and limit states design concepts; analysis of ultimate load capacity and design of members subject to flexure, shear, compression and torsion (beams, columns and isolated footings); basic elements of prestressed concrete: analysis of beam sections at transfer and service loads.

Steel Structures: Analysis and design of tension and compression members, beams and beam-columns, column bases; connections - simple and eccentric, beam-column connections, plate girders and trusses; plastic analysis of beams and frames.

GEOTECHNICAL ENGINEERING

Soil Mechanics: Origin of soils; soil classification; three-phase system, fundamental definitions, relationship and inter-relationships; permeability and seepage; effective stress principle: consolidation, compaction; shear strength.

Foundation Engineering: Sub-surface investigation - scope, drilling bore holes, sampling, penetrometer tests, plate load test; earth pressure theories, effect of water table, layered soils; stability of slopes - infinite slopes, finite slopes; foundation types - foundation design requirements; shallow foundations; bearing capacity, effect of shape, water table and other factors, stress distribution, settlement analysis in sands and clays; deep foundations - pile types, dynamic and static formulae, load capacity of piles in sands and clays.

WATER RESOURCES ENGINEERING

Fluid Mechanics and Hydraulics: Hydrostatics, applications of Bernoulli equation, laminar and turbulent flow in pipes, pipe networks; concept of boundary layer and its growth; uniform flow, critical flow and gradually varied flow in channels, specific energy concept, hydraulic jump; forces on immersed bodies; flow measurement in channels; tanks and pipes; dimensional analysis and hydraulic modeling. Applications of momentum equation, potential flow, kinematics of flow; velocity triangles and specific speed of pumps and turbines.

Hydrology: Hydrologic cycle; rainfall; evaporation infiltration, unit hydrographs, flood estimation, reservoir design, reservoir and channel routing, well hydraulics.

Irrigation: Duty, delta, estimation of evapo-transpiration; crop water requirements; design of lined and unlined canals; waterways; head works, gravity dams and Ogee spillways. Designs of weirs on permeable foundation, irrigation methods.

ENVIRONMENTAL ENGINEERING

Water requirements; quality and standards, basic unit processes and operations for water treatment, distribution of water. Sewage and sewerage treatment: quantity and characteristic of waste water sewerage; primary and secondary treatment of waste water; sludge disposal; effluent discharge standards.

TRANSPORTATION ENGINEERING

Highway planning; geometric design of highways; testing and specifications of paving materials; design of flexible and rigid pavements.

CH - CHEMICAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear

differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

CHEMICAL ENGINEERING

Process Calculations and Thermodynamics: Laws of conservation of mass and energy; use of tie components; recycle, bypass and purge calculations; degree of freedom analysis.

First and Second laws of thermodynamics and their applications; equations of state and thermodynamic properties of real systems; phase equilibria; fugacity, excess properties and correlations of activity coefficients; chemical reaction equilibria.

Fluid Mechanics and Mechanical Operations: Fluid statics, Newtonian and non-Newtonian fluids, Bernoulli equation, Macroscopic friction factors, energy balance, dimensional analysis, shell balances, flow through pipeline systems, flow meters, pumps and compressors, packed and fluidized beds, elementary boundary layer theory, size reduction and size separation; free and hindered settling; centrifuge and cyclones; thickening and classification, filtration, mixing and agitation; conveying of solids.

Heat Transfer: Conduction, convection and radiation, heat transfer coefficients, steady and unsteady heat conduction, boiling, condensation and evaporation; types of heat exchangers and evaporators and their design.

Mass Transfer: Fick's law, molecular diffusion in fluids, mass transfer coefficients, film, penetration and surface renewal theories; momentum, heat and mass transfer analogies; stagewise and continuous contacting and stage efficiencies; HTU & NTU concepts design and operation of equipment for distillation, absorption, leaching, liquid-liquid extraction, crystallization, drying, humidification, dehumidification and adsorption.

Chemical Reaction Engineering: Theories of reaction rates; kinetics of homogeneous reactions, interpretation of kinetic data, single and multiple reactions in ideal reactors, non-ideal reactors; residence time; non-isothermal reactors; kinetics of heterogeneous catalytic reactions; diffusion effects in catalysis.

Instrumentation and Process Control: Measurement of process variables; sensors, transducers and their dynamics, dynamics of simple systems, dynamics such as CSTRs, transfer functions and responses of simple systems, process reaction curve, controller modes (P, PI, and PID); control valves; analysis of closed loop systems including stability, frequency response (including Bode plots) and controller tuning, cascade, feed forward control.

Plant Design and Economics: Design and sizing of chemical engineering equipment such as compressors, heat exchangers, multistage contactors; principles of process economics and cost estimation including total annualized cost, cost indexes, rate of return, payback period, discounted cash flow, optimization in Design.

Chemical Technology: Inorganic chemical industries; sulfuric acid, NaOH, fertilizers (Ammonia, Urea, SSP and TSP); natural products industries (Pulp and Paper, Sugar, Oil, and Fats); petroleum refining and petrochemicals; polymerization industries; polyethylene, polypropylene, PVC and polyester synthetic fibers.

CS - COMPUTER SCIENCE AND ENGINEERING

ENGINEERING MATHEMATICS

Mathematical Logic: Propositional Logic; First Order Logic.

Probability: Conditional Probability; Mean, Median, Mode and Standard Deviation; Random Variables; Distributions; uniform, normal, exponential, Poisson, Binomial.

Set Theory & Algebra: Sets; Relations; Functions; Groups; Partial Orders; Lattice; Boolean Algebra.

Combinatorics: Permutations; Combinations; Counting; Summation; generating functions; recurrence relations; asymptotics.

Graph Theory: Connectivity; spanning trees; Cut vertices & edges; covering; matching; independent sets; Colouring; Planarity; Isomorphism.

Linear Algebra: Algebra of matrices, determinants, systems of linear equations, Eigen values and Eigen vectors.

Numerical Methods: LU decomposition for systems of linear equations; numerical solutions of non linear algebraic equations by Secant, Bisection and Newton-Raphson Methods; Numerical integration by trapezoidal and Simpson's rules.

Calculus: Limit, Continuity & differentiability, Mean value Theorems, Theorems of integral calculus, evaluation of definite & improper integrals, Partial derivatives, Total derivatives, maxima & minima.

THEORY OF COMPUTATION

Formal Languages and Automata Theory: Regular languages and finite automata, Context free languages and Push-down automata, Recursively enumerable sets and Turing machines, Un-decidability;

Analysis of Algorithms and Computational Complexity: Asymptotic analysis (best, worst, average case) of time and space, Upper and lower bounds on the complexity of specific problems, NP-completeness.

COMPUTER HARDWARE

Digital Logic: Logic functions, Minimization, Design and synthesis of Combinational and Sequential circuits; Number representation and Computer Arithmetic (fixed and floating point);

Computer Organization: Machine instructions and addressing modes, ALU and Data-path, hardwired and micro-programmed control, Memory interface, I/O interface (Interrupt and DMA mode), Serial communication interface, Instruction pipelining, Cache, main and secondary storage.

SOFTWARE SYSTEMS

Data structures: Notion of abstract data types, Stack, Queue, List, Set, String, Tree, Binary search tree, Heap, Graph;

Programming Methodology: C programming, Program control (iteration, recursion, Functions), Scope, Binding, Parameter passing, Elementary concepts of Object oriented, Functional and

Logic Programming;

Algorithms for problem solving: Tree and graph traversals, Connected components, Spanning trees, Shortest paths; Hashing, Sorting, Searching; Design techniques (Greedy, Dynamic Programming, Divide-and-conquer);

Compiler Design: Lexical analysis, Parsing, Syntax directed translation, Runtime environment, Code generation, Linking (static and dynamic); Operating Systems: Classical concepts (concurrency, synchronization, deadlock), Processes, threads and Inter-process communication, CPU scheduling, Memory management, File systems, I/O systems, Protection and security.

Databases: Relational model (ER-model, relational algebra, tuple calculus), Database design (integrity constraints, normal forms), Query languages (SQL), File structures (sequential files, indexing, B+ trees), Transactions and concurrency control;

Computer Networks: ISO/OSI stack, sliding window protocol, LAN Technologies (Ethernet, Token ring), TCP/UDP, IP, Basic concepts of switches, gateways, and routers.

CH - CHEMISTRY

PHYSICAL CHEMISTRY

Structure: Quantum theory - principles and techniques; applications to particle in a box, harmonic oscillator, rigid rotor and hydrogen atom; valence bond and molecular orbital theories and Huckel approximation, approximate techniques: variation and perturbation; symmetry, point groups; rotational, vibrational, electronic, NMR and ESR spectroscopy.

Equilibrium: First law of thermodynamics, heat, energy and work; second law of thermodynamics and entropy; third law and absolute entropy; free energy; partial molar quantities; ideal and non-ideal solutions; phase transformation: phase rule and phase diagrams- one, two, and three component systems; activity, activity coefficient, fugacity and fugacity coefficient ; chemical equilibrium, response of chemical equilibrium to temperature and pressure; colligative properties; kinetic theory of gases; thermodynamics of electrochemical cells; standard electrode potentials: applications - corrosion and energy conversion; molecular partition function (translational, rotational, vibrational and electronic).

Kinetics: Rates of chemical reactions, theories of reaction rates, collision and transition state theory; temperature dependence of chemical reactions; elementary reactions, consecutive elementary reactions; steady state approximation, kinetics of photochemical reactions and free radical polymerization, homogenous and heterogeneous catalysis.

INORGANIC CHEMISTRY

Non-Transition Elements: General characteristics, structure and reactions of simple and industrially important compounds, boranes, carboranes, silicates, silicones, diamond and graphite; hydrides, oxides and oxoacids of N, P, S and halogens; boron nitride, borazines and phosphazenes; xenon compounds. Shapes of molecules, hard-soft acid base concept.

Transition Elements: General characteristics of d and f block elements; coordination chemistry: structure and isomerism, stability, theories of metal-ligand bonding (CFT and LFT), electronic spectra and magnetic properties of transition metal complexes and lanthanides; metal carbonyls, metal-metal bonds and metal atom clusters, metallocenes; transition metal complexes with bonds to hydrogen, alkyls, alkenes, and arenes; metal carbenes; use of organometallic compounds as catalysts in organic synthesis; mechanisms of substitution and electron transfer reactions of coordination complexes. Role of metals with special reference to Na, K, Mg, Ca, Fe, Co, Zn, and Mo in biological systems.

Solids: Crystal systems and lattices, Miller planes, crystal packing, crystal defects; Bragg's

Law; ionic crystals, band theory, metals and semiconductors. Spinels.

Instrumental methods of analysis: atomic absorption, UV-visible spectrometry, chromatographic and electro-analytical methods.

ORGANIC CHEMISTRY

Synthesis, reactions and mechanisms involving the following: Alkenes, alkynes, arenes, alcohols, phenols, aldehydes, ketones, carboxylic acids and their derivatives; halides, nitro compounds and amines; stereochemical and conformational effects on reactivity and specificity; reactions with diborane and peracids. Michael reaction, Robinson annulation, reactivity umpolung, acyl anion equivalents; molecular rearrangements involving electron deficient atoms.

Photochemistry: Basic principles, photochemistry of olefins, carbonyl compounds, arenes, photo oxidation and reduction.

Pericyclic reactions: Cycloadditions, electrocyclic reactions, sigmatropic reactions; Woodward-Hoffmann rules.

Heterocycles: Structural properties and reactions of furan, pyrrole, thiophene, pyridine, indole.

Biomolecules: Structure, properties and reactions of mono- and di-saccharides, physico-chemical properties of amino acids, structural features of proteins and nucleic acids.

Spectroscopy: Principles and applications of IR, UV-visible, NMR and mass spectrometry in the determination of structures of organic compounds.

EC - ELECTRONICS AND COMMUNICATION ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix Algebra, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Mean value theorems, Theorems of integral calculus, Evaluation of definite and improper integrals, Partial Derivatives, Maxima and minima, Multiple integrals, Fourier series. Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equation (linear and nonlinear), Higher order linear differential equations with constant coefficients, Method of variation of parameters, Cauchy's and Euler's equations, Initial and boundary value problems, Partial Differential Equations and variable separable method.

Complex variables: Analytic functions, Cauchy's integral theorem and integral formula, Taylor's and Laurent' series, Residue theorem, solution integrals.

Probability and Statistics: Sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Discrete and continuous distributions, Poisson, Normal and Binomial distribution, Correlation and regression analysis.

Numerical Methods: Solutions of non-linear algebraic equations, single and multi-step methods for differential equations.

Transform Theory: Fourier transform, Laplace transform, Z-transform.

ELECTRONICS & COMMUNICATION ENGINEERING

Networks: Network graphs: matrices associated with graphs; incidence, fundamental cut set and fundamental circuit matrices. Solution methods: nodal and mesh analysis. Network theorems: superposition, Thevenin and Norton's maximum power transfer, Wye-Delta transformation. Steady state sinusoidal analysis using phasors. Linear constant coefficient differential equations; time domain analysis of simple RLC circuits, Solution of network equations using Laplace transform: frequency domain analysis of RLC circuits. 2-port network parameters: driving point and transfer functions. State equations for networks.

Electronic Devices: Energy bands in silicon, intrinsic and extrinsic silicon. Carrier transport in silicon: diffusion current, drift current, mobility, resistivity. Generation and recombination of carriers. p-n junction diode, Zener diode, tunnel diode, BJT, JFET, MOS capacitor, MOSFET, LED, p-I-n and avalanche photo diode, LASERs. Device technology: integrated circuits fabrication process, oxidation, diffusion, ion implantation, photolithography, n-tub, p-tub and twin-tub CMOS process.

Analog Circuits: Equivalent circuits (large and small-signal) of diodes, BJTs, JFETs, and MOSFETs. Simple diode circuits, clipping, clamping, rectifier. Biasing and bias stability of transistor and FET amplifiers. Amplifiers: single-and multi-stage, differential, operational, feedback and power. Analysis of amplifiers; frequency response of amplifiers. Simple op-amp circuits. Filters. Sinusoidal oscillators; criterion for oscillation; single-transistor and op-amp configurations. Function generators and wave-shaping circuits. Power supplies.

Digital circuits: Boolean algebra, minimization of Boolean functions; logic gates digital IC families (DTL, TTL, ECL, MOS, CMOS). Combinational circuits: arithmetic circuits, code converters, multiplexers and decoders. Sequential circuits: latches and flip-flops, counters and shift-registers. Sample and hold circuits, ADCs, DACs. Semiconductor memories. Microprocessor(8085): architecture, programming, memory and I/O interfacing.

Signals and Systems: Definitions and properties of Laplace transform, continuous-time and discrete-time Fourier series, continuous-time and discrete-time Fourier Transform, z-transform. Sampling theorems. Linear Time-Invariant (LTI) Systems: definitions and properties; casuality, stability, impulse response, convolution, poles and zeros frequency response, group delay, phase delay. Signal transmission through LTI systems. Random signals and noise: probability, random variables, probability density function, autocorrelation, power spectral density.

Controls Systems: Basic control system components; block diagrammatic description, reduction of block diagrams. Open loop and closed loop (feedback) systems and stability analysis of these systems. Signal flow graphs and their use in determining transfer functions of systems; transient and steady state analysis of LTI control systems and frequency response. Tools and techniques for LTI control system analysis: root loci, Routh-Hurwitz criterion, Bode and Nyquist plots. Control system compensators: elements of lead and lag compensation, elements of Proportional-Integral-Derivative(PID) control. State variable representation and solution of state equation of LTI control systems.

Communications: Analog communication systems: amplitude and angle modulation and demodulation systems, spectral analysis of these operations, superheterodyne receivers; elements of hardware, realizations of analog communication systems; signal-to-noise ratio (SNR) calculations for amplitude modulation (AM) and frequency modulation (FM) for low noise conditions. Digital communication systems: pulse code modulation (PCM), differential pulse code modulation (DPCM), delta modulation (DM); digital modulation schemes-amplitude, phase and frequency shift keying schemes (ASK, PSK, FSK), matched filter receivers, bandwith consideration and probability of error calculations for these schemes.

Electromagnetics: Elements of vector calculus: divergence and curl; Gauss' and Stokes' theorems, Maxwell's equations: differential and integral forms. Wave equation, Poynting vector. Plane waves: propagation through various media; reflection and refraction; phase and group velocity; skin depth. Transmission lines: characteristic impedance; impedance transformation; Smith chart; impedance matching; pulse excitation. Waveguides: modes in rectangular waveguides; boundary conditions; cut-off frequencies; dispersion relations.

Antennas: Dipole antennas; antenna arrays; radiation pattern; reciprocity theorem, antenna gain.

EE - ELECTRICAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix Algebra, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Mean value theorems, Theorems of integral calculus, Evaluation of definite and improper integrals, Partial Derivatives, Maxima and minima, Multiple integrals, Fourier series. Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equation (linear and nonlinear), Higher order linear differential equations with constant coefficients, Method of variation of parameters, Cauchy's and Euler's equations, Initial and boundary value problems, Partial Differential Equations and variable separable method.

Complex variables: Analytic functions, Cauchy's integral theorem and integral formula, Taylor's and Laurent' series, Residue theorem, solution integrals.

Probability and Statistics: Sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Discrete and continuous distributions, Poisson, Normal and Binomial distribution, Correlation and regression analysis.

Numerical Methods: Solutions of non-linear algebraic equations, single and multi-step methods for differential equations.

Transform Theory: Fourier transform, Laplace transform, Z-transform.

ELECTRICAL ENGINEERING

Electrical Circuits and Fields: Network graph, KCL, KVL, node/ cut set, mesh/ tie set analysis, transient response of d.c. and a.c. networks; sinusoidal steady-state analysis; resonance in electrical circuits; concepts of ideal voltage and current sources, network theorems, driving point, immittance and transfer functions of two port networks, elementary concepts of filters; three phase circuits; Fourier series and its application; Gauss theorem, electric field intensity and potential due to point, line, plane and spherical charge distribution, dielectrics, capacitance calculations for simple configurations; Ampere's and Biot-Savart's law, inductance calculations for simple configurations.

Electrical Machines: Single phase transformer - equivalent circuit, phasor diagram, tests, regulation and efficiency; three phase transformers - connections, parallel operation; auto transformer and three-winding transformer; principles of energy conversion, windings of rotating machines: D. C. generators and motors - characteristics, starting and speed control, armature reaction and commutation; three phase induction motors-performance characteristics, starting and speed control; single-phase induction motors; synchronous generators-performance, regulation, parallel operation; synchronous motors - starting, characteristics, applications, synchronous condensers; fractional horse power motors; permanent magnet and stepper motors.

Power Systems: Electric power generation - thermal, hydro, nuclear; transmission line parameters; steady-state performance of overhead transmission lines and cables and surge propagation; distribution systems, insulators, bundle conductors, corona and radio interference effects; per-unit quantities; bus admittance and impedance matrices; load flow; voltage control and power factor correction; economic operation; symmetrical components, analysis of symmetrical and unsymmetrical faults; principles of over current, differential and distance protections; concept of solid state relays and digital protection; circuit breakers;

concept of system stability-swing curves and equal area criterion; basic concepts of HVDC transmission.

Control Systems: Principles of feedback; transfer function; block diagrams: steady-state errors; stability-Routh and Nyquist criteria; Bode plots; compensation; root loci; elementary state variable formulation; state transition matrix and response for Linear Time Invariant systems.

Electrical and Electronic Measurements: Bridges and potentiometers, PMMC, moving iron, dynamometer and induction type instruments; measurement of voltage, current, power, energy and power factor; instrument transformers; digital voltmeters and multimeters; phase, time and frequency measurement; Q-meter, oscilloscopes, potentiometric recorders, error analysis.

Analog and Digital Electronics: Characteristics of diodes, BJT, FET, SCR; amplifiers-biasing, equivalent circuit and frequency response; oscillators and feedback amplifiers, operational amplifiers- characteristics and applications; simple active filters; VCOs and timers; combinational and sequential logic circuits, multiplexer, Schmitt trigger, multivibrators, sample and hold circuits, A/D and D/A converters; microprocessors and their applications.

Power Electronics and Electric Drives: Semiconductor power devices-diodes, transistors, thyristors, triacs, GTOs, MOSFETs and IGBTs - static characteristics and principles of operation; triggering circuits; phase control rectifiers; bridge converters-fully controlled and half controlled; principles of choppers and inverters, basic concepts of adjustable speed dc and ac drives.

GG - GEOLOGY AND GEOPHYSICS

PART - I

Earth and planetary system; size, shape, internal structure and composition of the earth; atmosphere and greenhouse effect; isostasy; elements of seismology; continents and continental processes; physical oceanography; palaeomagnetism, continental drift plate tectonics, geothermal energy.

Weathering; soil formation; action of river, wind and glacier; oceans and oceanic features; earthquakes, volcanoes, orogeny and mountain building; elements of structural geology; crystallography; classification, composition and properties of minerals and rocks; engineering properties of rocks and soils, role of geology in the construction of engineering structures.

Processes of ore formation, occurrence and distribution of ores on land and on ocean floor; coal and petroleum resources in India; ground water geology including well hydraulics, geological time scale and geochronology; stratigraphic principles and stratigraphy of India; basics concepts of gravity, magnetic and electrical prospecting for ores and ground water.

PART - IIA: GEOLOGY

Crystal symmetry, forms, twinning; crystal chemistry; optical mineralogy, classification of minerals, diagnostic properties of rock minerals.

Mineralogy, structure, texture and classification of igneous, sedimentary and metamorphic rock, their origin and evolution; application of thermodynamics; structure and petrology of sedimentary rocks; sedimentary processes and environments, sedimentary facies, basin studies; basement cover relationship;

Primary and secondary structures; geometry and genesis of folds, faults, joints, unconformities, cleavage, schistosity and lineation; methods of projection. Tectonites and their significance; shear zone; superposed folding.

Morphology, classification and geological significance of important invertebrates, vertebrates, microfossils and palaeoflora; stratigraphic principles and Indian stratigraphy; geomorphic processes and agents; development and evolution of landforms; slope and drainage; processes on deep oceanic and near-shore regions; quantitative and applied geomorphology; air photo interpretation and remote sensing; chemical and optical properties of ore minerals; formation and localization of ore deposits; prospecting and exploration of economic minerals; coal and petroleum geology; origin and distribution of mineral and fuel deposits in India; ore dressing and mineral economics.

Cosmic abundance; meteorites; geochemical evolution of the earth; geochemical cycles; distribution of major, minor and trace elements; isotope geochemistry; geochemistry of waters including solution equilibria and water rock interaction.

Engineering properties of rocks and soils; rocks as construction material; geology of dams, tunnels and excavation sites; natural hazards; the fly ash problem; ground water geology and exploration; water quality; impact of human activity; Remote sensing techniques for the interpretation of landforms and resource management.

PART - II B: GEOPHYSICS

The earth as a planet; different motions of the earth; gravity filed of the earth and its shape; geochronology; isostasy, seismology and interior of the earth; variation of density, velocity, pressure, temperature, electrical and magnetic properties inside the earth; earthquakes-causes and measurements; zonation and seismic hazards; geomagnetic field, palaeomagnetism; oceanic and continental lithosphere; plate tectonics; heat flow; upper and lower atmospheric phenomena.

Theories of scalar and vector potential fields; Laplace, Maxwell and Helmholtz equations for solution of different types of boundary value problems for Cartesian, cylindrical and spherical polar coordinates; Green's theorem; Image theory; integral equations and conformal transformations in potential theory; Eikonal equation and ray theory.

'G' and 'g' units of measurement, density of rocks, gravimeters, preparation, analysis and interpretation of gravity maps; derivative maps, analytical continuation; gravity anomaly type curves; calculation of mass.

Earth's magnetic field, units of measurement, magnetic susceptibility of rocks, magnetometers, corrections, preparation of magnetic maps, magnetic anomaly type curve, analytical continuation, interpretation and application; magnetic well logging.

Conduction of electricity through rocks, electrical conductivities of metals, metallic, non-metallic and rock forming minerals, D.C. resistivity units and methods of measurement, electrode configuration for sounding and profiling, application of filter theory, interpretation of resistivity field data, application; self potential origin, classification, field measurement, interpretation of induced polarization time frequency, phase domain; IP units and methods of measurement, interpretation and application; ground-water exploration.

Origin of electromagnetic field elliptic polarization, methods of measurement for different source-receiver configuration components in EM measurements, interpretation and applications; earth's natural electromagnetic field, tellurics, magneto-tellurics; geomagnetic depth sounding principles, methods of measurement, processing of data and interpretation.

Seismic methods of prospecting: Reflection, refraction and CDP surveys; land and marine seismic sources, generation and propagation of elastic waves, velocity increasing with depth, geophones, hydrophones, recording instruments (DFS), digital formats, field layouts, seismic noises and noise profile analysis, optimum geophone grouping, noise cancellation by shot and geophone arrays, 2D and 3D seismic data acquisition and processing, CDP stacking charts, binning, filtering, dip-moveout, static and dynamic corrections, deconvolution, migration, signal processing, Fourier and Hilbert transforms, attribute analysis, bright and dim spots, seismic stratigraphy, high resolution seismics, VSP.

Principles and techniques of geophysical well-logging, SP, resistivity, induction, micro gamma ray, neutron, density, sonic, temperature, dip meter, caliper, nuclear magnetic, cement bond logging. Quantitative evaluation of formations from well logs; well hydraulics and application of geophysical methods for groundwater study; application of bore hole geophysics in ground water, mineral and oil exploration. Remote sensing techniques and application of remote sensing methods in geophysics.

IN - INSTRUMENTATION ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix Algebra, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Mean value theorems, Theorems of integral calculus, Evaluation of definite and improper integrals, Partial Derivatives, Maxima and minima, Multiple integrals, Fourier series. Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equation (linear and nonlinear), Higher order linear differential equations with constant coefficients, Method of variation of parameters, Cauchy's and Euler's equations, Initial and boundary value problems, Partial Differential Equations and variable separable method.

Complex variables: Analytic functions, Cauchy's integral theorem and integral formula, Taylor's and Laurent' series, Residue theorem, solution integrals.

Probability and Statistics: Sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Discrete and continuous distributions, Poisson, Normal and Binomial distribution, Correlation and regression analysis.

Numerical Methods: Solutions of non-linear algebraic equations, single and multi-step methods for differential equations.

Transform Theory: Fourier transform, Laplace transform, Z-transform.

INSTRUMENTATION ENGINEERING

Measurement Basics and Metrology: Static and dynamic characteristics of measurement systems. Standards and calibration. Error and uncertainty analysis, statistical analysis of data, and curve fitting. Linear and angular measurements; Measurement of straightness, flatness, roundness and roughness.

Transducers, Mechanical Measurements and Industrial Instrumentation: Transducers - elastic, resistive, inductive, capacitive, thermo-electric, piezoelectric, photoelectric, electro-mechanical, electro-chemical, and ultrasonic. Measurement of displacement, velocity (linear and rotational), acceleration, shock, vibration, force, torque, power, strain, stress, pressure, flow, temperature, humidity, viscosity, and density. energy storing elements, suspension systems and dampers.

Analog Electronics: Characteristics of diodes, BJTs, JFETs and MOSFETs; Diode circuits; Amplifiers: single and multi-stage, feedback; Frequency response; Operational amplifiers - design, characteristic, linear and non-linear applications: difference amplifiers; instrumentation amplifiers; precision rectifiers, I-to-V converters, active filters, oscillators, comparators, signal generators, wave shaping circuits.

Digital Electronics: Combinational logic circuits, minimization of Boolean functions; IC families (TTL, MOS, CMOS), arithmetic circuits, multiplexer and decoders. Sequential circuits: flip-flops, counters, shift registers. Schmitt trigger, timers, and multivibrators. Analog switches, multiplexers, S/H circuits. Analog-to-digital and digital-to-analog converters. Basics of computer organization and architecture. 8-bit microprocessor (8085), applications, memory, I/O interfacing, and microcontrollers.

Signals and Systems: Vectors and matrices; Fourier series; Fourier transforms; Ordinary differential equations. Impulse and frequency responses of first and second order systems. Laplace transform and transfer function, convolution and correlation. Amplitude and frequency modulations and demodulations. Discrete time systems, difference equations, impulse and frequency responses; Z-transforms and transfer functions; IIR and FIR filters.

Electrical and Electronic Measurements: Measurement of R, L and C; bridges and potentiometers. Measurement of voltage, current, power, power factor, and energy; Instrument transformers; Q meter, waveform analyzers. Digital volt-meters and multi-meters. Time, phase and frequency measurements; Oscilloscope. Noise and interference in instrumentation.

Control Systems & Process Control: Principles of feedback; transfer function, signal flow graphs. Stability criteria, Bode plots, root-loci, Routh and Nyquist criteria. Compensation techniques; State space analysis. System components: mechanical, hydraulic, pneumatic, electrical and electronic; Servos and synchros; Stepper motors. On-off, cascade, P, PI, PID and feed-forward controls. Controller tuning and general frequency response.

Analytical, Optical and Biomedical Instrumentation: Principles of spectrometry, UV, visible, IR mass spectrometry, X-ray methods; nuclear radiation measurements, gas, solid and semi conductor lasers and their characteristics, interferometers, basics of fibre optics, transducers in biomedical applications, cardiovascular system measurements, instrumentation for clinical laboratory.

MA - MATHEMATICS

Linear Algebra: Finite dimensional vector spaces. Linear transformations and their matrix representations, rank; systems of linear equations, eigenvalues and eigenvectors, minimal polynomial, Cayley-Hamilton theorem, diagonalisation, Hermitian, Skew-Hermitian and unitary matrices. Finite dimensional inner product spaces, self-adjoint and Normal linear operators, spectral theorem, Quadratic forms.

Complex Analysis: Analytic functions, conformal mappings, bilinear transformations, complex integration: Cauchy's integral theorem and formula, Liouville's theorem, maximum modulus principle, Taylor and Laurent's series, residue theorem and applications for evaluating real integrals.

Real Analysis: Sequences and series of functions, uniform convergence, power series, Fourier series, functions of several variables, maxima, minima, multiple integrals, line, surface and volume integrals, theorems of Green, Stokes and Gauss; metric spaces, completeness, Weierstrass approximation theorem, compactness. Lebesgue measure, measurable functions; Lebesgue integral, Fatou's lemma, dominated convergence theorem.

Ordinary Differential Equations: First order ordinary differential equations, existence and uniqueness theorems, systems of linear first order ordinary differential equations, linear ordinary differential equations of higher order with constant coefficients; linear second order ordinary differential equations with variable coefficients, method of Laplace transforms for solving ordinary differential equations, series solutions; Legendre and Bessel functions and their orthogonality, Sturm Liouville system, Greeen's functions.

Algebra: Normal subgroups and homomorphisms theorems, automorphisms. Group actions, sylow's theorems and their applications groups of order less than or equal to 20, Finite p-groups. Euclidean domains, Principal ideal domains and unique factorizations domains. Prime ideals and maximal ideals in commutative rings.

Functional Analysis: Banach spaces, Hahn-Banach theorems, open mapping and closed graph theorems, principle of uniform boundedness; Hilbert spaces, orthonormal sets, Riesz representation theorem, self-adjoint, unitary and normal linear operators on Hilbert Spaces.

Numerical Analysis: Numerical solution of algebraic and transcendental equations; bisection, secant method, Newton-Raphson method, fixed point iteration, interpolation: existence and error of polynomial interpolation, Lagrange, Newton, Hermite(osculatory)interpolations; numerical differentiation and integration, Trapezoidal and Simpson rules; Gaussian quadrature; (Gauss-Legendre and Gauss-Chebyshev), method of undetermined parameters, least square and orthonormal polynomial approximation; numerical solution of systems of linear equations: direct and iterative methods, (Jacobi Gauss-Seidel and SOR) with convergence; matrix eigenvalue problems: Jacobi and Given's methods, numerical solution of ordinary differential equations: initial value problems, Taylor series method, Runge-Kutta methods, predictor-corrector methods; convergence and stability.

Partial Differential Equations: Linear and quasilinear first order partial differential equations, method of characteristics; second order linear equations in two variables and their classification; Cauchy, Dirichlet and Neumann problems, Green's functions; solutions of Laplace, wave and diffusion equations in two variables Fourier series and transform methods of solutions of the above equations and applications to physical problems.

Mechanics: Forces in three dimensions, Poinsot central axis, virtual work, Lagrange's equations for holonomic systems, theory of small oscillations, Hamiltonian equations;

Topology: Basic concepts of topology, product topology, connectedness, compactness, countability and separation axioms, Urysohn's Lemma, Tietze extension theorem, metrization theorems, Tychonoff theorem on compactness of product spaces.

Probability and Statistics: Probability space, conditional probability, Bayes' theorem, independence, Random variables, joint and conditional distributions, standard probability distributions and their properties, expectation, conditional expectation, moments. Weak and strong law of large numbers, central limit theorem. Sampling distributions, UMVU estimators, sufficiency and consistency, maximum likelihood estimators. Testing of hypotheses, Neyman-Pearson tests, monotone likelihood ratio, likelihood ratio tests, standard parametric tests based on normal, X2 ,t, F-distributions. Linear regression and test for linearity of regression. Interval estimation.

Linear Programming: Linear programming problem and its formulation, convex sets their properties, graphical method, basic feasible solution, simplex method, big-M and two phase methods, infeasible and unbounded LPP's, alternate optima. Dual problem and duality theorems, dual simplex method and its application in post optimality analysis, interpretation of dual variables. Balanced and unbalanced transportation problems, unimodular property and u-v method for solving transportation problems. Hungarian method for solving assignment problems.

Calculus of Variations and Integral Equations: Variational problems with fixed boundaries; sufficient conditions for extremum, Linear integral equations of Fredholm and Volterra type, their iterative solutions. Fredholm alternative.

ME - MECHANICAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative,

Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

APPLIED MECHANICS AND DESIGN

Engineering Mechanics: Equivalent force systems, free-body concepts, equations of equilibrium, trusses and frames, virtual work and minimum potential energy. Kinematics and dynamics of particles and rigid bodies, impulse and momentum (linear and angular), energy methods, central force motion.

Strength of Materials: Stress and strain, stress-strain relationship and elastic constants, Mohr's circle for plane stress and plane strain, shear force and bending moment diagrams, bending and shear stresses, deflection of beams, torsion of circular shafts, thin and thick cylinders, Euler's theory of columns, strain energy methods, thermal stresses.

Theory of Machines: Displacement, velocity and acceleration, analysis of plane mechanisms, dynamic analysis of slider-crank mechanism, planar cams and followers, gear tooth profiles, kinematics of gears, governors and flywheels, balancing of reciprocating and rotating masses.

Vibrations: Free and forced vibration of single degree freedom systems, effect of damping, vibration isolation, resonance, critical speed of rotors.

Design of Machine Elements: Design for static and dynamic loading, failure theories, fatigue strength; design of bolted, riveted and welded joints; design of shafts and keys; design of spur gears, rolling and sliding contact bearings; brakes and clutches; belt, rope and chain drives.

FLUID MECHANICS AND THERMAL SCIENCES

Fluid Mechanics: Fluid properties, fluid statics, manometry, buoyancy; control-volume analysis of mass, momentum and energy; fluid acceleration; differential equations of continuity and momentum; Bernoulli's equation; viscous flow of incompressible fluids; boundary layer; elementary turbulent flow; flow through pipes, head losses in pipes, bends etc.

Heat-Transfer: Modes of heat transfer; one dimensional heat conduction, resistance concept, electrical analogy, unsteady heat conduction, fins; dimensionless parameters in free and forced convective heat transfer, various correlations for heat transfer in flow over flat plates and through pipes; thermal boundary layer; effect of turbulence; radiative heat transfer, black and grey surfaces, shape factors, network analysis; heat exchanger performance, LMTD and NTU methods.

Thermodynamics: Zeroth, First and Second laws of thermodynamics; thermodynamic system and processes; irreversibility and availability; behaviour of ideal and real gases, properties of pure substances, calculation of work and heat in ideal processes; analysis of thermodynamic cycles related to energy conversion; Carnot, Rankine, Otto, Diesel, Brayton and vapour compression cycles.

Power Plant Engineering: Steam generators; steam power cycles; steam turbines; impulse and reaction principles, velocity diagrams, pressure and velocity compounding; reheating and reheat factor; condensers and feed heaters.

I.C. Engines: Requirements and suitability of fuels in IC engines, fuel ratings, fuel-air mixture requirements; normal combustion in SI and CI engines; engine performance calculations.

Refrigeration and air-conditioning: Refrigerant compressors, expansion devices, condensers and evaporators; properties of moist air, psychrometric chart, basic psychometric processes.

Turbomachinery: Components of gas turbines; compression processes, centrifugal and axial flow compressors; axial flow turbines, elementary theory; hydraulic turbines; Euler-turbine equation; specific speed, Pelton-wheel, Francis and Kaplan turbines; centrifugal pumps.

MANUFACTURING AND INDUSTRIAL ENGINEERING

Engineering Materials: Structure and properties of engineering materials and their applications, heat treatment.

Metal Casting: Casting processes (expendable and non-expendable) -pattern, moulds and cores, heating and pouring, solidification and cooling, gating design, design considerations, defects.

Forming Processes: Stress-strain diagrams for ductile and brittle material, Plastic deformation and yield criteria, fundamentals of hot and cold working processes, Bulk metal forming processes (forging, rolling, extrusion, drawing), sheet metal working processes (punching, blanking, bending, deep drawing, coining, spinning, load estimation using homogeneous deformation methods, defects). processing of powder metals- atomization, compaction, sintering, secondary and finishing operations. forming and shaping of plastics- extrusion, injection moulding.

Joining Processes: Physics of welding, fusion and non-fusion welding processes, brazing and soldering, adhesive bonding, design considerations in welding, weld quality defects.

Machining and Machine Tool Operations: Mechanics of machining, single and multi-point cutting tools, tool geometry and materials, tool life and wear, cutting fluids, machinability, economics of machining, non-traditional machining processes.

Metrology and Inspection: Limits, fits and tolerances, linear and angular measurements, comparators, gauge design, interferometry, form and finish measurement, measurement of screw threads, alignment and testing methods.

Tool Engineering: Principles of work holding, design of jigs and fixtures.

Computer Integrated Manufacturing: Basic concepts of CAD, CAM and their integration tools.

Manufacturing Analysis: Part-print analysis, tolerance analysis in manufacturing and assembly, time and cost analysis.

Work-Study: Method study, work measurement, time study, work sampling, job evaluation, merit rating.

Production Planning and Control: Forecasting models, aggregate production planning, master scheduling, materials requirements planning.

Inventory Control: Deterministic and probabilistic models, safety stock inventory control systems.

Operations Research: Linear programming, simplex and duplex method, transportation, assignment, network flow models, simple queuing models, PERT and CPM

MN - MINING ENGINEERING

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

MINING ENGINEERING

Mechanics: Equivalent force systems, equations of equilibrium, two dimensional frames and trusses, free body diagrams, friction forces, particle kinematics and dynamics.

Mine Development, Geomechanics and Strata Control: Drivages for underground mine development, drilling methods and machines, explosives, blasting devices and practices, shaft sinking. Physico-mechanical properties of rocks, rock mass classification, ground control instrumentation and stress measurement techniques, theories of rock failure, ground vibrations, stress distribution around mine openings, subsidence, design of supports in roadways and workings, stability of open pits, slopes.

Mining Methods and Machinery: Surface mining - layout, development, loading, transportation and mechanization, continuous surface mining systems. Underground coal mining - bord and pillar system, longwall mining, thick seam mining methods. Underground metal mining: different stoping methods, stope mechanization, ore handling systems, mine filling. Generation and transmission of mechanical, hydraulic, and pneumatic power. Materials handling - haulages, conveyors, ropeways, face and development machinery, hoisting systems, and pumps.

Ventilation, Underground Hazards and Surface Environment: Underground atmosphere, heat load sources and thermal environment, air cooling, mechanics of air flow distribution, natural and mechanical ventilation, mine fans and their usage, auxiliary ventilation. Subsurface hazards from fires, explosions, gases, dust, and inundation, rescue apparatus and practices, safety in mines, accident analysis, noise, mine lighting. Air and water pollution: causes, dispersion, quality standards, and control.

Surveying, Mine Planning and Systems Engineering: Fundamentals of engineering surveying, Levels and levelling, Theodolite, tacheometry, triangulation, contouring, errors and adjustments, correlation, underground surveying, curves, photogrammetry, field astronomy, GPS fundamentals. Principles of planning - Sampling methods and practices, reserve estimation techniques, basics of geostatistics, optimization of facility location, cash flow concepts and mine valuation, open pit design. Work study, concepts of reliability, reliability of series and parallel systems. Linear programming, transportation and assignment problems, queueing, network analysis, inventory control.

MT - METALLURGICAL ENGINEERING

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

METALLURGICAL ENGINEERING

Thermodynamics and Rate Processes: Laws of thermodynamics, activity, equilibrium constant, applications to metallurgical systems, solutions, phase equilibria, basic kinetic laws, order of reactions, rate constants and rate limiting steps principles of electro chemistry, aqueous, corrosion and protection of metals, oxidation and high temperature corrosion - characterization and control; momentum transfer - concepts of viscosity, shell balances, Bernoulli's equation; heat transfer - conduction, convection and heat transfer coefficient relations, radiation, mass transfer - diffusion and Fick's laws.

Extractive Metallurgy: Flotation, gravity and other methods of mineral processing; agglomeration, pyro-hydro-and electro-metallurgical processes; material and energy balances; principles and processes for the extraction of non-ferrous metals - aluminium, copper, zinc, lead, magnesium, nickel, titanium and other rare metals; iron and steel making - principles, blast furnace, direct reduction processes, primary and secondary steel making, deoxidation and inclusion in steel; ingot and continuous casting; stainless steel making, design of furnaces; fuels and refractories.

Physical Metallurgy: Crystal structure and bonding characteristics of metals, alloys, ceramics and polymers; solid solutions; solidification; phase transformation and binary phase diagrams; principles of heat treatment of steels, aluminum alloys and cast irons; recovery, recrystallization and grain growth; industrially important ferrous and non-ferrous alloys; elements of X-ray and electron diffraction; principles of scanning and transmission electron microscopy; elements of ceramics, composites and electronic materials; electronic basis of thermal, optical, electrical and magnetic properties of materials.

Mechanical Metallurgy: Elements of elasticity and plasticity; defects in crystals; elements of dislocation theory - types of dislocations, slip and twinning, stress fields of dislocations, dislocation interactions and reactions, methods of seeing dislocations; strengthening mechanisms; tensile, fatigue and creep behaviour; superplasticity; fracture - Griffith theory, ductile to brittle transition, fracture toughness; failure analysis; mechanical testing - tension, compression, torsion, hardness, impact, creep, fatigue, fracture toughness and formability tests.

Manufacturing Processes: Metal casting - patterns, moulds, melting, gating, feeding and casting processes, defects and castings, hot and cold working of metals; Metal forming - fundamentals of metal forming, rolling wire drawing, extrusion, forming, sheet metal forming processes, defects in forming; Metal joining - soldering, brazing and welding, common welding processes, welding metallurgy, problems associated with welding of steels and aluminium alloys, defects in welding, powder metallurgy; NDT methods - ultrasonic, radiography, eddy current, acoustic emission and magnetic.

PH - PHYSICS

Mathematical Physics: Linear vector space, matrices; vector calculus; linear differential equations; elements of complex analysis; Laplace transforms, Fourier analysis, elementary ideas about tensors.

Classical Mechanics: Conservation laws; central forces; collisions and scattering in laboratory and centre of mass reference frames; mechanics of system of particles; rigid body dynamics; moment of inertia tensor; noninertial frames and pseudo forces; variational principle; Lagrange's and Hamilton's formalisms; equation of motion, cyclic coordinates, Poisson bracket; periodic motion, small oscillations, normal modes; wave equation and wave propagation; special theory of relativity - Lorentz transformations, relativistic kinematics, mass-energy equivalence.

Electromagnetic Theory: Laplace and Poisson equations; conductors and dielectrics; boundary value problems; Ampere's and Biot-Savart's laws; Faraday's law; Maxwell's equations; scalar and vector potentials; Coulomb and Lorentz gauges; boundary conditions at interfaces; electromagnetic waves; interference, diffraction and polarization; radiation from moving charges.

Quantum Mechanics: Physical basis of quantum mechanics; uncertainty principle; Schrodinger equation; one and three dimensional potential problems; Particle in a box, harmonic oscillator, hydrogen atom; linear vectors and operators in Hilbert space; angular momentum and spin; addition of angular momentum; time independent perturbation theory; elementary scattering theory.

Atomic and Molecular Physics: Spectra of one-and many-electron atoms; LS and jj coupling; hyperfine structure; Zeeman and Stark effects; electric dipole transitions and selection rules; X-ray spectra; rotational and vibrational spectra of diatomic molecules; electronic transition in diatomic molecules, Franck-Condon principle; Raman effect; NMR and ESR; lasers.

Thermodynamics and Statistical Physics: Laws of thermodynamics; macrostates, phase space; probability ensembles; partition function, free energy, calculation of thermodynamic quantities; classical and quantum statistics; degenerate Fermi gas; black body radiation and Planck's distribution law; Bose-Einstein condensation; first and second order phase transitions, critical point.

Solid State Physics: Elements of crystallography; diffraction methods for structure determination; bonding in solids; elastic properties of solids; defects in crystals; lattice vibrations and thermal properties of solids; free electron theory; band theory of solids; metals, semiconductors and insulators; transport properties; optical, dielectric and magnetic properties of solids; elements of superconductivity.

Nuclear and Particle Physics: Rutheford scattering; basic properties of nuclei; radioactive decay; nuclear forces; two nucleon problem; nuclear reactions; conservation laws; fission and fusion; nuclear models; particle accelerators, detectors; elementary particles; photons, baryons, mesons and leptons; Quark model.

Electronics: Network analysis; semiconductor devices; bipolar transistors; FETs; power supplies, amplifier, oscillators; operational amplifiers; elements of digital electronics; logic circuits.

PI - PRODUCTION AND INDUSTRIAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

GENERAL ENGINEERING:

Engineering Materials: Structure and properties of engineering materials and their applications; effect of strain, strain rate and temperature on mechanical properties of metals and alloys; heat treatment of metals and alloys.

Applied Mechanics: Engineering mechanics - equivalent force systems, free body concepts, equations of equilibrium, virtual work and minimum potential energy; strength of materials-stress, strain and their relationship, Mohr's circle, deflection of beams, bending and shear stress, Euler's theory of columns.

Theory of Machines and Design: Analysis of planar mechanisms, plane cams and followers; governers and fly wheels; design of elements-failure theories; design of bolted, riveted and welded joints; design of shafts, keys, belt drives, brakes and clutches.

Thermal Engineering: Fluid machines - fluid statics, Bernoulli's equation, flow through pipes, equations of continuity and momentum; Thermodynamics - zeroth, First and Second laws of thermodynamics, thermodynamic system and processes, calculation of work and heat for systems and control volumes; Heat transfer - fundamentals of conduction, convection and radiation.

PRODUCTION ENGINEERING

Metal Casting: Casting processes; patterns-materials; allowances; moulds and cores - materials, making and testing; melting and founding of cast iron, steels and nonferrous metals and alloys; solidification; design of casting, gating and risering; casting defects and inspection.

Metal working: Stress-strain in elastic and plastic deformation; deformation mechanisms; hot and cold working-forging, rolling, extrusion, wire and tube drawing; sheet metal working; analysis of rolling, forging, extrusion and wire /rod drawing; metal working defects, high energy rate forming processes-explosive, magnetic, electro and electrohydraulic.

Metal Joining Processes: Welding processes - gas shielded metal arc, TIG, MIG, submerged arc, electroslag, thermit, resistance, pressure and forge welding; thermal cutting; other joining processes - soldering, brazing, braze welding; welding codes, welding symbols, design of welded joints, defects and inspection; introduction to modern welding processes - friction, ultrasonic, explosive, electron beam, laser and plasma.

Machining and Machine Tool Operations: Machining processes-turning, drilling, boring, milling, shaping, planing, sawing, gear cutting, thread production, broaching, grinding, lapping, honing super finishing; mechanics of cutting- Merchant's analysis, geometry of cutting tools, cutting forces, power requirements; selection of process parameters; tool materials, tool wear and tool life, cutting fluids, machinability; nontraditional machining processes and hybrid processes- EDM, CHM, ECM, USM, LBM, EBM, AJM, PAM AND WJM; economics of machining.

Metrology and Inspection: Limits and fits, linear and angular measurements by mechanical and optical methods, comparators; design of limit gauges; interferometry; measurement of straightness, flatness, roundness, squareness and symmetry; surface finish measurement; inspection of screw threads and gears; alignment testing.

Powder Metallurgy and Processing of Plastics: Production of powders, compaction, sintering; Polymers and composites; injection, compression and blow molding, extrusion, calendaring and thermoforming; molding of composites.

Tool Engineering: Work-holding-location and clamping; principles and methods; design of jigs and fixtures; design of press working tools, forging dies.

Manufacturing Analysis: Sources of errors in manufacturing; process capability; part-print analysis; tolerance analysis in manufacturing and assembly; process planning; parameter selection and comparison of production alternatives; time and cost analysis; Issues in choosing manufacturing technologies and strategies.

Computer Integrated Manufacturing: Basic concepts of CAD, CAM, CAPP, group technology, NC, CNC, DNC, FMS, Robotics and CIM.

INDUSTRIAL ENGINEERING

Product Design and Development: Principles of good product design, component and tolerance design; efficiency, quality and cost considerations; product life cycle; standardization, simplification, diversification, value analysis, concurrent engineering.

Engineering Economy and Costing: Financial statements; elementary cost accounting, methods of depreciation; break-even analysis, techniques for evaluation of capital investments.

Work System Design: Taylor's scientific management, Gilbreths's contributions; productivity concepts and measurements; method study, micro-motion study, principles of motion economy; human factors engineering, ergonomics; work measurement - time study, PMTS, work sampling; job evaluation, merit rating, wage administration, incentive systems; business process reengineering.

Logistics and Facility Design: Facility location factors, evaluation of alternatives, types of plant layout, evaluation; computer aided layout; assembly line balancing; material handling systems; supply chain management.

Production Planning and Inventory Control: Inventory Function costs, classifications - deterministic and probabilistic models; quantity discount; safety stock; inventory control system; Forecasting techniques - causal and time series models, moving average, exponential smoothing; trend and seasonality; aggregate production planning; master scheduling; bill of materials and material requirement planning; order control and flow control, routing, scheduling and priority dispatching; JIT; Kanban PULL systems; bottleneck scheduling and theory of constraints.

Operation Research: Linear programming - problem formulation, simplex method, duality and sensitivity analysis; transportation; assignment; network flow models, constrained optimization and Lagrange multipliers; simple queuing models; dynamic programming; simulation; PERT and CPM, time-cost trade-off, resource leveling.

Quality Control: Taguchi method; design of experiments; quality costs, statistical quality assurance, process control charts, acceptance sampling, zero defects; quality circles, total quality management.

Reliability and Maintenance: Reliability, availability and maintainability; probabilistic failure and repair times; system reliability; preventive maintenance and replacement, TPM.

Management Information System: Value of information; information storage and retrieval system - database and data structures; interactive systems; knowledge based systems.

Intellectual Property System: Definition of intellectual property, importance of IPR; TRIPS, and its implications, WIPO and Global IP structure, and IPS in India; patent, copyright, industrial design and trademark; meanings, rules and procedures, terms, infringements and remedies.

PY - PHARMACEUTICAL SCIENCES

Natural Products: Pharmacognosy & Phytochemistry - Chemistry, tests, isolation, characterization and estimation of phytopharmaceuticals belonging to the group of Alkaloids, Glycosides, Terpenoids, Steroids, Bioflavanoids, Purines, Guggul lipids. Pharmacognosy of crude drugs which contain the above constituents. Standardisation of raw materials and herbal products. WHO guide lines. Quantitative microscopy including modern techniques used for evaluation. Biotechnological principles and techniques for plant development Tissue culture.

Pharmacology: General pharmacological principles including Toxicology. Drug interaction. Pharmacology of drugs acting on Central nervous system, Cardiovascular system, Autonomic nervous system, Gastro intestinal system and Respiratory system. Pharmacology of Autocoids, Hormones, Chemotherapeutic agents including anticancer drugs. Bioassays. Immuno Pharmacology.

Medicinal Chemistry: Structure, nomenclature, classification, synthesis, SAR and metabolism of the following category of drugs which are official in Indian Pharmacopoeia and British Pharmacopoeia Hypnotics and Sedatives, Analgesics, NSAIDS, Neuroleptics, Antidepressants, Anxiolytics, Anticonvulsants, Antihistaminics, Local anaesthetics, Cardio Vascular drugs - Antianginal agents Vasodilators, Adrenergic & cholinergic drugs, Cardiotonic agents, Diuretics, Antihypertensive drugs, Hypoglycemic agents, Antilipedmic agents, Coagulants, Anticoagulants, Antiplatelet agents. Chemotherapeutic agents - Antibiotics, Antibacterials, Sulphadrugs. Antiproliozoal drugs, Antiviral, Antitubercular, Antimalarial, Anticancer, Antiamoebic drugs. Diagnostic agents. Preparation and storage and uses of official Radiopharmaceuticals. Vitamins and Hormones.

Pharmaceutics: Development, manufacturing standards, labeling, packing as per the pharmacopoeal requirements, Storage of different dosage forms and new drug delivery systems. Biopharmaceutics and Pharmacokinetics and their importance in formulation. Formulation and preparation of cosmetics - lipstick, shampoo, creams, nail preparations and dentifrices. Pharmaceutical calculations.

Pharmaceutical Jurisprudence: Legal aspects of manufacture, storage, sale of drugs. D and C act and rules. Pharmacy act.

Pharmaceutical Analysis: Principles, instrumentation and applications of the following. Absorption spectroscopy (UV, visible & IR), Fluorimetry, Flame photometry, Potentiometry, Conductometry and Plarography. Pharmacopoeial assays. Principles of NMR, ESR, Mass spectroscopy, X-ray diffraction analysis and different chromatographic methods.

Biochemistry and Clinical Pharmacy: Biochemical role of hormones, Vitamins, Enzymes, Nucleic acids. Bioenergetics. General principles of immunology. Immunological techniques. Adverse drug interaction.

Microbiology: Principles and methods of microbiological assays of the Pharmacopoeia. Methods of preparation of official sera and vaccines. Serological and diagnostic tests. Applications of microorganisms in Bio Conversions and in Pharmaceutical industry.

TF - TEXTILE ENGINEERING AND FIBRE SCIENCE

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

TEXTILE ENGINEERING & FIBRE SCIENCE

Textile Fibres: Classification of textile fibres according to their nature and origin; general characteristics of textile fibres-their chemical and physical structures and their properties; essential characteristics of fibre forming polymers; uses of natural and man-made fibres; physical and chemical methods of fibre and blend identification and blend analysis.

Melt Spinning processes with special reference to polyamide and polyester fibres; wet and dry spinning of viscose and acrylic fibres; post spinning operations-drawing, heat setting, texturing- false twist and air-jet, tow-to-top conversion. Methods of investigating fibre structure e.g. X-ray diffraction, birefringence, optical and electron microscopy, I.R. absorption, thermal methods; structure and morphology and principal natural and man-made fibres, mechanical properties of fibres, moisture sorption in fibres; fibre structure and property correlation.

Textile Testing: Sampling techniques, sample size and sampling errors; measurement of fibre length, fineness, crimp, strength and reflectance; measurement of cotton fibre maturity ad trash content; HVI and AFIS for fibre testing. Measurement of yarn count, twist and hairiness; tensile testing of fibres, yarn and fabrics; evenness testing of slivers, rovings and yarns; testing equipment for measurement test methods of fabric properties like thickness, compressibility, air permeability, drape, crease recovery, tear strength bursting strength and abrasion resistance. Correlation analysis, significance tests and analysis of variance; frequency distributions and control charts.

Yarn Manufacture and Yarn Structure: Modern methods of opening, cleaning and blending of fibrous materials; the technology of carding with particular reference to modern developments; causes of irregularity introduced by drafting, the development of modern drafting systems; principles and techniques of preparing material for combing; recent development in combers; functions and synchronization of various mechanisms concerned with roving production; forces acting on yarn and traveller, ring and traveller designs; causes of end breakages; properties of doubles yarns; new methods of yarn production such as rotor spinning, air jet spinning and friction spinning.

Yarn diameter; specific volume, packing coefficient; twist-strength relationship; fibre orientation in yarn; fibre migration.

Fabric Manufacture and Fabric Structure: Principles of cheese and cone winding processes and machines; random and precision winding; package faults and their remedies; yarn clearers and tensioners; different systems of yarn splicing; features of modern cone winding machines; different types of warping creels; features of modern beam and sectional warping machines; different sizing systems, sizing of spun and filament yarns, modern sizing machines; principles of pirn winding processes and machines; primary and secondary motions of loom, effect of their settings and timings on fabric formation, fabric appearance and weaving performance; dobby and jacquard shedding; mechanics of weft insertion with shuttle; warp and weft stop motions, warp protection, weft replenishment; functional principles of weft insertion systems of shuttleless weaving machines, principles of multiphase and circular looms. Principles of weft and warp knitting; basic weft and warp knitted structures; classification, production and areas of application of nonwoven fabrics.

Basic woven fabric constructions and their derivatives; crepe, cord, terry, gauze, lino and double cloth constructions.

Peirce's equations for fabric geometry; thickness, cover and maximum sett of woven fabrics

Textile Chemical Processing: Preparatory processes for natural-and and their blends; mercerization of cotton; machines for yarn and fabric mercerization.

Dyeing and printing of natural- and synthetic- fibre fabrics and their blends with different dye classes; dyeing and printing machines; styles of printing; fastness properties of dyed and printed textile materials.

Finishing of textile materials, wash and wear, durable press, soil release, water repellent, flame retardant and antistatic finishes; shrink-resistance finish for wool; heat setting of synthetic-fibre fabrics, finishing machines; energy efficient processes; pollution control.

XE - ENGINERING SCIENCES

The syllabi of the sections of this paper are as follows:

SECTION A. ENGINEERING MATHEMATICS (Compulsory)

Linear Algebra : Determinates, algebra of matrices, rank, inverse, system of linear equations, symmetric, skew-symmetric and orthogonal matrices. Hermitian, skew-hermitian and unitary matrices. eigenvalues and eigenvectors, diagonalisation of matrices, Cayley-Hamiltonian, quadratic forms.

Calculus : Functions of single variables, limit, continuity and differentiability, Mean value theorems, Intermediate forms and L'Hospital rule, Maxima and minima, Taylor's series, Fundamental and mean value-theorems of integral calculus. Evaluation of definite and improper integrals, Beta and Gamma functions, Functions of two variables, limit, continuity, partial derivatives, Euler's theorem for homogeneous functions, total derivatives, maxima and minima, Lagrange method of multipliers, double and triple integrals and their applications, sequence and series, tests for convergence, power series, Fourier Series, Fourier integrals.

Complex variable: Analytic functions, Cauchy's integral theorem and integral formula without proof. Taylor's and Laurent' series, Residue theorem (without proof) with application to the evaluation of real integarls.

Vector Calculus: Gradient, divergence and curl, vector identities, directional derivatives, line, surface and volume integrals, Stokes, Gauss and Green's theorems (without proofs) with applications.

Ordinary Differential Equations: First order equation (linear and nonlinear), higher order linear differential equations with constant coefficients, method of variation of paramaters, Cauchy's and Euler's equations, initial and boundary value problems, power series solutions, Legendre polynomials and Bessel's functions of the first kind.

Partial Differential Equations: Variables separable method, solutions of one dimensional heat, wave and Laplace equations.

Probability and Statistics: Definitions of probability and simple theorems, conditional probability, mean, mode and standard deviation, random variables, discrete and continuous distributions, Poisson, normal and Binomial distribution, correlation and regression

Numerical Methods: L-U decomposition for systems of linear equations,Newton-Raphson method, numerical integration(trapezoidal and Simpson's rule), numerical methods for first order differential equation (Euler method)

SECTION B. COMPUTATIONAL SCIENCE

Numerical Methods: Truncation errors, round off errors and their propagation; Interpolation; Lagrange, Newton's forward, backward and divided difference formulas, least square curve fitting, solution of non-linear equations of one variables using bisection, false position, secant and Newton Raphson methods; Rate of convergence of these methods, general iterative methods. Simple and multiple roots of polynomials. Solutions of system of linear algebraic equations using Gauss elimination methods, Jacobi and Gauss-Seidel iterative methods and their rate of convergence; ill conditioned and well conditioned system. eigen values and eigen vectors using power methods. Numerical integration using trapezoidal, Simpson's rule and other quadrature formulas. Numerical Differentiation. Solution of boundary value problems. Solution of initial value problems of ordinary differential equations using Euler's method, predictor corrector and Runge Kutta method.

Programming : Elementary concepts and terminology of a computer system and system software, Fortran77 and C programming.

Fortran : Program organization, arithmetic statements, transfer of control, Do loops, subscripted variables, functions and subroutines.

C language : Basic data types and declarations, flow of control- iterative statement, conditional statement, unconditional branching, arrays, functions and procedures.

SECTION C. ELECTRICAL SCIENCES

Electric Circuits: Ideal voltage and current sources; RLC circuits, steady state and transient analysis of DC circuits, network theorems; alternating currents and voltages, single-phase AC circuits, resonance; three-phase circuits.

Magnetic circuits: Mmf and flux, and their relationship with voltage and current; transformer, equivalent circuit of a practical transformer, three-phase transformer connections.

Electrical machines: Principle of operation, characteristics, efficiency and regulation of DC and synchronous machines; equivalent circuit and performance of three-phase and single-phase induction motors.

Electronic Circuits: Characteristics of p-n junction diodes, zener diodes, bipolar junction transistors (BJT) and junction field effect transistors (JFET); MOSFET's structure, characteristics, and operations; rectifiers, filters, and regulated power supplies; biasing circuits, different configurations of transistor amplifiers, class A, B and C of power amplifiers; linear applications of operational amplifiers; oscillators; tuned and phase shift types.

Digital circuits: Number systems, Boolean algebra; logic gates, combinational circuits, flip-flops (RS, JK, D and T) counters.

Measuring instruments: Moving coil, moving iron, and dynamometer type instruments; shunts, instrument transformers, cathode ray oscilloscopes; D/A and A/D converters.

SECTION D. FLUID MECHANICS

Fluid Properties: Relation between stress and strain rate for Newtonian fluids

Hydrostatics, buoyancy, manometry

Concept of local and convective accelerations; control volume analysis for mass, momentum and energy conservation.

Differential equations of continuity and momentum (Euler's equation of motion); concept of fluid rotation, stream function, potential function; Bernoulli's equation and its applications.

Qualitative ideas of boundary layers and its separation; streamlined and bluff bodies; drag and lift forces.

Fully-developed pipe flow; laminar and turbulent flows; friction factor; Darcy Weisbach relation; Moody's friction chart; losses in pipe fittings; flow measurements using venturimeter and orifice plates.

Dimensional analysis; similitude and concept of dynamic similarity; importance of dimensionless numbers in model studies.

SECTION E. MATERIALS SCIENCE

Atomic structure and bonding in materials: metals, ceramics and polymers.

Structure of materials: Crystal systems, unit cells and space lattice; determination of structures of simple crystals by X-ray diffraction; Miller indices for planes and directions. Packing geometry in metallic, ionic and covalent solids.

Concept of amorphous, single and polycrystalline structures and their effects on properties of materials.

Imperfections in crystalline solids and their role in influencing various properties.

Fick´s laws of diffusion and applications of diffusion in sintering, doping of semiconductors and surface hardening of metals.

Alloys: solid solution and solubility limit. Binary phase diagram, intermediate phases and intermetallic compounds; iron-iron carbide phase diagram. Phase transformation in steels. Cold and hot working of metals, recovery, recrystallization and grain growth.

Properties and applications of ferrous and nonferrous alloys.

Structure, properties, processing and applications of traditional and advanced ceramics.

Polymers: classification, polymerization, structure and properties, additives for polymer products, processing and application.

Composites: properties and application of various composites.

Corrosion and environmental degradation of materials (metals, ceramics and polymers).

Mechanical properties of materials: Stress-strain diagrams of metallic, ceramic and polymeric materials, modulus of elasticity, yield strength, plastic deformation and toughness, tensile strength and elongation at break; viscoelasticity, hardness, impact strength. ductile and brittle fracture. creep and fatigue properties of materials.

Heat capacity, thermal conductivity, thermal expansion of materials.

Concept of energy band diagram for materials; conductors, semiconductors and insulators in terms of energy bands. Electrical conductivity, effect of temperature on conductivity in materials, intrinsic and extrinsic semiconductors, dielectric properties of materials.

Refraction, reflection, absorption and transmission of electromagnetic radiation in solids.

Origin of magnetism in metallic and ceramic materials, paramagnetism, diamagnetism, antiferromagnetism, ferromagnetism, ferrimagnetism in materials and magnetic hysteresis.

Advanced materials: Smart materials exhibiting ferroelectric, piezoelectric, optoelectronic, semiconducting behaviour; lasers and optical fibers; photoconductivity and superconductivity in materials.

SECTION F. SOLID MECHANICS

Equivalent force systems; free-body diagrams; equilibrium equations; analysis of determinate and indeterminate trusses and frames; friction.

Simple relative motion of particles; force as function of position, time and speed; force acting on a body in motion; laws of motion; law of conservation of energy; law of conservation of momentum

Stresses and strains; principal stresses and strains; Mohr's circle; generalized Hooke's Law; equilibrium equations; compatibility conditions; yield criteria.

Axial, shear and bending moment diagrams; axial, shear and bending stresses; deflection (for symmetric bending); torsion in circular shafts; thin cylinders; energy methods (Castigliano's Theorems); Euler buckling.

SECTION G. THERMODYNAMICS

Basic Concepts: Continuum, macroscopic approach, thermodynamic system (closed and open or control volume); thermodynamic properties and equilibrium; state of a system, state diagram, path and process; different modes of work; Zeroth law of thermodynamics; concept of temperature; heat.

First Law of Thermodynamics: Energy, enthalpy, specific heats, first law applied to systems and control volumes, steady and unsteady flow analysis.

Second Law of Thermodynamics: Kelvin-Planck and Clausius statements, reversible and irreversible processes, Carnot theorems, thermodynamic temperature scale, Clausius inequality and concept of entropy, principle of increase of entropy; availability and irreversibility.

Properties of Pure Substances: Thermodynamic properties of pure substances in solid, liquid and vapour phases, P-V-T behaviour of simple compressible substances, phase rule, thermodynamic property tables and charts, ideal and real gases, equations of state, compressibility chart.

Thermodynamic Relations: T-ds relations, Maxwell equations, Joule-Thomson coefficient, coefficient of volume expansion, adiabatic and isothermal compressibilities, Clapeyron equation.

Ideal Gas Mixtures: Dalton's and Amagat's laws, calculations of properties, air-water vapour mixtures.

XL - LIFE SCIENCES

The syllabi of the Sections of this paper are as follows:

SECTION H. CHEMISTRY (Compulsory)

Atomic structure and periodicity: Quantum chemistry; Planck's quantum theory, wave particle duality, uncertainty principle, quantum mechanical model of hydrogen atom; electronic configuration of atoms; periodic table and periodic properties; ionization energy, election affinity, electronegativity, atomic size.

Structure and bonding: Ionic and covalent bonding M.O. and V.B. approaches for diatomic molecules, VSEPR theory and shape of molecules, hybridisation, resonance, dipole moment, structure parameters such as bond length, bond angle and bond energy, hydrogen bonding, van der Waals interactions. Ionic solids; ionic radii, lattice energy (Born-Haber Cycle).

s.p. and d Block Elements: Oxides, halides and hydrides of alkali and alkaline earth metals, B, Al, S, N, P and S, silicones, general characteristics of 3d elements, coordination complexes: valence bond and crystal field theory, color, geometry and magnetic properties.

Chemical Equilibria: Colligative properties of solutions, ionic equilibria in solution, solubility product, common ion effect, hydrolysis of salts, pH, buffer and their applications in chemical analysis.

Electrochemistry: Conductance, Kohlrausch law, Half Cell potentials, emf, Nernst equation, galvanic cells, thermodynamic aspects and their applications.

Reaction Kinetics: Rate constant, order of reaction, molecularity, activation energy, zero, first and second order kinetics, equilibrium constants (Kc, Kp and Kx) for homogeneous reactions, catalysis and elementary enzyme reactions.

Thermodynamics: First law, reversible and irreversible processes, internal energy, enthalpy, Kirchoff's equation, heat of reaction, Hess law, heat of formation, Second law, entropy, free energy, and work function. Gibbs-Helmholtz equation, Clausius-Clapeyron equation, free energy change and equilibrium constant, Troutons rule, Third law of thermodynamics.

Mechanistic Basis of Organic Reactions: Elementary treatment of SN1, SN2, E1 and E2 reactions, Hoffmann and Saytzeff rules, Addition reactions, Markonikoff rule and Kharash effect, Diels-Alder reaction, aromatic electrophilic substitution, orientation effect as exemplified by various functional groups.

Structure-Reactivity Correlations: Acids and bases, electronic and steric effects, optical and geometrical isomerism, tautomerism, concept of aromaticity

SECTION I. BIOCHEMISTRY

Organization of life. Importance of water. Cell structure and organelles. Structure and function of biomolecules: Carbohydrates, Lipids, Proteins and Nucleic acids. Biochemical separation techniques. Spectroscopic methods; UV-visible and fluorescence. Protein structure, folding and function: Myoglobin, Hemoglobin, Lysozyme, ribonuclease A, Carboxypeptidase and Chymotrypsin. Enzyme kinetics and regulation, Coenzymes.

Metabolism and bioenergitics. Generation and utilization of ATP. Photosynthesis. Major metabolic pathways and their regulation. Biological membranes. Transport across membranes. Signal transduction; hormones and neurotransmitters.

DNA replication, transcription and translation. Biochemical regulation of gene expression. Recombinant DNA technology and applications. Genomics and Proteomics.

The immune system. Active and passive immunity. Complement system. Antobody structure, function and diversity. Cells of the immune system: T, B and macrophages. T and B cell activation. Major histocompatibilty complex. T cell receptor. Immunological techniques: Immunodiffusion, immunoelectrophoresis, RIA and ELISA.

SECTION J. BIOTECHNOLOGY

Recombinant DNA technology for the production of therapeutic proteins. Micro array technology. Heterologous protein expression systems in bacteria, yeast etc.

Architecture of plant genome; plant tissue culture techniques; methods of gene transfer into plant cells; manipulation of phenotypic traits in plants; plant cell fermentations and production of secondary metabolites using suspension/ immobilized cell culture; methods for plant micro propagation; crop improvement and development of transgenic plants. Expression of animal proteins in plants.

Animal cell metabolism and regulation; cell cycle; primary cell culture; nutritional requirements for animal cell culture; techniques for the mass culture of animal cell lines; production of vaccines; growth hormones and interferons using animal cell culture; cytokines-production and therapeutic uses; hybridoma technology; vectors for gene transfer and expression in animal cells. Transgenic animals and molecular pharming.

Microbial production of industrial enzymes; methods for immobilization of enzymes; kinetics of soluble and immobilized enzymes; application of soluble and immobilized enzymes; enzyme-based sensors.

Microbial growth kinetics; batch, fed batch and continuous culture of microbial cells; media for industrial fermentations; sterilization of air and media; design features and operation of stirred tank, air-lift and fluidized bed reactors; aeration and agitation in aerobic fermentations; recovery and purification of fermentation products- filtration, centrifugation, cell disintegration, solvent extraction and chromatographic separations; industrial fermentations for the production of ethanol, citric acid, lysine, penicillin and other biomolecules; simple calculations based on material and energy balance of fermentation processes; application of microbes in the management of domestic and industrial wastes.

SECTION K. BOTANY

Anatomy: Roots, stem and leaves of land plants, meristems, vascular system, their ontogeny, structure and functions. Plant cell structure, organisation, organelles, cytoskeleton, cell wall and membranes.

Development: Cell cycle, cell division, senescence, hormonal regulation of growth; life cycle of an angiosperm, pollination, fertilization, embryogenesis, seed formation, seed storage proteins, seed dormancy and germination. Concept of cellular totipotency, organogenesis and somatic embryogenesis, somaclonal variation, embryo culture, in vitro fertilization.

Physiology and Biochemistry: Plant water relations, transport of minerals and solutes, N2 metabolism, proteins and nucleic acid, respiration, photophysiology, photosynthesis, photorespiration; biosynthesis, mechanism of action and physiological effects of plant growth regulators.

Genetics: Principles of Mendelian inheritance, linkage, recombination and genetic mapping; extrachromosomal inheritance; eukaryotic genome organization (chromatin structure) and regulation of gene expression, gene mutation, chromosome aberrations (numerical and structural), transposons.

Plant Breeding: Principles, methods - selection, hybridization, heterosis; male sterility, self and inter-specific incompatibility; haploidy; somatic cell hybridization; molecular marker-assisted selection; gene transfer methods viz. direct and vector-mediated, transgenic plants and their applications in agriculture.

Economic Botany: Economically important plants - cereals, pulses, plants yielding fiber, timber, sugar, beverages, oils, rubber, dyes, gums, drugs and narcotics - a general account.

Systematics: Systems of classification (non-phylogenetic vs. phylogenetic - outline), plant groups, molecular systematics.

Plant Pathology: Nature and classification of plant diseases, diseases of important crops caused by fungi, bacteria and viruses, and their control measures, mechanism(s) of pathogenesis and resistance, molecular detection of pathogens; plant-microbe beneficial interactions.

Ecology and Plant Geography: Ecosystems - types, dynamics, degradation, ecological succession; food chains; vegetation types of the world; pollution and global warming; speciation and extinction, conservation strategies, cryopreservation.

SECTION L. MICROBIOLOGY

Historical perspective - Discovery of the microbial world; Controversy over spontaneous generation; Role of microorganisms in transformation of organic matter and in the causation of diseases.

Methods in microbiology - Pure culture techniques; Theory and practice of sterilization; Principles of microbial nutrition; Construction of culture media; Enrichment culture techniques for isolation of chemoautotrophs, chemoheterotrophs and photosynthetic microorganisms.

Microbial evolution, systematics and taxonomy - Evolution of earth and earliest life forms; Primitive organisms and their metabolic strategies; New approaches to bacterial taxonomic classification including ribotyping; Nomenclature.

Microbial diversity - Bacteria, archea and their broad classification; Eukaryotic microbes, yeast, fungi, slime mold and protozoa; Viruses and their classification.

Microbial growth -The definition of growth, mathematical expression of growth, growth curve, measurement of growth and growth yields; Synchronous growth; Continuous culture.

Nutrition and metabolism - Overview of metabolism; Microbial nutrition; Energy classes of microorganisms; Culture media; Energetics, modes of ATP generation; ATP generation by heterotrophs; Fermentation; Glycolysis; Respiration; The citric acid cycle; Electron transport systems; Alternate modes of energy generation; Pathways (anabolism) in the biosynthesis of amino acids, purines, pyrimidines and fatty acids.

Metabolic diversity among microorganisms - Photosynthesis in microorganisms; Role of chlorophylls, carotenoids and phycobilins; Calvin cycle; Chemolithotrophy; Hydrogen- iron-nitrite-oxidizing bacteria; Nitrate and sulfate reduction; Methanogenesis and acetogenesis.

Prokaryotic cells: structure-function - Cells walls of eubacteria (peptidoglycan) and related molecules; Outer-membrane of gram-negative bacteria; Cell wall and cell membrane synthesis; Flagella and motility; Cell inclusions like endospores, gas vesicles.

Microbial diseases and host parasite relationships - Normal microflora of skin; Oral cavity; Gastrointestinal tract; Entry of pathogens into the host; Infectious disease transmission; Respiratory infections caused by bacteria and viruses; Tuberculosis; Sexually transmitted diseases including AIDS; Diseases transmitted by animals (Rabies, plague), insects and ticks (rikettsias, Lyme disease, malaria); Food and water borne diseases; Public health and water quality; Pahtogenic fungi; Emerging and resurgent infectious diseases.

Chemotherapy/Antibiotics - Antimicrobial agents; Sulfa drugs; Antibiotics; Pencillins and cephalosporins; Broad-spectrum antibiotics; Antibiotics from prokaryotes; Antifungal antibiotics; Mode of action; Resistance to antibiotics.

Microbial genetics - Genes, mutation and mutagenesis - UV and chemical mutagnes; Types of mutations; Ames test for mutagenesis; Methods of genetic analysis. Bacterial genetic system - Transformation; Conjugation; Transduction; Recombination; Plasmids and Transposons; Bacterial genetic map with reference to E. coli. Viruses and their genetic system - Phage ? and its life cycle; RNA phages; RNA viruses; Retroviruses; Genetic systems of yeast and Neurospora; Extrachromosomal inheritance and mitochondrial genetics; Basic concept of genomics.

SECTION M. ZOOLOGY

Animal world: Animal diversity, distribution, systematic and classification of animals, the phylogenetic relationship.

Evolution: Origin of life, history of life on earth, evolutionary theories, natural selection, adaptation, speciation.

Genetics: Principles of inheritance, molecular basis of heredity, the genetic material, transmission of genetic material, mutations, cytoplasmic inheritance.

Biochemistry and Molecular Biology: Nucleic acids, proteins and other biological macromolecules. Replication, transcription and translation, regulation of gene expression, organization of genome, Kreb's cycle, glycolysis, enzyme catalysis, hormones and their action.

Cell Biology: Structure of cell, cellular organelles and their structure and function, cell cycle, cell division, cellular differentiation, chromosome and chromatin structure. Eukaryotic gene organisation and expression.

Animal Anatomy and Physiology: Comparative physiology, the respiratory system, circulatory system, digestive system, the nervous system, the excretory system, the endocrine system, the reproductive system, the skeletal system, osmoregulation.

Parasitology and Immunology: Nature of parasite, host-parasite relation, protozoan and helminthic parasites, the immune response, cellular and humoral immune response, evolution of the immune system.

Development Biology: Embryonic development, cellular differentiation, organogenesis, metamorphosis, genetic basis of development.

Ecology: The ecosystem, habitats the food chain, population dynamics, species diversity, zoogeography, biogeochemical cycles, conservation biology.

Animal Behaviour: Types of behaviours, courtship, mating and territoriality, instinct, learning and memory, social behaviour across the animal taxa, communication, pheromones, evolution of animal behaviour.

IT - INFORMATION TECHNOLOGY

ENGINEERING MATHEMATICS

Mathematical Logic: Propositional Logic; First Order Logic.

Probability: Conditional Probability; Mean, Median, Mode and Standard Deviation; Random Variables; Distributions; uniform, normal, exponential, Poisson, Binomial.

Set Theory & Algebra: Sets; Relations; Functions; Groups; Partial Orders; Lattice; Boolean Algebra.

Combinatorics: Permutations; Combinations; Counting; Summation; generating functions; recurrence relations; asymptotics.

Graph Theory: Connectivity; spanning trees; Cut vertices & edges; covering; matching; independent sets; Colouring; Planarity; Isomorphism.

Linear Algebra: Algebra of matrices, determinants, systems of linear equations, Eigen values and Eigen vectors.

Numerical Methods: LU decomposition for systems of linear equations; numerical solutions of non linear algebraic equations by Secant, Bisection and Newton-Raphson Methods; Numerical integration by trapezoidal and Simpson's rules.

Calculus: Limit, Continuity & differentiability, Mean value Theorems, Theorems of integral calculus, evaluation of definite & improper integrals, Partial derivatives, Total derivatives, maxima & minima.

FORMAL LANGUAGES AND AUTOMATA

Regular Languages: finite automata, regular expressions, regular grammar.

Context free languages: push down automata, context free grammars

COMPUTER HARDWARE

Digital Logic: Logic functions, minimization, design and synthesis of combinatorial and sequential circuits, number representation and computer arithmetic (fixed and floating point)

Computer organization: Machine instructions and addressing modes, ALU and data path, hardwired and microprogrammed control, memory interface, I/O interface (interrupt and DMA mode), serial communication interface, instruction pipelining, cache, main and secondary storage

SOFTWARE SYSTEMS

Data structures and Algorithms: the notion of abstract data types, stack, queue, list, set, string, tree, binary search tree, heap, graph, tree and graph traversals, connected components, spanning trees, shortest paths, hashing, sorting, searching, design techniques (greedy, dynamic, divide and conquer), asymptotic analysis (best, worst, average cases) of time and space, upper and lower bounds, intractability

Programming Methodology: C programming, program control (iteration, recursion, functions), scope, binding, parameter passing, elementary concepts of object oriented programming

Operating Systems (in the context of Unix): classical concepts (concurrency, synchronization, deadlock), processes, threads and interprocess communication, CPU scheduling, memory management, file systems, I/O systems, protection and security

Information Systems and Software Engineering: information gathering, requirement and feasibility analysis, data flow diagrams, process specifications, input/output design, process life cycle, planning and managing the project, design, coding, testing, implementation, maintenance.

Databases: relational model, database design, integrity constraints, normal forms, query languages (SQL), file structures (sequential, indexed), b-trees, transaction and concurrency control

Data Communication: data encoding and transmission, data link control, multiplexing, packet switching, LAN architecture, LAN systems (Ethernet, token ring), Network devices: switches, gateways, routers

Networks: ISO/OSI stack, sliding window protocols, routing protocols, TCP/UDP, application layer protocols & systems (http, smtp, dns, ftp), network security

Web technologies: three tier web based architecture; JSP, ASP, J2EE, .NET systems; html, XML

AG - AGRICULTURAL ENGINEERING

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

FARM MACHINERY AND POWER:

Sources of power on the farm-human, animal, mechanical, electrical, wind, solar and biomass; design and selection of machine elements - gears, pulleys, chains and sprockets and belts; overload safety devices used in farm machinery; measurement of force, torque, speed, displacement and acceleration on machine elements.

Soil tillage; forces acting on a tillage tool; hitch systems and hitching of tillage implements; functional requirements, principles of working, construction and operation of manual, animal and power operated equipment for tillage. sowing, planting, fertilizer application, inter-cultivation, spraying, mowing, chaff cutting, harvesting, threshing and transport; testing of agricultural machinery and equipment; calculation of performance parameters -field capacity, efficiency, application rate and losses; cost analysis of implements and tractors.

Thermodynamic principles of I.C. engines; I.C. engine cycles; engine components; fuels and combustion; lubricants and their properties; I.C. engine systems - fuel, cooling, lubrication, ignition, electrical, intake and exhaust; selection, operation, maintenance and repair of I.C. engines; power efficiencies and measurement; calculation of power, torque, fuel consumption, heat load and power losses.

Tractors and power tillers - type, selection, maintenance and repair; tractor clutches and brakes; power transmission systems - gear trains, differential, final drives and power take-off; mechanics of tractor chassis; traction theory; three point hitches- free link and restrained link operations; mechanical steering and hydraulic control systems used in tractors; human engineering and safety in tractor design; tractor tests and performance.

SOIL AND WATER CONSERVATION ENGINEERING:

Ideal and real fluids, properties of fluids; hydrostatic pressure and its measurement; hydrostatic forces on plane and curved surface; continuity equation; Bernoulli's theorem; laminar and turbulent flow in pipes, Darcy-Weisbach and Hazen-Williams equations, Moody's diagram; flow through orifices and notches; flow in open channels.

Engineering properties of soils, fundamental definitions and relationships; index properties of soils; permeability and seepage analysis; shear strength, Mohr's circle of stresses; active and passive earth pressures; stability of slopes.

Hydrological cycle; precipitation measurement, analysis of precipitation data; abstraction from precipitation; runoff; hydrograph analysis, unit hydrograph theory and application; stream flow measurement; flood routing, hydrological reservoir and channel routing.

Mechanics of soil erosion, factors affecting erosion; soil loss estimation; biological and engineering measures to control erosion, terraces and bunds; vegetative waterways; gully control structures, drop, drop inlet and chute spillways; farm ponds; earthen dams; principles of watershed management.

Water requirement of crops; consumptive use and evapo-transpiration; irrigation scheduling; irrigation efficiencies; design of prismatic and silt loaded channels; methods of irrigation water application; design and evaluation of irrigation methods; drainage coefficient; surface and subsurface drainage systems; leaching requirement and salinity control; irrigation and drainage water quality; classification of pumps; pump characteristics; pump selection; types of aquifer; evaluation of aquifer properties; well hydraulics; ground water recharge.

AGRICULTURAL PROCESSING AND FOOD ENGINEERING:

Steady state heat transfer in conduction, convection and radiation; transient heat transfer in simple geometry; condensation and boiling heat transfer; working principles of heat exchangers; diffusive and convective mass transfer; simultaneous heat and mass transfer in agricultural processing operations.

Material and energy balances in food processing systems; water activity, sorption and desorption isotherms; centrifugal separation of solids, liquids and gases; kinetics of microbial death - pasteurisation and sterilization of liquid foods; preservation of food by cooling and freezing; psychrometry - properties of air-vapour mixture; concentration and dehydration of liquid foods - evaporators, tray, drum and spray dryers.

Mechanics and energy requirement in size reduction of granular solids; particle size analysis for comminuted solids; size separation by screening; fluidisation of granular solids; cleaning and grading efficiency and effectiveness of grain cleaners; conditioning and hydrothermal treatments for grains; dehydration of food grains; processes and machines for processing of cereals, pulses and oilseeds; design considerations for grain silos.

AR - ARCHITECTURE AND PLANNING

City planning: Historical development of cities; principles of city planning; new towns; survey methods, site planning, planning regulations and building bye-laws.

Housing: Concept of shelter; housing policies and design; community planning; role of government agencies; finance and management.

Landscape Design: Principles of landscape design and site planning; history and landscape styles; landscape elements and materials; planting design.

Computer Aided Design: Application of computers in architecture and planning; understanding elements of hardware and software; computer graphics; programming languages - C and Visual Basic and usage of packages such as AutoCAD.

Environmental and Building Science: Elements of environmental science; ecological principles concerning environment; role of micro-climate in design; climatic control through design elements; thermal comfort; elements of solar architecture; principles of lighting and illumination; basic principles of architectural acoustics; air pollution, noise pollution and their control.

Visual and Urban Design: Principles of visual composition; proportion, scale, rhythm, symmetry, harmony, balance, form and colour; sense of place and space, division of space; focal point, vista, imageability, visual survey.

History of Architecture: Indian - Indus valley, Vedic, Buddhist, Indo-Aryan, Dravidian and Mughal periods; European - Egyptian, Greek, Roman, medieval and renaissance periods.

Development of Contemporary Architecture: Architectural developments and impacts on society since industrial revolution; influence of modern art on architecture; works of national and international architects; post modernism in architecture.

Building Services: Water supply, Sewerage and Drainage systems; Sanitary fittings and fixtures; principles of electrification of buildings; elevators, their standards and uses; air-conditioning systems; fire fighting systems.

Building Construction and Management: Building construction techniques, methods and details; building systems and prefabrication of building elements; principles of modular coordination; estimation, specification, valuation, professional practice; project management, PERT, CPM.

Materials and Structural Systems: Behavioural characteristics of all types of building materials e.g. mud, timber, bamboo, brick, concrete, steel, glass, FRP; principles of strength of materials; design of structural elements in wood, steel and RCC; elastic and limit state design; complex structural systems; principles of pre-stressing.

Planning Theory: Planning process; multilevel planning; comprehensive planning; central place theory; settlement pattern; land use and land utilization.

Techniques of Planning: Planning surveys; Preparation of urban and regional structure plans, development plans, action plans; site planning principles and design; statistical methods; application of remote sensing techniques in urban and regional planning.

Traffic and Transportation Planning: Principles of traffic engineering and transportation planning; methods of conducting surveys; design of roads, intersections and parking areas; hierarchy of roads and levels of services; traffic and transport management in urban areas; traffic safety and traffic laws; public transportation planning; modes of transportation.

Services and Amenities: Principles and design of water supply systems, sewerage systems, solid waste disposal systems, power supply and communication systems; Health, education, recreation and demography related standards at various levels of the settlements.

Development Administration and Management: Planning laws; development control and zoning regulations; laws relating to land acquisition; development enforcements, land ceiling; regional and urban plan preparations; planning and municipal administration; taxation, revenue resources and fiscal management; public participation and role of NGO.

CE - CIVIL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

STRUCTURAL ENGINEERING

Mechanics: Bending moments and shear forces in statically determinate beams; simple stress and strain: relationship; stress and strain in two dimensions, principal stresses, stress transformation, Mohr's circle; simple bending theory; flexural shear stress; thin-walled pressure vessels; uniform torsion.

Structural Analysis: Analysis of statically determinate trusses, arches and frames; displacements in statically determinate structures and analysis of statically indeterminate structures by force/energy methods; analysis by displacement methods (slope-deflection and moment-distribution methods); influence lines for determinate and indeterminate structures; basic concepts of matrix methods of structural analysis.

Concrete Structures: Basic working stress and limit states design concepts; analysis of ultimate load capacity and design of members subject to flexure, shear, compression and torsion (beams, columns and isolated footings); basic elements of prestressed concrete: analysis of beam sections at transfer and service loads.

Steel Structures: Analysis and design of tension and compression members, beams and beam-columns, column bases; connections - simple and eccentric, beam-column connections, plate girders and trusses; plastic analysis of beams and frames.

GEOTECHNICAL ENGINEERING

Soil Mechanics: Origin of soils; soil classification; three-phase system, fundamental definitions, relationship and inter-relationships; permeability and seepage; effective stress principle: consolidation, compaction; shear strength.

Foundation Engineering: Sub-surface investigation - scope, drilling bore holes, sampling, penetrometer tests, plate load test; earth pressure theories, effect of water table, layered soils; stability of slopes - infinite slopes, finite slopes; foundation types - foundation design requirements; shallow foundations; bearing capacity, effect of shape, water table and other factors, stress distribution, settlement analysis in sands and clays; deep foundations - pile types, dynamic and static formulae, load capacity of piles in sands and clays.

WATER RESOURCES ENGINEERING

Fluid Mechanics and Hydraulics: Hydrostatics, applications of Bernoulli equation, laminar and turbulent flow in pipes, pipe networks; concept of boundary layer and its growth; uniform flow, critical flow and gradually varied flow in channels, specific energy concept, hydraulic jump; forces on immersed bodies; flow measurement in channels; tanks and pipes; dimensional analysis and hydraulic modeling. Applications of momentum equation, potential flow, kinematics of flow; velocity triangles and specific speed of pumps and turbines.

Hydrology: Hydrologic cycle; rainfall; evaporation infiltration, unit hydrographs, flood estimation, reservoir design, reservoir and channel routing, well hydraulics.

Irrigation: Duty, delta, estimation of evapo-transpiration; crop water requirements; design of lined and unlined canals; waterways; head works, gravity dams and Ogee spillways. Designs of weirs on permeable foundation, irrigation methods.

ENVIRONMENTAL ENGINEERING

Water requirements; quality and standards, basic unit processes and operations for water treatment, distribution of water. Sewage and sewerage treatment: quantity and characteristic of waste water sewerage; primary and secondary treatment of waste water; sludge disposal; effluent discharge standards.

TRANSPORTATION ENGINEERING

Highway planning; geometric design of highways; testing and specifications of paving materials; design of flexible and rigid pavements.

CH - CHEMICAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional

probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

CHEMICAL ENGINEERING

Process Calculations and Thermodynamics: Laws of conservation of mass and energy; use of tie components; recycle, bypass and purge calculations; degree of freedom analysis.

First and Second laws of thermodynamics and their applications; equations of state and thermodynamic properties of real systems; phase equilibria; fugacity, excess properties and correlations of activity coefficients; chemical reaction equilibria.

Fluid Mechanics and Mechanical Operations: Fluid statics, Newtonian and non-Newtonian fluids, Bernoulli equation, Macroscopic friction factors, energy balance, dimensional analysis, shell balances, flow through pipeline systems, flow meters, pumps and compressors, packed and fluidized beds, elementary boundary layer theory, size reduction and size separation; free and hindered settling; centrifuge and cyclones; thickening and classification, filtration, mixing and agitation; conveying of solids.

Heat Transfer: Conduction, convection and radiation, heat transfer coefficients, steady and unsteady heat conduction, boiling, condensation and evaporation; types of heat exchangers and evaporators and their design.

Mass Transfer: Fick's law, molecular diffusion in fluids, mass transfer coefficients, film, penetration and surface renewal theories; momentum, heat and mass transfer analogies; stagewise and continuous contacting and stage efficiencies; HTU & NTU concepts design and operation of equipment for distillation, absorption, leaching, liquid-liquid extraction, crystallization, drying, humidification, dehumidification and adsorption.

Chemical Reaction Engineering: Theories of reaction rates; kinetics of homogeneous reactions, interpretation of kinetic data, single and multiple reactions in ideal reactors, non-ideal reactors; residence time; non-isothermal reactors; kinetics of heterogeneous catalytic reactions; diffusion effects in catalysis.

Instrumentation and Process Control: Measurement of process variables; sensors, transducers and their dynamics, dynamics of simple systems, dynamics such as CSTRs, transfer functions and responses of simple systems, process reaction curve, controller modes (P, PI, and PID); control valves; analysis of closed loop systems including stability, frequency response (including Bode plots) and controller tuning, cascade, feed forward control.

Plant Design and Economics: Design and sizing of chemical engineering equipment such as compressors, heat exchangers, multistage contactors; principles of process economics and cost estimation including total annualized cost, cost indexes, rate of return, payback period, discounted cash flow, optimization in Design.

Chemical Technology: Inorganic chemical industries; sulfuric acid, NaOH, fertilizers (Ammonia, Urea, SSP and TSP); natural products industries (Pulp and Paper, Sugar, Oil, and Fats); petroleum refining and petrochemicals; polymerization industries; polyethylene, polypropylene, PVC and polyester synthetic fibers.

CS - COMPUTER SCIENCE AND ENGINEERING

ENGINEERING MATHEMATICS

Mathematical Logic: Propositional Logic; First Order Logic.

Probability: Conditional Probability; Mean, Median, Mode and Standard Deviation; Random Variables; Distributions; uniform, normal, exponential, Poisson, Binomial.

Set Theory & Algebra: Sets; Relations; Functions; Groups; Partial Orders; Lattice; Boolean Algebra.

Combinatorics: Permutations; Combinations; Counting; Summation; generating functions; recurrence relations; asymptotics.

Graph Theory: Connectivity; spanning trees; Cut vertices & edges; covering; matching; independent sets; Colouring; Planarity; Isomorphism.

Linear Algebra: Algebra of matrices, determinants, systems of linear equations, Eigen values and Eigen vectors.

Numerical Methods: LU decomposition for systems of linear equations; numerical solutions of non linear algebraic equations by Secant, Bisection and Newton-Raphson Methods; Numerical integration by trapezoidal and Simpson's rules.

Calculus: Limit, Continuity & differentiability, Mean value Theorems, Theorems of integral calculus, evaluation of definite & improper integrals, Partial derivatives, Total derivatives, maxima & minima.

THEORY OF COMPUTATION

Formal Languages and Automata Theory: Regular languages and finite automata, Context free languages and Push-down automata, Recursively enumerable sets and Turing machines, Un-decidability;

Analysis of Algorithms and Computational Complexity: Asymptotic analysis (best, worst, average case) of time and space, Upper and lower bounds on the complexity of specific problems, NP-completeness.

COMPUTER HARDWARE

Digital Logic: Logic functions, Minimization, Design and synthesis of Combinational and Sequential circuits; Number representation and Computer Arithmetic (fixed and floating point);

Computer Organization: Machine instructions and addressing modes, ALU and Data-path, hardwired and micro-programmed control, Memory interface, I/O interface (Interrupt and DMA mode), Serial communication interface, Instruction pipelining, Cache, main and secondary storage.

SOFTWARE SYSTEMS

Data structures: Notion of abstract data types, Stack, Queue, List, Set, String, Tree, Binary search tree, Heap, Graph;

Programming Methodology: C programming, Program control (iteration, recursion, Functions), Scope, Binding, Parameter passing, Elementary concepts of Object oriented, Functional and Logic Programming;

Algorithms for problem solving: Tree and graph traversals, Connected components, Spanning trees, Shortest paths; Hashing, Sorting, Searching; Design techniques (Greedy, Dynamic Programming, Divide-and-conquer);

Compiler Design: Lexical analysis, Parsing, Syntax directed translation, Runtime environment, Code generation, Linking (static and dynamic); Operating Systems: Classical concepts (concurrency, synchronization, deadlock), Processes, threads and Inter-process communication, CPU scheduling, Memory management, File systems, I/O systems, Protection and security.

Databases: Relational model (ER-model, relational algebra, tuple calculus), Database design (integrity constraints, normal forms), Query languages (SQL), File structures (sequential files, indexing, B+ trees), Transactions and concurrency control;

Computer Networks: ISO/OSI stack, sliding window protocol, LAN Technologies (Ethernet, Token ring), TCP/UDP, IP, Basic concepts of switches, gateways, and routers.

CH - CHEMISTRY

PHYSICAL CHEMISTRY

Structure: Quantum theory - principles and techniques; applications to particle in a box, harmonic oscillator, rigid rotor and hydrogen atom; valence bond and molecular orbital theories and Huckel approximation, approximate techniques: variation and perturbation; symmetry, point groups; rotational, vibrational, electronic, NMR and ESR spectroscopy.

Equilibrium: First law of thermodynamics, heat, energy and work; second law of thermodynamics and entropy; third law and absolute entropy; free energy; partial molar quantities; ideal and non-ideal solutions; phase transformation: phase rule and phase diagrams- one, two, and three component systems; activity, activity coefficient, fugacity and fugacity coefficient ; chemical equilibrium, response of chemical equilibrium to temperature and pressure; colligative properties; kinetic theory of gases; thermodynamics of electrochemical cells; standard electrode potentials: applications - corrosion and energy conversion; molecular partition function (translational, rotational, vibrational and electronic).

Kinetics: Rates of chemical reactions, theories of reaction rates, collision and transition state theory; temperature dependence of chemical reactions; elementary reactions, consecutive elementary reactions; steady state approximation, kinetics of photochemical reactions and free radical polymerization, homogenous and heterogeneous catalysis.

INORGANIC CHEMISTRY

Non-Transition Elements: General characteristics, structure and reactions of simple and industrially important compounds, boranes, carboranes, silicates, silicones, diamond and graphite; hydrides, oxides and oxoacids of N, P, S and halogens; boron nitride, borazines and phosphazenes; xenon compounds. Shapes of molecules, hard-soft acid base concept.

Transition Elements: General characteristics of d and f block elements; coordination chemistry: structure and isomerism, stability, theories of metal-ligand bonding (CFT and LFT), electronic spectra and magnetic properties of transition metal complexes and lanthanides; metal carbonyls, metal-metal bonds and metal atom clusters, metallocenes; transition metal complexes with bonds to hydrogen, alkyls, alkenes, and arenes; metal carbenes; use of organometallic compounds as catalysts in organic synthesis; mechanisms of substitution and electron transfer reactions of coordination complexes. Role of metals with special reference to Na, K, Mg, Ca, Fe, Co, Zn, and Mo in biological systems.

Solids: Crystal systems and lattices, Miller planes, crystal packing, crystal defects; Bragg's Law; ionic crystals, band theory, metals and semiconductors. Spinels.

Instrumental methods of analysis: atomic absorption, UV-visible spectrometry, chromatographic and electro-analytical methods.

ORGANIC CHEMISTRY

Synthesis, reactions and mechanisms involving the following: Alkenes, alkynes, arenes, alcohols, phenols, aldehydes, ketones, carboxylic acids and their derivatives; halides, nitro compounds and amines; stereochemical and conformational effects on reactivity and specificity; reactions with diborane and peracids. Michael reaction, Robinson annulation, reactivity umpolung, acyl anion equivalents; molecular rearrangements involving electron deficient atoms.

Photochemistry: Basic principles, photochemistry of olefins, carbonyl compounds, arenes, photo oxidation and reduction.

Pericyclic reactions: Cycloadditions, electrocyclic reactions, sigmatropic reactions; Woodward-Hoffmann rules.

Heterocycles: Structural properties and reactions of furan, pyrrole, thiophene, pyridine, indole.

Biomolecules: Structure, properties and reactions of mono- and di-saccharides, physico-chemical properties of amino acids, structural features of proteins and nucleic acids.

Spectroscopy: Principles and applications of IR, UV-visible, NMR and mass spectrometry in the determination of structures of organic compounds.

EC - ELECTRONICS AND COMMUNICATION ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix Algebra, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Mean value theorems, Theorems of integral calculus, Evaluation of definite and improper integrals, Partial Derivatives, Maxima and minima, Multiple integrals, Fourier series. Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equation (linear and nonlinear), Higher order linear differential equations with constant coefficients, Method of variation of parameters, Cauchy's and Euler's equations, Initial and boundary value problems, Partial Differential Equations and variable separable method.

Complex variables: Analytic functions, Cauchy's integral theorem and integral formula, Taylor's and Laurent' series, Residue theorem, solution integrals.

Probability and Statistics: Sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Discrete and continuous distributions, Poisson, Normal and Binomial distribution, Correlation and regression analysis.

Numerical Methods: Solutions of non-linear algebraic equations, single and multi-step methods for differential equations.

Transform Theory: Fourier transform, Laplace transform, Z-transform.

ELECTRONICS & COMMUNICATION ENGINEERING

Networks: Network graphs: matrices associated with graphs; incidence, fundamental cut set and fundamental circuit matrices. Solution methods: nodal and mesh analysis. Network theorems: superposition, Thevenin and Norton's maximum power transfer, Wye-Delta transformation. Steady state sinusoidal analysis using phasors. Linear constant coefficient differential equations; time domain analysis of simple RLC circuits, Solution of network equations using Laplace transform: frequency domain analysis of RLC circuits. 2-port network parameters: driving point and transfer functions. State equations for networks.

Electronic Devices: Energy bands in silicon, intrinsic and extrinsic silicon. Carrier transport in silicon: diffusion current, drift current, mobility, resistivity. Generation and recombination of carriers. p-n junction diode, Zener diode, tunnel diode, BJT, JFET, MOS capacitor, MOSFET, LED, p-I-n and avalanche photo diode, LASERs. Device technology: integrated circuits fabrication process, oxidation, diffusion, ion implantation, photolithography, n-tub, p-tub and twin-tub CMOS process.

Analog Circuits: Equivalent circuits (large and small-signal) of diodes, BJTs, JFETs, and MOSFETs. Simple diode circuits, clipping, clamping, rectifier. Biasing and bias stability of transistor and FET amplifiers. Amplifiers: single-and multi-stage, differential, operational, feedback and power. Analysis of amplifiers; frequency response of amplifiers. Simple op-amp circuits. Filters. Sinusoidal oscillators; criterion for oscillation; single-transistor and op-amp configurations. Function generators and wave-shaping circuits. Power supplies.

Digital circuits: Boolean algebra, minimization of Boolean functions; logic gates digital IC families (DTL, TTL, ECL, MOS, CMOS). Combinational circuits: arithmetic circuits, code converters, multiplexers and decoders. Sequential circuits: latches and flip-flops, counters and shift-registers. Sample and hold circuits, ADCs, DACs. Semiconductor memories. Microprocessor(8085): architecture, programming, memory and I/O interfacing.

Signals and Systems: Definitions and properties of Laplace transform, continuous-time and discrete-time Fourier series, continuous-time and discrete-time Fourier Transform, z-transform. Sampling theorems. Linear Time-Invariant (LTI) Systems: definitions and properties; casuality, stability, impulse response, convolution, poles and zeros frequency response, group delay, phase delay. Signal transmission through LTI systems. Random signals and noise: probability, random variables, probability density function, autocorrelation, power spectral density.

Controls Systems: Basic control system components; block diagrammatic description, reduction of block diagrams. Open loop and closed loop (feedback) systems and stability analysis of these systems. Signal flow graphs and their use in determining transfer functions of systems; transient and steady state analysis of LTI control systems and frequency response. Tools and techniques for LTI control system analysis: root loci, Routh-Hurwitz criterion, Bode and Nyquist plots. Control system compensators: elements of lead and lag compensation, elements of Proportional-Integral-Derivative(PID) control. State variable representation and solution of state equation of LTI control systems.

Communications: Analog communication systems: amplitude and angle modulation and demodulation systems, spectral analysis of these operations, superheterodyne receivers; elements of hardware, realizations of analog communication systems; signal-to-noise ratio (SNR) calculations for amplitude modulation (AM) and frequency modulation (FM) for low noise conditions. Digital communication systems: pulse code modulation (PCM), differential pulse code modulation (DPCM), delta modulation (DM); digital modulation schemes-amplitude, phase and frequency shift keying schemes (ASK, PSK, FSK), matched filter receivers, bandwith consideration and probability of error calculations for these schemes.

Electromagnetics: Elements of vector calculus: divergence and curl; Gauss' and Stokes' theorems, Maxwell's equations: differential and integral forms. Wave equation, Poynting vector. Plane waves: propagation through various media; reflection and refraction; phase and group velocity; skin depth. Transmission lines: characteristic impedance; impedance transformation; Smith chart; impedance matching; pulse excitation. Waveguides: modes in rectangular waveguides; boundary conditions; cut-off frequencies; dispersion relations. Antennas: Dipole antennas; antenna arrays; radiation pattern; reciprocity theorem, antenna gain.

EE - ELECTRICAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix Algebra, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Mean value theorems, Theorems of integral calculus, Evaluation of definite and improper integrals, Partial Derivatives, Maxima and minima, Multiple integrals, Fourier series. Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equation (linear and nonlinear), Higher order linear differential equations with constant coefficients, Method of variation of parameters, Cauchy's and Euler's equations, Initial and boundary value problems, Partial Differential Equations and variable separable method.

Complex variables: Analytic functions, Cauchy's integral theorem and integral formula, Taylor's and Laurent' series, Residue theorem, solution integrals.

Probability and Statistics: Sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Discrete and continuous distributions, Poisson, Normal and Binomial distribution, Correlation and regression analysis.

Numerical Methods: Solutions of non-linear algebraic equations, single and multi-step methods for differential equations.

Transform Theory: Fourier transform, Laplace transform, Z-transform.

ELECTRICAL ENGINEERING

Electrical Circuits and Fields: Network graph, KCL, KVL, node/ cut set, mesh/ tie set analysis, transient response of d.c. and a.c. networks; sinusoidal steady-state analysis; resonance in electrical circuits; concepts of ideal voltage and current sources, network theorems, driving point, immittance and transfer functions of two port networks, elementary concepts of filters; three phase circuits; Fourier series and its application; Gauss theorem, electric field intensity and potential due to point, line, plane and spherical charge distribution, dielectrics, capacitance calculations for simple configurations; Ampere's and Biot-Savart's law, inductance calculations for simple configurations.

Electrical Machines: Single phase transformer - equivalent circuit, phasor diagram, tests, regulation and efficiency; three phase transformers - connections, parallel operation; auto transformer and three-winding transformer; principles of energy conversion, windings of rotating machines: D. C. generators and motors - characteristics, starting and speed control, armature reaction and commutation; three phase induction motors-performance characteristics, starting and speed control; single-phase induction motors; synchronous generators-performance, regulation, parallel operation; synchronous motors - starting, characteristics, applications, synchronous condensers; fractional horse power motors; permanent magnet and stepper motors.

Power Systems: Electric power generation - thermal, hydro, nuclear; transmission line parameters; steady-state performance of overhead transmission lines and cables and surge propagation; distribution systems, insulators, bundle conductors, corona and radio interference effects; per-unit quantities; bus admittance and impedance matrices; load flow; voltage control and power factor correction; economic operation; symmetrical components, analysis of symmetrical and unsymmetrical faults; principles of over current, differential and distance protections; concept of solid state relays and digital protection; circuit breakers; concept of system stability-swing curves and equal area criterion; basic concepts of HVDC transmission.

Control Systems: Principles of feedback; transfer function; block diagrams: steady-state errors; stability-Routh and Nyquist criteria; Bode plots; compensation; root loci; elementary state variable formulation; state transition matrix and response for Linear Time Invariant systems.

Electrical and Electronic Measurements: Bridges and potentiometers, PMMC, moving iron, dynamometer and induction type instruments; measurement of voltage, current, power, energy and power factor; instrument transformers; digital voltmeters and multimeters; phase, time and frequency measurement; Q-meter, oscilloscopes, potentiometric recorders, error analysis.

Analog and Digital Electronics: Characteristics of diodes, BJT, FET, SCR; amplifiers-biasing, equivalent circuit and frequency response; oscillators and feedback amplifiers, operational amplifiers- characteristics and applications; simple active filters; VCOs and timers; combinational and sequential logic circuits, multiplexer, Schmitt trigger, multivibrators, sample and hold circuits, A/D and D/A converters; microprocessors and their applications.

Power Electronics and Electric Drives: Semiconductor power devices-diodes, transistors, thyristors, triacs, GTOs, MOSFETs and IGBTs - static characteristics and principles of operation; triggering circuits; phase control rectifiers; bridge converters-fully controlled and half controlled; principles of choppers and inverters, basic concepts of adjustable speed dc and ac drives.

GG - GEOLOGY AND GEOPHYSICS

PART - I

Earth and planetary system; size, shape, internal structure and composition of the earth; atmosphere and greenhouse effect; isostasy; elements of seismology; continents and continental processes; physical oceanography; palaeomagnetism, continental drift plate tectonics, geothermal energy.

Weathering; soil formation; action of river, wind and glacier; oceans and oceanic features; earthquakes, volcanoes, orogeny and mountain building; elements of structural geology; crystallography; classification, composition and properties of minerals and rocks; engineering properties of rocks and soils, role of geology in the construction of engineering structures.

Processes of ore formation, occurrence and distribution of ores on land and on ocean floor; coal and petroleum resources in India; ground water geology including well hydraulics, geological time scale and geochronology; stratigraphic principles and stratigraphy of India; basics concepts of gravity, magnetic and electrical prospecting for ores and ground water.

PART - IIA: GEOLOGY

Crystal symmetry, forms, twinning; crystal chemistry; optical mineralogy, classification of minerals, diagnostic properties of rock minerals.

Mineralogy, structure, texture and classification of igneous, sedimentary and metamorphic rock, their origin and evolution; application of thermodynamics; structure and petrology of sedimentary rocks; sedimentary processes and environments, sedimentary facies, basin studies; basement cover relationship;

Primary and secondary structures; geometry and genesis of folds, faults, joints, unconformities, cleavage, schistosity and lineation; methods of projection. Tectonites and their significance; shear zone; superposed folding.

Morphology, classification and geological significance of important invertebrates, vertebrates, microfossils and palaeoflora; stratigraphic principles and Indian stratigraphy; geomorphic processes and agents; development and evolution of landforms; slope and drainage; processes on deep oceanic and near-shore regions; quantitative and applied geomorphology; air photo interpretation and remote sensing; chemical and optical properties of ore minerals; formation and localization of ore deposits; prospecting and exploration of economic minerals; coal and petroleum geology; origin and distribution of mineral and fuel deposits in India; ore dressing and mineral economics.

Cosmic abundance; meteorites; geochemical evolution of the earth; geochemical cycles; distribution of major, minor and trace elements; isotope geochemistry; geochemistry of waters including solution equilibria and water rock interaction.

Engineering properties of rocks and soils; rocks as construction material; geology of dams, tunnels and excavation sites; natural hazards; the fly ash problem; ground water geology and exploration; water quality; impact of human activity; Remote sensing techniques for the interpretation of landforms and resource management.

PART - II B: GEOPHYSICS

The earth as a planet; different motions of the earth; gravity filed of the earth and its shape; geochronology; isostasy, seismology and interior of the earth; variation of density, velocity, pressure, temperature, electrical and magnetic properties inside the earth; earthquakes-causes and measurements; zonation and seismic hazards; geomagnetic field, palaeomagnetism; oceanic and continental lithosphere; plate tectonics; heat flow; upper and lower atmospheric phenomena.

Theories of scalar and vector potential fields; Laplace, Maxwell and Helmholtz equations for solution of different types of boundary value problems for Cartesian, cylindrical and spherical polar coordinates; Green's theorem; Image theory; integral equations and conformal transformations in potential theory; Eikonal equation and ray theory.

'G' and 'g' units of measurement, density of rocks, gravimeters, preparation, analysis and interpretation of gravity maps; derivative maps, analytical continuation; gravity anomaly type curves; calculation of mass.

Earth's magnetic field, units of measurement, magnetic susceptibility of rocks, magnetometers, corrections, preparation of magnetic maps, magnetic anomaly type curve, analytical continuation, interpretation and application; magnetic well logging.

Conduction of electricity through rocks, electrical conductivities of metals, metallic, non-metallic and rock forming minerals, D.C. resistivity units and methods of measurement, electrode configuration for sounding and profiling, application of filter theory, interpretation of resistivity field data, application; self potential origin, classification, field measurement, interpretation of induced polarization time frequency, phase domain; IP units and methods of measurement, interpretation and application; ground-water exploration.

Origin of electromagnetic field elliptic polarization, methods of measurement for different source-receiver configuration components in EM measurements, interpretation and applications; earth's natural electromagnetic field, tellurics, magneto-tellurics; geomagnetic depth sounding principles, methods of measurement, processing of data and interpretation.

Seismic methods of prospecting: Reflection, refraction and CDP surveys; land and marine seismic sources, generation and propagation of elastic waves, velocity increasing with depth, geophones, hydrophones, recording instruments (DFS), digital formats, field layouts, seismic noises and noise profile analysis, optimum geophone grouping, noise cancellation by shot and geophone arrays, 2D and 3D seismic data acquisition and processing, CDP stacking charts, binning, filtering, dip-moveout, static and dynamic corrections, deconvolution, migration, signal processing, Fourier and Hilbert transforms, attribute analysis, bright and dim spots, seismic stratigraphy, high resolution seismics, VSP.

Principles and techniques of geophysical well-logging, SP, resistivity, induction, micro gamma ray, neutron, density, sonic, temperature, dip meter, caliper, nuclear magnetic, cement bond logging. Quantitative evaluation of formations from well logs; well hydraulics and application of geophysical methods for groundwater study; application of bore hole geophysics in ground water, mineral and oil exploration. Remote sensing techniques and application of remote sensing methods in geophysics.

IN - INSTRUMENTATION ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix Algebra, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Mean value theorems, Theorems of integral calculus, Evaluation of definite and improper integrals, Partial Derivatives, Maxima and minima, Multiple integrals, Fourier series. Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equation (linear and nonlinear), Higher order linear differential equations with constant coefficients, Method of variation of parameters, Cauchy's and Euler's equations, Initial and boundary value problems, Partial Differential Equations and variable separable method.

Complex variables: Analytic functions, Cauchy's integral theorem and integral formula, Taylor's and Laurent' series, Residue theorem, solution integrals.

Probability and Statistics: Sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Discrete and continuous distributions, Poisson, Normal and Binomial distribution, Correlation and regression analysis.

Numerical Methods: Solutions of non-linear algebraic equations, single and multi-step methods for differential equations.

Transform Theory: Fourier transform, Laplace transform, Z-transform.

INSTRUMENTATION ENGINEERING

Measurement Basics and Metrology: Static and dynamic characteristics of measurement systems. Standards and calibration. Error and uncertainty analysis, statistical analysis of data, and curve fitting. Linear and angular measurements; Measurement of straightness, flatness, roundness and roughness.

Transducers, Mechanical Measurements and Industrial Instrumentation: Transducers - elastic, resistive, inductive, capacitive, thermo-electric, piezoelectric, photoelectric, electro-mechanical, electro-chemical, and ultrasonic. Measurement of displacement, velocity (linear and rotational), acceleration, shock, vibration, force, torque, power, strain, stress, pressure, flow, temperature, humidity, viscosity, and density. energy storing elements, suspension systems and dampers.

Analog Electronics: Characteristics of diodes, BJTs, JFETs and MOSFETs; Diode circuits; Amplifiers: single and multi-stage, feedback; Frequency response; Operational amplifiers - design, characteristic, linear and non-linear applications: difference amplifiers; instrumentation amplifiers; precision rectifiers, I-to-V converters, active filters, oscillators, comparators, signal generators, wave shaping circuits.

Digital Electronics: Combinational logic circuits, minimization of Boolean functions; IC families (TTL, MOS, CMOS), arithmetic circuits, multiplexer and decoders. Sequential circuits: flip-flops, counters, shift registers. Schmitt trigger, timers, and multivibrators. Analog switches, multiplexers, S/H circuits. Analog-to-digital and digital-to-analog converters. Basics of computer organization and architecture. 8-bit microprocessor (8085), applications, memory, I/O interfacing, and microcontrollers.

Signals and Systems: Vectors and matrices; Fourier series; Fourier transforms; Ordinary differential equations. Impulse and frequency responses of first and second order systems.

Laplace transform and transfer function, convolution and correlation. Amplitude and frequency modulations and demodulations. Discrete time systems, difference equations, impulse and frequency responses; Z-transforms and transfer functions; IIR and FIR filters.

Electrical and Electronic Measurements: Measurement of R, L and C; bridges and potentiometers. Measurement of voltage, current, power, power factor, and energy; Instrument transformers; Q meter, waveform analyzers. Digital volt-meters and multi-meters. Time, phase and frequency measurements; Oscilloscope. Noise and interference in instrumentation.

Control Systems & Process Control: Principles of feedback; transfer function, signal flow graphs. Stability criteria, Bode plots, root-loci, Routh and Nyquist criteria. Compensation techniques; State space analysis. System components: mechanical, hydraulic, pneumatic, electrical and electronic; Servos and synchros; Stepper motors. On-off, cascade, P, PI, PID and feed-forward controls. Controller tuning and general frequency response.

Analytical, Optical and Biomedical Instrumentation: Principles of spectrometry, UV, visible, IR mass spectrometry, X-ray methods; nuclear radiation measurements, gas, solid and semi conductor lasers and their characteristics, interferometers, basics of fibre optics, transducers in biomedical applications, cardiovascular system measurements, instrumentation for clinical laboratory.

MA - MATHEMATICS

Linear Algebra: Finite dimensional vector spaces. Linear transformations and their matrix representations, rank; systems of linear equations, eigenvalues and eigenvectors, minimal polynomial, Cayley-Hamilton theorem, diagonalisation, Hermitian, Skew-Hermitian and unitary matrices. Finite dimensional inner product spaces, self-adjoint and Normal linear operators, spectral theorem, Quadratic forms.

Complex Analysis: Analytic functions, conformal mappings, bilinear transformations, complex integration: Cauchy's integral theorem and formula, Liouville's theorem, maximum modulus principle, Taylor and Laurent's series, residue theorem and applications for evaluating real integrals.

Real Analysis: Sequences and series of functions, uniform convergence, power series, Fourier series, functions of several variables, maxima, minima, multiple integrals, line, surface and volume integrals, theorems of Green, Stokes and Gauss; metric spaces, completeness, Weierstrass approximation theorem, compactness. Lebesgue measure, measurable functions; Lebesgue integral, Fatou's lemma, dominated convergence theorem.

Ordinary Differential Equations: First order ordinary differential equations, existence and uniqueness theorems, systems of linear first order ordinary differential equations, linear ordinary differential equations of higher order with constant coefficients; linear second order ordinary differential equations with variable coefficients, method of Laplace transforms for solving ordinary differential equations, series solutions; Legendre and Bessel functions and their orthogonality, Sturm Liouville system, Greeen's functions.

Algebra: Normal subgroups and homomorphisms theorems, automorphisms. Group actions, sylow's theorems and their applications groups of order less than or equal to 20, Finite p-groups. Euclidean domains, Principal ideal domains and unique factorizations domains. Prime ideals and maximal ideals in commutative rings.

Functional Analysis: Banach spaces, Hahn-Banach theorems, open mapping and closed graph theorems, principle of uniform boundedness; Hilbert spaces, orthonormal sets, Riesz representation theorem, self-adjoint, unitary and normal linear operators on Hilbert Spaces.

Numerical Analysis: Numerical solution of algebraic and transcendental equations; bisection, secant method, Newton-Raphson method, fixed point iteration, interpolation: existence and error of polynomial interpolation, Lagrange, Newton, Hermite(osculatory)interpolations; numerical differentiation and integration, Trapezoidal and Simpson rules; Gaussian quadrature; (Gauss-Legendre and Gauss-Chebyshev), method of undetermined parameters, least square and orthonormal polynomial approximation; numerical solution of systems of linear equations: direct and iterative methods, (Jacobi Gauss-Seidel and SOR) with convergence; matrix eigenvalue problems: Jacobi and Given's methods, numerical solution of ordinary differential equations: initial value problems, Taylor series method, Runge-Kutta methods, predictor-corrector methods; convergence and stability.

Partial Differential Equations: Linear and quasilinear first order partial differential equations, method of characteristics; second order linear equations in two variables and their classification; Cauchy, Dirichlet and Neumann problems, Green's functions; solutions of Laplace, wave and diffusion equations in two variables Fourier series and transform methods of solutions of the above equations and applications to physical problems.

Mechanics: Forces in three dimensions, Poinsot central axis, virtual work, Lagrange's equations for holonomic systems, theory of small oscillations, Hamiltonian equations;

Topology: Basic concepts of topology, product topology, connectedness, compactness, countability and separation axioms, Urysohn's Lemma, Tietze extension theorem, metrization theorems, Tychonoff theorem on compactness of product spaces.

Probability and Statistics: Probability space, conditional probability, Bayes' theorem, independence, Random variables, joint and conditional distributions, standard probability distributions and their properties, expectation, conditional expectation, moments. Weak and strong law of large numbers, central limit theorem. Sampling distributions, UMVU estimators, sufficiency and consistency, maximum likelihood estimators. Testing of hypotheses, Neyman-Pearson tests, monotone likelihood ratio, likelihood ratio tests, standard parametric tests based on normal, X2 ,t, F-distributions. Linear regression and test for linearity of regression. Interval estimation.

Linear Programming: Linear programming problem and its formulation, convex sets their properties, graphical method, basic feasible solution, simplex method, big-M and two phase methods, infeasible and unbounded LPP's, alternate optima. Dual problem and duality theorems, dual simplex method and its application in post optimality analysis, interpretation of dual variables. Balanced and unbalanced transportation problems, unimodular property and u-v method for solving transportation problems. Hungarian method for solving assignment problems.

Calculus of Variations and Integral Equations: Variational problems with fixed boundaries; sufficient conditions for extremum, Linear integral equations of Fredholm and Volterra type, their iterative solutions. Fredholm alternative.

ME - MECHANICAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

APPLIED MECHANICS AND DESIGN

Engineering Mechanics: Equivalent force systems, free-body concepts, equations of equilibrium, trusses and frames, virtual work and minimum potential energy. Kinematics and dynamics of particles and rigid bodies, impulse and momentum (linear and angular), energy methods, central force motion.

Strength of Materials: Stress and strain, stress-strain relationship and elastic constants, Mohr's circle for plane stress and plane strain, shear force and bending moment diagrams, bending and shear stresses, deflection of beams, torsion of circular shafts, thin and thick cylinders, Euler's theory of columns, strain energy methods, thermal stresses.

Theory of Machines: Displacement, velocity and acceleration, analysis of plane mechanisms, dynamic analysis of slider-crank mechanism, planar cams and followers, gear tooth profiles, kinematics of gears, governors and flywheels, balancing of reciprocating and rotating masses.

Vibrations: Free and forced vibration of single degree freedom systems, effect of damping, vibration isolation, resonance, critical speed of rotors.

Design of Machine Elements: Design for static and dynamic loading, failure theories, fatigue strength; design of bolted, riveted and welded joints; design of shafts and keys; design of spur gears, rolling and sliding contact bearings; brakes and clutches; belt, rope and chain drives.

FLUID MECHANICS AND THERMAL SCIENCES

Fluid Mechanics: Fluid properties, fluid statics, manometry, buoyancy; control-volume analysis of mass, momentum and energy; fluid acceleration; differential equations of continuity and momentum; Bernoulli's equation; viscous flow of incompressible fluids; boundary layer; elementary turbulent flow; flow through pipes, head losses in pipes, bends etc.

Heat-Transfer: Modes of heat transfer; one dimensional heat conduction, resistance concept, electrical analogy, unsteady heat conduction, fins; dimensionless parameters in free and forced convective heat transfer, various correlations for heat transfer in flow over flat plates and through pipes; thermal boundary layer; effect of turbulence; radiative heat transfer, black and grey surfaces, shape factors, network analysis; heat exchanger performance, LMTD and NTU methods.

Thermodynamics: Zeroth, First and Second laws of thermodynamics; thermodynamic system and processes; irreversibility and availability; behaviour of ideal and real gases, properties of pure substances, calculation of work and heat in ideal processes; analysis of thermodynamic cycles related to energy conversion; Carnot, Rankine, Otto, Diesel, Brayton and vapour compression cycles.

Power Plant Engineering: Steam generators; steam power cycles; steam turbines; impulse and reaction principles, velocity diagrams, pressure and velocity compounding; reheating and reheat factor; condensers and feed heaters.

I.C. Engines: Requirements and suitability of fuels in IC engines, fuel ratings, fuel-air mixture requirements; normal combustion in SI and CI engines; engine performance calculations.

Refrigeration and air-conditioning: Refrigerant compressors, expansion devices, condensers and evaporators; properties of moist air, psychrometric chart, basic psychometric processes.

Turbomachinery: Components of gas turbines; compression processes, centrifugal and axial flow compressors; axial flow turbines, elementary theory; hydraulic turbines; Euler-turbine equation; specific speed, Pelton-wheel, Francis and Kaplan turbines; centrifugal pumps.

MANUFACTURING AND INDUSTRIAL ENGINEERING

Engineering Materials: Structure and properties of engineering materials and their applications, heat treatment.

Metal Casting: Casting processes (expendable and non-expendable) -pattern, moulds and cores, heating and pouring, solidification and cooling, gating design, design considerations, defects.

Forming Processes: Stress-strain diagrams for ductile and brittle material, Plastic deformation and yield criteria, fundamentals of hot and cold working processes, Bulk metal forming processes (forging, rolling, extrusion, drawing), sheet metal working processes (punching, blanking, bending, deep drawing, coining, spinning, load estimation using homogeneous deformation methods, defects). processing of powder metals- atomization, compaction, sintering, secondary and finishing operations. forming and shaping of plastics- extrusion, injection moulding.

Joining Processes: Physics of welding, fusion and non-fusion welding processes, brazing and soldering, adhesive bonding, design considerations in welding, weld quality defects.

Machining and Machine Tool Operations: Mechanics of machining, single and multi-point cutting tools, tool geometry and materials, tool life and wear, cutting fluids, machinability, economics of machining, non-traditional machining processes.

Metrology and Inspection: Limits, fits and tolerances, linear and angular measurements, comparators, gauge design, interferometry, form and finish measurement, measurement of screw threads, alignment and testing methods.

Tool Engineering: Principles of work holding, design of jigs and fixtures.

Computer Integrated Manufacturing: Basic concepts of CAD, CAM and their integration tools.

Manufacturing Analysis: Part-print analysis, tolerance analysis in manufacturing and assembly, time and cost analysis.

Work-Study: Method study, work measurement, time study, work sampling, job evaluation, merit rating.

Production Planning and Control: Forecasting models, aggregate production planning, master scheduling, materials requirements planning.

Inventory Control: Deterministic and probabilistic models, safety stock inventory control systems.

Operations Research: Linear programming, simplex and duplex method, transportation, assignment, network flow models, simple queuing models, PERT and CPM

MN - MINING ENGINEERING

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

MINING ENGINEERING

Mechanics: Equivalent force systems, equations of equilibrium, two dimensional frames and trusses, free body diagrams, friction forces, particle kinematics and dynamics.

Mine Development, Geomechanics and Strata Control: Drivages for underground mine development, drilling methods and machines, explosives, blasting devices and practices, shaft sinking. Physico-mechanical properties of rocks, rock mass classification, ground control instrumentation and stress measurement techniques, theories of rock failure, ground vibrations, stress distribution around mine openings, subsidence, design of supports in roadways and workings, stability of open pits, slopes.

Mining Methods and Machinery: Surface mining - layout, development, loading, transportation and mechanization, continuous surface mining systems. Underground coal mining - bord and pillar system, longwall mining, thick seam mining methods. Underground metal mining: different stoping methods, stope mechanization, ore handling systems, mine filling. Generation and transmission of mechanical, hydraulic, and pneumatic power. Materials handling - haulages, conveyors, ropeways, face and development machinery, hoisting systems, and pumps.

Ventilation, Underground Hazards and Surface Environment: Underground atmosphere, heat load sources and thermal environment, air cooling, mechanics of air flow distribution, natural and mechanical ventilation, mine fans and their usage, auxiliary ventilation. Subsurface hazards from fires, explosions, gases, dust, and inundation, rescue apparatus and practices, safety in mines, accident analysis, noise, mine lighting. Air and water pollution: causes, dispersion, quality standards, and control.

Surveying, Mine Planning and Systems Engineering: Fundamentals of engineering surveying, Levels and levelling, Theodolite, tacheometry, triangulation, contouring, errors and adjustments, correlation, underground surveying, curves, photogrammetry, field astronomy, GPS fundamentals. Principles of planning - Sampling methods and practices, reserve estimation techniques, basics of geostatistics, optimization of facility location, cash flow concepts and mine valuation, open pit design. Work study, concepts of reliability, reliability of series and parallel systems. Linear programming, transportation and assignment problems, queueing, network analysis, inventory control.

MT - METALLURGICAL ENGINEERING

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

METALLURGICAL ENGINEERING

Thermodynamics and Rate Processes: Laws of thermodynamics, activity, equilibrium constant, applications to metallurgical systems, solutions, phase equilibria, basic kinetic laws, order of reactions, rate constants and rate limiting steps principles of electro chemistry, aqueous, corrosion and protection of metals, oxidation and high temperature corrosion - characterization and control; momentum transfer - concepts of viscosity, shell balances, Bernoulli's equation; heat transfer - conduction, convection and heat transfer coefficient relations, radiation, mass transfer - diffusion and Fick's laws.

Extractive Metallurgy: Flotation, gravity and other methods of mineral processing; agglomeration, pyro-hydro-and electro-metallurgical processes; material and energy balances; principles and processes for the extraction of non-ferrous metals - aluminium, copper, zinc, lead, magnesium, nickel, titanium and other rare metals; iron and steel making - principles, blast furnace, direct reduction processes, primary and secondary steel making, deoxidation and inclusion in steel; ingot and continuous casting; stainless steel making, design of furnaces; fuels and refractories.

Physical Metallurgy: Crystal structure and bonding characteristics of metals, alloys, ceramics and polymers; solid solutions; solidification; phase transformation and binary phase diagrams; principles of heat treatment of steels, aluminum alloys and cast irons; recovery, recrystallization and grain growth; industrially important ferrous and non-ferrous alloys; elements of X-ray and electron diffraction; principles of scanning and transmission electron microscopy; elements of ceramics, composites and electronic materials; electronic basis of thermal, optical, electrical and magnetic properties of materials.

Mechanical Metallurgy: Elements of elasticity and plasticity; defects in crystals; elements of dislocation theory - types of dislocations, slip and twinning, stress fields of dislocations, dislocation interactions and reactions, methods of seeing dislocations; strengthening mechanisms; tensile, fatigue and creep behaviour; superplasticity; fracture - Griffith theory, ductile to brittle transition, fracture toughness; failure analysis; mechanical testing - tension, compression, torsion, hardness, impact, creep, fatigue, fracture toughness and formability tests.

Manufacturing Processes: Metal casting - patterns, moulds, melting, gating, feeding and casting processes, defects and castings, hot and cold working of metals; Metal forming - fundamentals of metal forming, rolling wire drawing, extrusion, forming, sheet metal forming processes, defects in forming; Metal joining - soldering, brazing and welding, common welding processes, welding metallurgy, problems associated with welding of steels and aluminium alloys, defects in welding, powder metallurgy; NDT methods - ultrasonic, radiography, eddy current, acoustic emission and magnetic.

PH - PHYSICS

Mathematical Physics: Linear vector space, matrices; vector calculus; linear differential equations; elements of complex analysis; Laplace transforms, Fourier analysis, elementary ideas about tensors.

Classical Mechanics: Conservation laws; central forces; collisions and scattering in laboratory and centre of mass reference frames; mechanics of system of particles; rigid body dynamics; moment of inertia tensor; noninertial frames and pseudo forces; variational principle; Lagrange's and Hamilton's formalisms; equation of motion, cyclic coordinates, Poisson bracket; periodic motion, small oscillations, normal modes; wave equation and wave propagation; special theory of relativity - Lorentz transformations, relativistic kinematics, mass-energy equivalence.

Electromagnetic Theory: Laplace and Poisson equations; conductors and dielectrics; boundary value problems; Ampere's and Biot-Savart's laws; Faraday's law; Maxwell's equations; scalar and vector potentials; Coulomb and Lorentz gauges; boundary conditions at interfaces; electromagnetic waves; interference, diffraction and polarization; radiation from moving charges.

Quantum Mechanics: Physical basis of quantum mechanics; uncertainty principle; Schrodinger equation; one and three dimensional potential problems; Particle in a box, harmonic oscillator, hydrogen atom; linear vectors and operators in Hilbert space; angular momentum and spin; addition of angular momentum; time independent perturbation theory; elementary scattering theory.

Atomic and Molecular Physics: Spectra of one-and many-electron atoms; LS and jj coupling; hyperfine structure; Zeeman and Stark effects; electric dipole transitions and selection rules; X-ray spectra; rotational and vibrational spectra of diatomic molecules; electronic transition in diatomic molecules, Franck-Condon principle; Raman effect; NMR and ESR; lasers.

Thermodynamics and Statistical Physics: Laws of thermodynamics; macrostates, phase space; probability ensembles; partition function, free energy, calculation of thermodynamic quantities; classical and quantum statistics; degenerate Fermi gas; black body radiation and Planck's distribution law; Bose-Einstein condensation; first and second order phase transitions, critical point.

Solid State Physics: Elements of crystallography; diffraction methods for structure determination; bonding in solids; elastic properties of solids; defects in crystals; lattice vibrations and thermal properties of solids; free electron theory; band theory of solids; metals, semiconductors and insulators; transport properties; optical, dielectric and magnetic properties of solids; elements of superconductivity.

Nuclear and Particle Physics: Rutheford scattering; basic properties of nuclei; radioactive decay; nuclear forces; two nucleon problem; nuclear reactions; conservation laws; fission and fusion; nuclear models; particle accelerators, detectors; elementary particles; photons, baryons, mesons and leptons; Quark model.

Electronics: Network analysis; semiconductor devices; bipolar transistors; FETs; power supplies, amplifier, oscillators; operational amplifiers; elements of digital electronics; logic circuits.

PI - PRODUCTION AND INDUSTRIAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

GENERAL ENGINEERING:

Engineering Materials: Structure and properties of engineering materials and their applications; effect of strain, strain rate and temperature on mechanical properties of metals and alloys; heat treatment of metals and alloys.

Applied Mechanics: Engineering mechanics - equivalent force systems, free body concepts, equations of equilibrium, virtual work and minimum potential energy; strength of materials-stress, strain and their relationship, Mohr's circle, deflection of beams, bending and shear stress, Euler's theory of columns.

Theory of Machines and Design: Analysis of planar mechanisms, plane cams and followers; governers and fly wheels; design of elements-failure theories; design of bolted, riveted and welded joints; design of shafts, keys, belt drives, brakes and clutches.

Thermal Engineering: Fluid machines - fluid statics, Bernoulli's equation, flow through pipes, equations of continuity and momentum; Thermodynamics - zeroth, First and Second laws of thermodynamics, thermodynamic system and processes, calculation of work and heat for systems and control volumes; Heat transfer - fundamentals of conduction, convection and radiation.

PRODUCTION ENGINEERING

Metal Casting: Casting processes; patterns-materials; allowances; moulds and cores - materials, making and testing; melting and founding of cast iron, steels and nonferrous metals and alloys; solidification; design of casting, gating and risering; casting defects and inspection.

Metal working: Stress-strain in elastic and plastic deformation; deformation mechanisms; hot and cold working-forging, rolling, extrusion, wire and tube drawing; sheet metal working; analysis of rolling, forging, extrusion and wire /rod drawing; metal working defects, high energy rate forming processes-explosive, magnetic, electro and electrohydraulic.

Metal Joining Processes: Welding processes - gas shielded metal arc, TIG, MIG, submerged arc, electroslag, thermit, resistance, pressure and forge welding; thermal cutting; other joining processes - soldering, brazing, braze welding; welding codes, welding symbols, design of welded joints, defects and inspection; introduction to modern welding processes - friction, ultrasonic, explosive, electron beam, laser and plasma.

Machining and Machine Tool Operations: Machining processes-turning, drilling, boring, milling, shaping, planing, sawing, gear cutting, thread production, broaching, grinding, lapping, honing super finishing; mechanics of cutting- Merchant's analysis, geometry of cutting tools, cutting forces, power requirements; selection of process parameters; tool materials, tool wear and tool life, cutting fluids, machinability; nontraditional machining processes and hybrid processes- EDM, CHM, ECM, USM, LBM, EBM, AJM, PAM AND WJM; economics of machining.

Metrology and Inspection: Limits and fits, linear and angular measurements by mechanical and optical methods, comparators; design of limit gauges; interferometry; measurement of straightness, flatness, roundness, squareness and symmetry; surface finish measurement; inspection of screw threads and gears; alignment testing.

Powder Metallurgy and Processing of Plastics: Production of powders, compaction, sintering; Polymers and composites; injection, compression and blow molding, extrusion, calendaring and thermoforming; molding of composites.

Tool Engineering: Work-holding-location and clamping; principles and methods; design of jigs and fixtures; design of press working tools, forging dies.

Manufacturing Analysis: Sources of errors in manufacturing; process capability; part-print analysis; tolerance analysis in manufacturing and assembly; process planning; parameter selection and comparison of production alternatives; time and cost analysis; Issues in choosing manufacturing technologies and strategies.

Computer Integrated Manufacturing: Basic concepts of CAD, CAM, CAPP, group technology, NC, CNC, DNC, FMS, Robotics and CIM.

INDUSTRIAL ENGINEERING

Product Design and Development: Principles of good product design, component and tolerance design; efficiency, quality and cost considerations; product life cycle; standardization, simplification, diversification, value analysis, concurrent engineering.

Engineering Economy and Costing: Financial statements; elementary cost accounting, methods of depreciation; break-even analysis, techniques for evaluation of capital investments.

Work System Design: Taylor's scientific management, Gilbreths's contributions; productivity concepts and measurements; method study, micro-motion study, principles of motion economy; human factors engineering, ergonomics; work measurement - time study, PMTS, work sampling; job evaluation, merit rating, wage administration, incentive systems; business process reengineering.

Logistics and Facility Design: Facility location factors, evaluation of alternatives, types of plant layout, evaluation; computer aided layout; assembly line balancing; material handling systems; supply chain management.

Production Planning and Inventory Control: Inventory Function costs, classifications - deterministic and probabilistic models; quantity discount; safety stock; inventory control system; Forecasting techniques - causal and time series models, moving average, exponential smoothing; trend and seasonality; aggregate production planning; master scheduling; bill of materials and material requirement planning; order control and flow control, routing, scheduling and priority dispatching; JIT; Kanban PULL systems; bottleneck scheduling and theory of constraints.

Operation Research: Linear programming - problem formulation, simplex method, duality and sensitivity analysis; transportation; assignment; network flow models, constrained optimization and Lagrange multipliers; simple queuing models; dynamic programming; simulation; PERT and CPM, time-cost trade-off, resource leveling.

Quality Control: Taguchi method; design of experiments; quality costs, statistical quality assurance, process control charts, acceptance sampling, zero defects; quality circles, total quality management.

Reliability and Maintenance: Reliability, availability and maintainability; probabilistic failure and repair times; system reliability; preventive maintenance and replacement, TPM.

Management Information System: Value of information; information storage and retrieval system - database and data structures; interactive systems; knowledge based systems.

Intellectual Property System: Definition of intellectual property, importance of IPR; TRIPS, and its implications, WIPO and Global IP structure, and IPS in India; patent, copyright, industrial design and trademark; meanings, rules and procedures, terms, infringements and remedies.

PY - PHARMACEUTICAL SCIENCES

Natural Products: Pharmacognosy & Phytochemistry - Chemistry, tests, isolation, characterization and estimation of phytopharmaceuticals belonging to the group of Alkaloids, Glycosides, Terpenoids, Steroids, Bioflavanoids, Purines, Guggul lipids. Pharmacognosy of crude drugs which contain the above constituents. Standardisation of raw materials and herbal products. WHO guide lines. Quantitative microscopy including modern techniques used for evaluation. Biotechnological principles and techniques for plant development Tissue culture.

Pharmacology: General pharmacological principles including Toxicology. Drug interaction. Pharmacology of drugs acting on Central nervous system, Cardiovascular system, Autonomic nervous system, Gastro intestinal system and Respiratory system. Pharmacology of Autocoids, Hormones, Chemotherapeutic agents including anticancer drugs. Bioassays. Immuno Pharmacology.

Medicinal Chemistry: Structure, nomenclature, classification, synthesis, SAR and metabolism of the following category of drugs which are official in Indian Pharmacopoeia and British Pharmacopoeia Hypnotics and Sedatives, Analgesics, NSAIDS, Neuroleptics, Antidepressants, Anxiolytics, Anticonvulsants, Antihistaminics, Local anaesthetics, Cardio Vascular drugs - Antianginal agents Vasodilators, Adrenergic & cholinergic drugs, Cardiotonic agents, Diuretics, Antihypertensive drugs, Hypoglycemic agents, Antilipedmic agents, Coagulants, Anticoagulants, Antiplatelet agents. Chemotherapeutic agents - Antibiotics, Antibacterials, Sulphadrugs. Antiproliozoal drugs, Antiviral, Antitubercular, Antimalarial, Anticancer, Antiamoebic drugs. Diagnostic agents. Preparation and storage and uses of official Radiopharmaceuticals. Vitamins and Hormones.

Pharmaceutics: Development, manufacturing standards, labeling, packing as per the pharmacopoeal requirements, Storage of different dosage forms and new drug delivery systems. Biopharmaceutics and Pharmacokinetics and their importance in formulation. Formulation and preparation of cosmetics - lipstick, shampoo, creams, nail preparations and dentifrices. Pharmaceutical calculations.

Pharmaceutical Jurisprudence: Legal aspects of manufacture, storage, sale of drugs. D and C act and rules. Pharmacy act.

Pharmaceutical Analysis: Principles, instrumentation and applications of the following. Absorption spectroscopy (UV, visible & IR), Fluorimetry, Flame photometry, Potentiometry, Conductometry and Plarography. Pharmacopoeial assays. Principles of NMR, ESR, Mass spectroscopy, X-ray diffraction analysis and different chromatographic methods.

Biochemistry and Clinical Pharmacy: Biochemical role of hormones, Vitamins, Enzymes, Nucleic acids. Bioenergetics. General principles of immunology. Immunological techniques. Adverse drug interaction.

Microbiology: Principles and methods of microbiological assays of the Pharmacopoeia. Methods of preparation of official sera and vaccines. Serological and diagnostic tests. Applications of microorganisms in Bio Conversions and in Pharmaceutical industry.

TF - TEXTILE ENGINEERING AND FIBRE SCIENCE

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

TEXTILE ENGINEERING & FIBRE SCIENCE

Textile Fibres: Classification of textile fibres according to their nature and origin; general characteristics of textile fibres-their chemical and physical structures and their properties; essential characteristics of fibre forming polymers; uses of natural and man-made fibres; physical and chemical methods of fibre and blend identification and blend analysis.

Melt Spinning processes with special reference to polyamide and polyester fibres; wet and dry spinning of viscose and acrylic fibres; post spinning operations-drawing, heat setting, texturing- false twist and air-jet, tow-to-top conversion. Methods of investigating fibre structure e.g. X-ray diffraction, birefringence, optical and electron microscopy, I.R. absorption, thermal methods; structure and morphology and principal natural and man-made fibres, mechanical properties of fibres, moisture sorption in fibres; fibre structure and property correlation.

Textile Testing: Sampling techniques, sample size and sampling errors; measurement of fibre length, fineness, crimp, strength and reflectance; measurement of cotton fibre maturity ad trash content; HVI and AFIS for fibre testing. Measurement of yarn count, twist and hairiness; tensile testing of fibres, yarn and fabrics; evenness testing of slivers, rovings and yarns; testing equipment for measurement test methods of fabric properties like thickness, compressibility, air permeability, drape, crease recovery, tear strength bursting strength and abrasion resistance. Correlation analysis, significance tests and analysis of variance; frequency distributions and control charts.

Yarn Manufacture and Yarn Structure: Modern methods of opening, cleaning and blending of fibrous materials; the technology of carding with particular reference to modern developments; causes of irregularity introduced by drafting, the development of modern drafting systems; principles and techniques of preparing material for combing; recent development in combers; functions and synchronization of various mechanisms concerned with roving production; forces acting on yarn and traveller, ring and traveller designs; causes of end breakages; properties of doubles yarns; new methods of yarn production such as rotor spinning, air jet spinning and friction spinning.

Yarn diameter; specific volume, packing coefficient; twist-strength relationship; fibre orientation in yarn; fibre migration.

Fabric Manufacture and Fabric Structure: Principles of cheese and cone winding processes and machines; random and precision winding; package faults and their remedies; yarn clearers and tensioners; different systems of yarn splicing; features of modern cone winding machines; different types of warping creels; features of modern beam and sectional warping machines; different sizing systems, sizing of spun and filament yarns, modern sizing machines; principles of pirn winding processes and machines; primary and secondary motions of loom, effect of their settings and timings on fabric formation, fabric appearance and weaving performance; dobby and jacquard shedding; mechanics of weft insertion with shuttle; warp and weft stop motions, warp protection, weft replenishment; functional principles of weft insertion systems of shuttleless weaving machines, principles of multiphase and circular looms. Principles of weft and warp knitting; basic weft and warp knitted structures; classification, production and areas of application of nonwoven fabrics.

Basic woven fabric constructions and their derivatives; crepe, cord, terry, gauze, lino and double cloth constructions.

Peirce's equations for fabric geometry; thickness, cover and maximum sett of woven fabrics

Textile Chemical Processing: Preparatory processes for natural-and and their blends; mercerization of cotton; machines for yarn and fabric mercerization.

Dyeing and printing of natural- and synthetic- fibre fabrics and their blends with different dye classes; dyeing and printing machines; styles of printing; fastness properties of dyed and printed textile materials.

Finishing of textile materials, wash and wear, durable press, soil release, water repellent, flame retardant and antistatic finishes; shrink-resistance finish for wool; heat setting of synthetic-fibre fabrics, finishing machines; energy efficient processes; pollution control.

XE - ENGINERING SCIENCES

The syllabi of the sections of this paper are as follows:

SECTION A. ENGINEERING MATHEMATICS (Compulsory)

Linear Algebra : Determinates, algebra of matrices, rank, inverse, system of linear equations, symmetric, skew-symmetric and orthogonal matrices. Hermitian, skew-hermitian and unitary matrices. eigenvalues and eigenvectors, diagonalisation of matrices, Cayley-Hamiltonian, quadratic forms.

Calculus : Functions of single variables, limit, continuity and differentiability, Mean value theorems, Intermediate forms and L'Hospital rule, Maxima and minima, Taylor's series, Fundamental and mean value-theorems of integral calculus. Evaluation of definite and improper integrals, Beta and Gamma functions, Functions of two variables, limit, continuity, partial derivatives, Euler's theorem for homogeneous functions, total derivatives, maxima and minima, Lagrange method of multipliers, double and triple integrals and their applications, sequence and series, tests for convergence, power series, Fourier Series, Fourier integrals.

Complex variable: Analytic functions, Cauchy's integral theorem and integral formula without proof. Taylor's and Laurent' series, Residue theorem (without proof) with application to the evaluation of real integarls.

Vector Calculus: Gradient, divergence and curl, vector identities, directional derivatives, line, surface and volume integrals, Stokes, Gauss and Green's theorems (without proofs) with applications.

Ordinary Differential Equations: First order equation (linear and nonlinear), higher order linear differential equations with constant coefficients, method of variation of paramaters, Cauchy's and Euler's equations, initial and boundary value problems, power series solutions, Legendre polynomials and Bessel's functions of the first kind.

Partial Differential Equations: Variables separable method, solutions of one dimensional heat, wave and Laplace equations.

Probability and Statistics: Definitions of probability and simple theorems, conditional probability, mean, mode and standard deviation, random variables, discrete and continuous distributions, Poisson, normal and Binomial distribution, correlation and regression

Numerical Methods: L-U decomposition for systems of linear equations,Newton-Raphson method, numerical integration(trapezoidal and Simpson's rule), numerical methods for first order differential equation (Euler method)

SECTION B. COMPUTATIONAL SCIENCE

Numerical Methods: Truncation errors, round off errors and their propagation; Interpolation; Lagrange, Newton's forward, backward and divided difference formulas, least square curve fitting, solution of non-linear equations of one variables using bisection, false position, secant and Newton Raphson methods; Rate of convergence of these methods, general iterative methods. Simple and multiple roots of polynomials. Solutions of system of linear algebraic equations using Gauss elimination methods, Jacobi and Gauss-Seidel iterative methods and their rate of convergence; ill conditioned and well conditioned system. eigen values and eigen vectors using power methods. Numerical integration using trapezoidal, Simpson's rule and other quadrature formulas. Numerical Differentiation. Solution of boundary value problems. Solution of initial value problems of ordinary differential equations using Euler's method, predictor corrector and Runge Kutta method.

Programming : Elementary concepts and terminology of a computer system and system software, Fortran77 and C programming.

Fortran : Program organization, arithmetic statements, transfer of control, Do loops, subscripted variables, functions and subroutines.

C language : Basic data types and declarations, flow of control- iterative statement, conditional statement, unconditional branching, arrays, functions and procedures.

SECTION C. ELECTRICAL SCIENCES

Electric Circuits: Ideal voltage and current sources; RLC circuits, steady state and transient analysis of DC circuits, network theorems; alternating currents and voltages, single-phase AC circuits, resonance; three-phase circuits.

Magnetic circuits: Mmf and flux, and their relationship with voltage and current; transformer, equivalent circuit of a practical transformer, three-phase transformer connections.

Electrical machines: Principle of operation, characteristics, efficiency and regulation of DC and synchronous machines; equivalent circuit and performance of three-phase and single-phase induction motors.

Electronic Circuits: Characteristics of p-n junction diodes, zener diodes, bipolar junction transistors (BJT) and junction field effect transistors (JFET); MOSFET's structure, characteristics, and operations; rectifiers, filters, and regulated power supplies; biasing circuits, different configurations of transistor amplifiers, class A, B and C of power amplifiers; linear applications of operational amplifiers; oscillators; tuned and phase shift types.

Digital circuits: Number systems, Boolean algebra; logic gates, combinational circuits, flip-flops (RS, JK, D and T) counters.

Measuring instruments: Moving coil, moving iron, and dynamometer type instruments; shunts, instrument transformers, cathode ray oscilloscopes; D/A and A/D converters.

SECTION D. FLUID MECHANICS

Fluid Properties: Relation between stress and strain rate for Newtonian fluids

Hydrostatics, buoyancy, manometry

Concept of local and convective accelerations; control volume analysis for mass, momentum and energy conservation.

Differential equations of continuity and momentum (Euler's equation of motion); concept of fluid rotation, stream function, potential function; Bernoulli's equation and its applications.

Qualitative ideas of boundary layers and its separation; streamlined and bluff bodies; drag and lift forces.

Fully-developed pipe flow; laminar and turbulent flows; friction factor; Darcy Weisbach relation; Moody's friction chart; losses in pipe fittings; flow measurements using venturimeter and orifice plates.

Dimensional analysis; similitude and concept of dynamic similarity; importance of dimensionless numbers in model studies.

SECTION E. MATERIALS SCIENCE

Atomic structure and bonding in materials: metals, ceramics and polymers.

Structure of materials: Crystal systems, unit cells and space lattice; determination of structures of simple crystals by X-ray diffraction; Miller indices for planes and directions. Packing geometry in metallic, ionic and covalent solids.

Concept of amorphous, single and polycrystalline structures and their effects on properties of materials.

Imperfections in crystalline solids and their role in influencing various properties.

Fick´s laws of diffusion and applications of diffusion in sintering, doping of semiconductors and surface hardening of metals.

Alloys: solid solution and solubility limit. Binary phase diagram, intermediate phases and intermetallic compounds; iron-iron carbide phase diagram. Phase transformation in steels. Cold and hot working of metals, recovery, recrystallization and grain growth.

Properties and applications of ferrous and nonferrous alloys.

Structure, properties, processing and applications of traditional and advanced ceramics.

Polymers: classification, polymerization, structure and properties, additives for polymer products, processing and application.

Composites: properties and application of various composites.

Corrosion and environmental degradation of materials (metals, ceramics and polymers).

Mechanical properties of materials: Stress-strain diagrams of metallic, ceramic and polymeric materials, modulus of elasticity, yield strength, plastic deformation and toughness, tensile strength and elongation at break; viscoelasticity, hardness, impact strength. ductile and brittle fracture. creep and fatigue properties of materials.

Heat capacity, thermal conductivity, thermal expansion of materials.

Concept of energy band diagram for materials; conductors, semiconductors and insulators in terms of energy bands. Electrical conductivity, effect of temperature on conductivity in materials, intrinsic and extrinsic semiconductors, dielectric properties of materials.

Refraction, reflection, absorption and transmission of electromagnetic radiation in solids.

Origin of magnetism in metallic and ceramic materials, paramagnetism, diamagnetism, antiferromagnetism, ferromagnetism, ferrimagnetism in materials and magnetic hysteresis.

Advanced materials: Smart materials exhibiting ferroelectric, piezoelectric, optoelectronic, semiconducting behaviour; lasers and optical fibers; photoconductivity and superconductivity in materials.

SECTION F. SOLID MECHANICS

Equivalent force systems; free-body diagrams; equilibrium equations; analysis of determinate and indeterminate trusses and frames; friction.

Simple relative motion of particles; force as function of position, time and speed; force acting on a body in motion; laws of motion; law of conservation of energy; law of conservation of momentum

Stresses and strains; principal stresses and strains; Mohr's circle; generalized Hooke's Law; equilibrium equations; compatibility conditions; yield criteria.

Axial, shear and bending moment diagrams; axial, shear and bending stresses; deflection (for symmetric bending); torsion in circular shafts; thin cylinders; energy methods (Castigliano's Theorems); Euler buckling.

SECTION G. THERMODYNAMICS

Basic Concepts: Continuum, macroscopic approach, thermodynamic system (closed and open or control volume); thermodynamic properties and equilibrium; state of a system, state diagram, path and process; different modes of work; Zeroth law of thermodynamics; concept of temperature; heat.

First Law of Thermodynamics: Energy, enthalpy, specific heats, first law applied to systems and control volumes, steady and unsteady flow analysis.

Second Law of Thermodynamics: Kelvin-Planck and Clausius statements, reversible and irreversible processes, Carnot theorems, thermodynamic temperature scale, Clausius inequality and concept of entropy, principle of increase of entropy; availability and irreversibility.

Properties of Pure Substances: Thermodynamic properties of pure substances in solid, liquid and vapour phases, P-V-T behaviour of simple compressible substances, phase rule, thermodynamic property tables and charts, ideal and real gases, equations of state, compressibility chart.

Thermodynamic Relations: T-ds relations, Maxwell equations, Joule-Thomson coefficient, coefficient of volume expansion, adiabatic and isothermal compressibilities, Clapeyron equation.

Ideal Gas Mixtures: Dalton's and Amagat's laws, calculations of properties, air-water vapour mixtures.

XL - LIFE SCIENCES

The syllabi of the Sections of this paper are as follows:

SECTION H. CHEMISTRY (Compulsory)

Atomic structure and periodicity: Quantum chemistry; Planck's quantum theory, wave particle duality, uncertainty principle, quantum mechanical model of hydrogen atom; electronic configuration of atoms; periodic table and periodic properties; ionization energy, election affinity, electronegativity, atomic size.

Structure and bonding: Ionic and covalent bonding M.O. and V.B. approaches for diatomic molecules, VSEPR theory and shape of molecules, hybridisation, resonance, dipole moment, structure parameters such as bond length, bond angle and bond energy, hydrogen bonding, van der Waals interactions. Ionic solids; ionic radii, lattice energy (Born-Haber Cycle).

s.p. and d Block Elements: Oxides, halides and hydrides of alkali and alkaline earth metals, B, Al, S, N, P and S, silicones, general characteristics of 3d elements, coordination complexes: valence bond and crystal field theory, color, geometry and magnetic properties.

Chemical Equilibria: Colligative properties of solutions, ionic equilibria in solution, solubility product, common ion effect, hydrolysis of salts, pH, buffer and their applications in chemical analysis.

Electrochemistry: Conductance, Kohlrausch law, Half Cell potentials, emf, Nernst equation, galvanic cells, thermodynamic aspects and their applications.

Reaction Kinetics: Rate constant, order of reaction, molecularity, activation energy, zero, first and second order kinetics, equilibrium constants (K_c, K_p and K_x) for homogeneous reactions, catalysis and elementary enzyme reactions.

Thermodynamics: First law, reversible and irreversible processes, internal energy, enthalpy, Kirchoff's equation, heat of reaction, Hess law, heat of formation, Second law, entropy, free energy, and work function. Gibbs-Helmholtz equation, Clausius-Clapeyron equation, free energy change and equilibrium constant, Troutons rule, Third law of thermodynamics.

Mechanistic Basis of Organic Reactions: Elementary treatment of SN1, SN2, E1 and E2 reactions, Hoffmann and Saytzeff rules, Addition reactions, Markonikoff rule and Kharash effect, Diels-Alder reaction, aromatic electrophilic substitution, orientation effect as exemplified by various functional groups.

Structure-Reactivity Correlations: Acids and bases, electronic and steric effects, optical and geometrical isomerism, tautomerism, concept of aromaticity

SECTION I. BIOCHEMISTRY

Organization of life. Importance of water. Cell structure and organelles. Structure and function of biomolecules: Carbohydrates, Lipids, Proteins and Nucleic acids. Biochemical separation techniques. Spectroscopic methods; UV-visible and fluorescence. Protein structure, folding and function: Myoglobin, Hemoglobin, Lysozyme, ribonuclease A, Carboxypeptidase and Chymotrypsin. Enzyme kinetics and regulation, Coenzymes.

Metabolism and bioenergitics. Generation and utilization of ATP. Photosynthesis. Major metabolic pathways and their regulation. Biological membranes. Transport across membranes. Signal transduction; hormones and neurotransmitters.

DNA replication, transcription and translation. Biochemical regulation of gene expression. Recombinant DNA technology and applications. Genomics and Proteomics.

The immune system. Active and passive immunity. Complement system. Antobody structure, function and diversity. Cells of the immune system: T, B and macrophages. T and B cell activation. Major histocompatibilty complex. T cell receptor. Immunological techniques: Immunodiffusion, immunoelectrophoresis, RIA and ELISA.

SECTION J. BIOTECHNOLOGY

Recombinant DNA technology for the production of therapeutic proteins. Micro array technology. Heterologous protein expression systems in bacteria, yeast etc.

Architecture of plant genome; plant tissue culture techniques; methods of gene transfer into plant cells; manipulation of phenotypic traits in plants; plant cell fermentations and production of secondary metabolites using suspension/ immobilized cell culture; methods for plant micro propagation; crop improvement and development of transgenic plants. Expression of animal proteins in plants.

Animal cell metabolism and regulation; cell cycle; primary cell culture; nutritional requirements for animal cell culture; techniques for the mass culture of animal cell lines; production of vaccines; growth hormones and interferons using animal cell culture; cytokines-production and therapeutic uses; hybridoma technology; vectors for gene transfer and expression in animal cells. Transgenic animals and molecular pharming.

Microbial production of industrial enzymes; methods for immobilization of enzymes; kinetics of soluble and immobilized enzymes; application of soluble and immobilized enzymes; enzyme-based sensors.

Microbial growth kinetics; batch, fed batch and continuous culture of microbial cells; media for industrial fermentations; sterilization of air and media; design features and operation of stirred tank, air-lift and fluidized bed reactors; aeration and agitation in aerobic fermentations; recovery and purification of fermentation products- filtration, centrifugation, cell disintegration, solvent extraction and chromatographic separations; industrial fermentations for the production of ethanol, citric acid, lysine, penicillin and other biomolecules; simple calculations based on material and energy balance of fermentation processes; application of microbes in the management of domestic and industrial wastes.

SECTION K. BOTANY

Anatomy: Roots, stem and leaves of land plants, meristems, vascular system, their ontogeny, structure and functions. Plant cell structure, organisation, organelles, cytoskeleton, cell wall and membranes.

Development: Cell cycle, cell division, senescence, hormonal regulation of growth; life cycle of an angiosperm, pollination, fertilization, embryogenesis, seed formation, seed storage proteins, seed dormancy and germination. Concept of cellular totipotency, organogenesis and somatic embryogenesis, somaclonal variation, embryo culture, in vitro fertilization.

Physiology and Biochemistry: Plant water relations, transport of minerals and solutes, N2 metabolism, proteins and nucleic acid, respiration, photophysiology, photosynthesis, photorespiration; biosynthesis, mechanism of action and physiological effects of plant growth regulators.

Genetics: Principles of Mendelian inheritance, linkage, recombination and genetic mapping;

extrachromosomal inheritance; eukaryotic genome organization (chromatin structure) and regulation of gene expression, gene mutation, chromosome aberrations (numerical and structural), transposons.

Plant Breeding: Principles, methods - selection, hybridization, heterosis; male sterility, self and inter-specific incompatibility; haploidy; somatic cell hybridization; molecular marker-assisted selection; gene transfer methods viz. direct and vector-mediated, transgenic plants and their applications in agriculture.

Economic Botany: Economically important plants - cereals, pulses, plants yielding fiber, timber, sugar, beverages, oils, rubber, dyes, gums, drugs and narcotics - a general account.

Systematics: Systems of classification (non-phylogenetic vs. phylogenetic - outline), plant groups, molecular systematics.

Plant Pathology: Nature and classification of plant diseases, diseases of important crops caused by fungi, bacteria and viruses, and their control measures, mechanism(s) of pathogenesis and resistance, molecular detection of pathogens; plant-microbe beneficial interactions.

Ecology and Plant Geography: Ecosystems - types, dynamics, degradation, ecological succession; food chains; vegetation types of the world; pollution and global warming; speciation and extinction, conservation strategies, cryopreservation.

SECTION L. MICROBIOLOGY

Historical perspective - Discovery of the microbial world; Controversy over spontaneous generation; Role of microorganisms in transformation of organic matter and in the causation of diseases.

Methods in microbiology - Pure culture techniques; Theory and practice of sterilization; Principles of microbial nutrition; Construction of culture media; Enrichment culture techniques for isolation of chemoautotrophs, chemoheterotrophs and photosynthetic microorganisms.

Microbial evolution, systematics and taxonomy - Evolution of earth and earliest life forms; Primitive organisms and their metabolic strategies; New approaches to bacterial taxonomic classification including ribotyping; Nomenclature.

Microbial diversity - Bacteria, archea and their broad classification; Eukaryotic microbes, yeast, fungi, slime mold and protozoa; Viruses and their classification.

Microbial growth -The definition of growth, mathematical expression of growth, growth curve, measurement of growth and growth yields; Synchronous growth; Continuous culture.

Nutrition and metabolism - Overview of metabolism; Microbial nutrition; Energy classes of microorganisms; Culture media; Energetics, modes of ATP generation; ATP generation by heterotrophs; Fermentation; Glycolysis; Respiration; The citric acid cycle; Electron transport systems; Alternate modes of energy generation; Pathways (anabolism) in the biosynthesis of amino acids, purines, pyrimidines and fatty acids.

Metabolic diversity among microorganisms - Photosynthesis in microorganisms; Role of chlorophylls, carotenoids and phycobilins; Calvin cycle; Chemolithotrophy; Hydrogen- iron-nitrite-oxidizing bacteria; Nitrate and sulfate reduction; Methanogenesis and acetogenesis.

Prokaryotic cells: structure-function - Cells walls of eubacteria (peptidoglycan) and related molecules; Outer-membrane of gram-negative bacteria; Cell wall and cell membrane synthesis; Flagella and motility; Cell inclusions like endospores, gas vesicles.

Microbial diseases and host parasite relationships - Normal microflora of skin; Oral cavity;

Gastrointestinal tract; Entry of pathogens into the host; Infectious disease transmission; Respiratory infections caused by bacteria and viruses; Tuberculosis; Sexually transmitted diseases including AIDS; Diseases transmitted by animals (Rabies, plague), insects and ticks (rikettsias, Lyme disease, malaria); Food and water borne diseases; Public health and water quality; Pahtogenic fungi; Emerging and resurgent infectious diseases.

Chemotherapy/Antibiotics - Antimicrobial agents; Sulfa drugs; Antibiotics; Pencillins and cephalosporins; Broad-spectrum antibiotics; Antibiotics from prokaryotes; Antifungal antibiotics; Mode of action; Resistance to antibiotics.

Microbial genetics - Genes, mutation and mutagenesis - UV and chemical mutagnes; Types of mutations; Ames test for mutagenesis; Methods of genetic analysis. Bacterial genetic system - Transformation; Conjugation; Transduction; Recombination; Plasmids and Transposons; Bacterial genetic map with reference to E. coli. Viruses and their genetic system - Phage ? and its life cycle; RNA phages; RNA viruses; Retroviruses; Genetic systems of yeast and Neurospora; Extrachromosomal inheritance and mitochondrial genetics; Basic concept of genomics.

SECTION M. ZOOLOGY

Animal world: Animal diversity, distribution, systematic and classification of animals, the phylogenetic relationship.

Evolution: Origin of life, history of life on earth, evolutionary theories, natural selection, adaptation, speciation.

Genetics: Principles of inheritance, molecular basis of heredity, the genetic material, transmission of genetic material, mutations, cytoplasmic inheritance.

Biochemistry and Molecular Biology: Nucleic acids, proteins and other biological macromolecules. Replication, transcription and translation, regulation of gene expression, organization of genome, Kreb's cycle, glycolysis, enzyme catalysis, hormones and their action.

Cell Biology: Structure of cell, cellular organelles and their structure and function, cell cycle, cell division, cellular differentiation, chromosome and chromatin structure. Eukaryotic gene organisation and expression.

Animal Anatomy and Physiology: Comparative physiology, the respiratory system, circulatory system, digestive system, the nervous system, the excretory system, the endocrine system, the reproductive system, the skeletal system, osmoregulation.

Parasitology and Immunology: Nature of parasite, host-parasite relation, protozoan and helminthic parasites, the immune response, cellular and humoral immune response, evolution of the immune system.

Development Biology: Embryonic development, cellular differentiation, organogenesis, metamorphosis, genetic basis of development.

Ecology: The ecosystem, habitats the food chain, population dynamics, species diversity, zoogeography, biogeochemical cycles, conservation biology.

Animal Behaviour: Types of behaviours, courtship, mating and territoriality, instinct, learning and memory, social behaviour across the animal taxa, communication, pheromones, evolution of animal behaviour.

IT - INFORMATION TECHNOLOGY

ENGINEERING MATHEMATICS

Mathematical Logic: Propositional Logic; First Order Logic.

Probability: Conditional Probability; Mean, Median, Mode and Standard Deviation; Random Variables; Distributions; uniform, normal, exponential, Poisson, Binomial.

Set Theory & Algebra: Sets; Relations; Functions; Groups; Partial Orders; Lattice; Boolean Algebra.

Combinatorics: Permutations; Combinations; Counting; Summation; generating functions; recurrence relations; asymptotics.

Graph Theory: Connectivity; spanning trees; Cut vertices & edges; covering; matching; independent sets; Colouring; Planarity; Isomorphism.

Linear Algebra: Algebra of matrices, determinants, systems of linear equations, Eigen values and Eigen vectors.

Numerical Methods: LU decomposition for systems of linear equations; numerical solutions of non linear algebraic equations by Secant, Bisection and Newton-Raphson Methods; Numerical integration by trapezoidal and Simpson's rules.

Calculus: Limit, Continuity & differentiability, Mean value Theorems, Theorems of integral calculus, evaluation of definite & improper integrals, Partial derivatives, Total derivatives, maxima & minima.

FORMAL LANGUAGES AND AUTOMATA

Regular Languages: finite automata, regular expressions, regular grammar.

Context free languages: push down automata, context free grammars

COMPUTER HARDWARE

Digital Logic: Logic functions, minimization, design and synthesis of combinatorial and sequential circuits, number representation and computer arithmetic (fixed and floating point)

Computer organization: Machine instructions and addressing modes, ALU and data path, hardwired and microprogrammed control, memory interface, I/O interface (interrupt and DMA mode), serial communication interface, instruction pipelining, cache, main and secondary storage

SOFTWARE SYSTEMS

Data structures and Algorithms: the notion of abstract data types, stack, queue, list, set, string, tree, binary search tree, heap, graph, tree and graph traversals, connected components, spanning trees, shortest paths, hashing, sorting, searching, design techniques (greedy, dynamic, divide and conquer), asymptotic analysis (best, worst, average cases) of time and space, upper and lower bounds, intractability

Programming Methodology: C programming, program control (iteration, recursion, functions), scope, binding, parameter passing, elementary concepts of object oriented programming

Operating Systems (in the context of Unix): classical concepts (concurrency, synchronization, deadlock), processes, threads and interprocess communication, CPU scheduling, memory management, file systems, I/O systems, protection and security

Information Systems and Software Engineering: information gathering, requirement and feasibility analysis, data flow diagrams, process specifications, input/output design, process life cycle, planning and managing the project, design, coding, testing, implementation, maintenance.

Databases: relational model, database design, integrity constraints, normal forms, query languages (SQL), file structures (sequential, indexed), b-trees, transaction and concurrency control

Data Communication: data encoding and transmission, data link control, multiplexing, packet switching, LAN architecture, LAN systems (Ethernet, token ring), Network devices: switches, gateways, routers

Networks: ISO/OSI stack, sliding window protocols, routing protocols, TCP/UDP, application layer protocols & systems (http, smtp, dns, ftp), network security

Web technologies: three tier web based architecture; JSP, ASP, J2EE, .NET systems; html, XML

AG - AGRICULTURAL ENGINEERING

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

FARM MACHINERY AND POWER:

Sources of power on the farm-human, animal, mechanical, electrical, wind, solar and biomass; design and selection of machine elements - gears, pulleys, chains and sprockets and belts; overload safety devices used in farm machinery; measurement of force, torque, speed, displacement and acceleration on machine elements.

Soil tillage; forces acting on a tillage tool; hitch systems and hitching of tillage implements; functional requirements, principles of working, construction and operation of manual, animal and power operated equipment for tillage. sowing, planting, fertilizer application, inter-cultivation, spraying, mowing, chaff cutting, harvesting, threshing and transport; testing of agricultural machinery and equipment; calculation of performance parameters -field capacity, efficiency, application rate and losses; cost analysis of implements and tractors.

Thermodynamic principles of I.C. engines; I.C. engine cycles; engine components; fuels and combustion; lubricants and their properties; I.C. engine systems - fuel, cooling, lubrication, ignition, electrical, intake and exhaust; selection, operation, maintenance and repair of I.C. engines; power efficiencies and measurement; calculation of power, torque, fuel consumption, heat load and power losses.

Tractors and power tillers - type, selection, maintenance and repair; tractor clutches and brakes; power transmission systems - gear trains, differential, final drives and power take-off; mechanics of tractor chassis; traction theory; three point hitches- free link and restrained link operations; mechanical steering and hydraulic control systems used in tractors; human engineering and safety in tractor design; tractor tests and performance.

SOIL AND WATER CONSERVATION ENGINEERING:

Ideal and real fluids, properties of fluids; hydrostatic pressure and its measurement; hydrostatic forces on plane and curved surface; continuity equation; Bernoulli's theorem; laminar and turbulent flow in pipes, Darcy-Weisbach and Hazen-Williams equations, Moody's diagram; flow through orifices and notches; flow in open channels.

Engineering properties of soils, fundamental definitions and relationships; index properties of soils; permeability and seepage analysis; shear strength, Mohr's circle of stresses; active and passive earth pressures; stability of slopes.

Hydrological cycle; precipitation measurement, analysis of precipitation data; abstraction from precipitation; runoff; hydrograph analysis, unit hydrograph theory and application; stream flow measurement; flood routing, hydrological reservoir and channel routing.

Mechanics of soil erosion, factors affecting erosion; soil loss estimation; biological and engineering measures to control erosion, terraces and bunds; vegetative waterways; gully control structures, drop, drop inlet and chute spillways; farm ponds; earthen dams; principles of watershed management.

Water requirement of crops; consumptive use and evapo-transpiration; irrigation scheduling; irrigation efficiencies; design of prismatic and silt loaded channels; methods of irrigation water application; design and evaluation of irrigation methods; drainage coefficient; surface and subsurface drainage systems; leaching requirement and salinity control; irrigation and drainage water quality; classification of pumps; pump characteristics; pump selection; types of aquifer; evaluation of aquifer properties; well hydraulics; ground water recharge.

AGRICULTURAL PROCESSING AND FOOD ENGINEERING:

Steady state heat transfer in conduction, convection and radiation; transient heat transfer in simple geometry; condensation and boiling heat transfer; working principles of heat exchangers; diffusive and convective mass transfer; simultaneous heat and mass transfer in agricultural processing operations.

Material and energy balances in food processing systems; water activity, sorption and desorption isotherms; centrifugal separation of solids, liquids and gases; kinetics of microbial death - pasteurisation and sterilization of liquid foods; preservation of food by cooling and freezing; psychrometry - properties of air-vapour mixture; concentration and dehydration of liquid foods - evaporators, tray, drum and spray dryers.

Mechanics and energy requirement in size reduction of granular solids; particle size analysis for comminuted solids; size separation by screening; fluidisation of granular solids; cleaning and grading efficiency and effectiveness of grain cleaners; conditioning and hydrothermal treatments for grains; dehydration of food grains; processes and machines for processing of cereals, pulses and oilseeds; design considerations for grain silos.

AR - ARCHITECTURE AND PLANNING

City planning: Historical development of cities; principles of city planning; new towns; survey methods, site planning, planning regulations and building bye-laws.

Housing: Concept of shelter; housing policies and design; community planning; role of government agencies; finance and management.

Landscape Design: Principles of landscape design and site planning; history and landscape styles; landscape elements and materials; planting design.

Computer Aided Design: Application of computers in architecture and planning; understanding elements of hardware and software; computer graphics; programming languages - C and Visual Basic and usage of packages such as AutoCAD.

Environmental and Building Science: Elements of environmental science; ecological principles concerning environment; role of micro-climate in design; climatic control through design elements; thermal comfort; elements of solar architecture; principles of lighting and illumination; basic principles of architectural acoustics; air pollution, noise pollution and their control.

Visual and Urban Design: Principles of visual composition; proportion, scale, rhythm, symmetry, harmony, balance, form and colour; sense of place and space, division of space; focal point, vista, imageability, visual survey.

History of Architecture: Indian - Indus valley, Vedic, Buddhist, Indo-Aryan, Dravidian and Mughal periods; European - Egyptian, Greek, Roman, medieval and renaissance periods.

Development of Contemporary Architecture: Architectural developments and impacts on society since industrial revolution; influence of modern art on architecture; works of national and international architects; post modernism in architecture.

Building Services: Water supply, Sewerage and Drainage systems; Sanitary fittings and fixtures; principles of electrification of buildings; elevators, their standards and uses; air-conditioning systems; fire fighting systems.

Building Construction and Management: Building construction techniques, methods and details; building systems and prefabrication of building elements; principles of modular coordination; estimation, specification, valuation, professional practice; project management, PERT, CPM.

Materials and Structural Systems: Behavioural characteristics of all types of building materials e.g. mud, timber, bamboo, brick, concrete, steel, glass, FRP; principles of strength of materials; design of structural elements in wood, steel and RCC; elastic and limit state design; complex structural systems; principles of pre-stressing.

Planning Theory: Planning process; multilevel planning; comprehensive planning; central place theory; settlement pattern; land use and land utilization.

Techniques of Planning: Planning surveys; Preparation of urban and regional structure plans, development plans, action plans; site planning principles and design; statistical methods; application of remote sensing techniques in urban and regional planning.

Traffic and Transportation Planning: Principles of traffic engineering and transportation planning; methods of conducting surveys; design of roads, intersections and parking areas; hierarchy of roads and levels of services; traffic and transport management in urban areas; traffic safety and traffic laws; public transportation planning; modes of transportation.

Services and Amenities: Principles and design of water supply systems, sewerage systems, solid waste disposal systems, power supply and communication systems; Health, education, recreation and demography related standards at various levels of the settlements.

Development Administration and Management: Planning laws; development control and zoning regulations; laws relating to land acquisition; development enforcements, land ceiling; regional and urban plan preparations; planning and municipal administration; taxation, revenue resources and fiscal management; public participation and role of NGO.

CE - CIVIL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

STRUCTURAL ENGINEERING

Mechanics: Bending moments and shear forces in statically determinate beams; simple stress and strain: relationship; stress and strain in two dimensions, principal stresses, stress transformation, Mohr's circle; simple bending theory; flexural shear stress; thin-walled pressure vessels; uniform torsion.

Structural Analysis: Analysis of statically determinate trusses, arches and frames; displacements in statically determinate structures and analysis of statically indeterminate structures by force/energy methods; analysis by displacement methods (slope-deflection and moment-distribution methods); influence lines for determinate and indeterminate structures; basic concepts of matrix methods of structural analysis.

Concrete Structures: Basic working stress and limit states design concepts; analysis of ultimate load capacity and design of members subject to flexure, shear, compression and torsion (beams, columns and isolated footings); basic elements of prestressed concrete: analysis of beam sections at transfer and service loads.

Steel Structures: Analysis and design of tension and compression members, beams and beam-columns, column bases; connections - simple and eccentric, beam-column connections, plate girders and trusses; plastic analysis of beams and frames.

GEOTECHNICAL ENGINEERING

Soil Mechanics: Origin of soils; soil classification; three-phase system, fundamental definitions, relationship and inter-relationships; permeability and seepage; effective stress principle: consolidation, compaction; shear strength.

Foundation Engineering: Sub-surface investigation - scope, drilling bore holes, sampling, penetrometer tests, plate load test; earth pressure theories, effect of water table, layered soils; stability of slopes - infinite slopes, finite slopes; foundation types - foundation design requirements; shallow foundations; bearing capacity, effect of shape, water table and other factors, stress distribution, settlement analysis in sands and clays; deep foundations - pile types, dynamic and static formulae, load capacity of piles in sands and clays.

WATER RESOURCES ENGINEERING

Fluid Mechanics and Hydraulics: Hydrostatics, applications of Bernoulli equation, laminar and turbulent flow in pipes, pipe networks; concept of boundary layer and its growth; uniform flow, critical flow and gradually varied flow in channels, specific energy concept, hydraulic jump; forces on immersed bodies; flow measurement in channels; tanks and pipes; dimensional analysis and hydraulic modeling. Applications of momentum equation, potential flow, kinematics of flow; velocity triangles and specific speed of pumps and turbines.

Hydrology: Hydrologic cycle; rainfall; evaporation infiltration, unit hydrographs, flood estimation, reservoir design, reservoir and channel routing, well hydraulics.

Irrigation: Duty, delta, estimation of evapo-transpiration; crop water requirements; design of lined and unlined canals; waterways; head works, gravity dams and Ogee spillways. Designs of weirs on permeable foundation, irrigation methods.

ENVIRONMENTAL ENGINEERING

Water requirements; quality and standards, basic unit processes and operations for water treatment, distribution of water. Sewage and sewerage treatment: quantity and characteristic of waste water sewerage; primary and secondary treatment of waste water; sludge disposal; effluent discharge standards.

TRANSPORTATION ENGINEERING

Highway planning; geometric design of highways; testing and specifications of paving materials; design of flexible and rigid pavements.

CH - CHEMICAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

CHEMICAL ENGINEERING

Process Calculations and Thermodynamics: Laws of conservation of mass and energy; use of tie components; recycle, bypass and purge calculations; degree of freedom analysis.

First and Second laws of thermodynamics and their applications; equations of state and thermodynamic properties of real systems; phase equilibria; fugacity, excess properties and correlations of activity coefficients; chemical reaction equilibria.

Fluid Mechanics and Mechanical Operations: Fluid statics, Newtonian and non-Newtonian fluids, Bernoulli equation, Macroscopic friction factors, energy balance, dimensional analysis, shell balances, flow through pipeline systems, flow meters, pumps and compressors, packed and fluidized beds, elementary boundary layer theory, size reduction and size separation; free and hindered settling; centrifuge and cyclones; thickening and classification, filtration, mixing and agitation; conveying of solids.

Heat Transfer: Conduction, convection and radiation, heat transfer coefficients, steady and unsteady heat conduction, boiling, condensation and evaporation; types of heat exchangers and evaporators and their design.

Mass Transfer: Fick's law, molecular diffusion in fluids, mass transfer coefficients, film, penetration and surface renewal theories; momentum, heat and mass transfer analogies; stagewise and continuous contacting and stage efficiencies; HTU & NTU concepts design and operation of equipment for distillation, absorption, leaching, liquid-liquid extraction, crystallization, drying, humidification, dehumidification and adsorption.

Chemical Reaction Engineering: Theories of reaction rates; kinetics of homogeneous reactions, interpretation of kinetic data, single and multiple reactions in ideal reactors, non-ideal reactors; residence time; non-isothermal reactors; kinetics of heterogeneous catalytic reactions; diffusion effects in catalysis.

Instrumentation and Process Control: Measurement of process variables; sensors, transducers and their dynamics, dynamics of simple systems, dynamics such as CSTRs, transfer functions and responses of simple systems, process reaction curve, controller modes (P, PI, and PID); control valves; analysis of closed loop systems including stability, frequency response (including Bode plots) and controller tuning, cascade, feed forward control.

Plant Design and Economics: Design and sizing of chemical engineering equipment such as compressors, heat exchangers, multistage contactors; principles of process economics and cost estimation including total annualized cost, cost indexes, rate of return, payback period, discounted cash flow, optimization in Design.

Chemical Technology: Inorganic chemical industries; sulfuric acid, NaOH, fertilizers (Ammonia, Urea, SSP and TSP); natural products industries (Pulp and Paper, Sugar, Oil, and Fats); petroleum refining and petrochemicals; polymerization industries; polyethylene, polypropylene, PVC and polyester synthetic fibers.

CS - COMPUTER SCIENCE AND ENGINEERING

ENGINEERING MATHEMATICS

Mathematical Logic: Propositional Logic; First Order Logic.

Probability: Conditional Probability; Mean, Median, Mode and Standard Deviation; Random Variables; Distributions; uniform, normal, exponential, Poisson, Binomial.

Set Theory & Algebra: Sets; Relations; Functions; Groups; Partial Orders; Lattice; Boolean Algebra.

Combinatorics: Permutations; Combinations; Counting; Summation; generating functions; recurrence relations; asymptotics.

Graph Theory: Connectivity; spanning trees; Cut vertices & edges; covering; matching; independent sets; Colouring; Planarity; Isomorphism.

Linear Algebra: Algebra of matrices, determinants, systems of linear equations, Eigen values and Eigen vectors.

Numerical Methods: LU decomposition for systems of linear equations; numerical solutions of non linear algebraic equations by Secant, Bisection and Newton-Raphson Methods; Numerical integration by trapezoidal and Simpson's rules.

Calculus: Limit, Continuity & differentiability, Mean value Theorems, Theorems of integral calculus, evaluation of definite & improper integrals, Partial derivatives, Total derivatives, maxima & minima.

THEORY OF COMPUTATION

Formal Languages and Automata Theory: Regular languages and finite automata, Context free languages and Push-down automata, Recursively enumerable sets and Turing machines, Un-decidability;

Analysis of Algorithms and Computational Complexity: Asymptotic analysis (best, worst, average case) of time and space, Upper and lower bounds on the complexity of specific problems, NP-completeness.

COMPUTER HARDWARE

Digital Logic: Logic functions, Minimization, Design and synthesis of Combinational and Sequential circuits; Number representation and Computer Arithmetic (fixed and floating point);

Computer Organization: Machine instructions and addressing modes, ALU and Data-path, hardwired and micro-programmed control, Memory interface, I/O interface (Interrupt and DMA mode), Serial communication interface, Instruction pipelining, Cache, main and secondary storage.

SOFTWARE SYSTEMS

Data structures: Notion of abstract data types, Stack, Queue, List, Set, String, Tree, Binary search tree, Heap, Graph;

Programming Methodology: C programming, Program control (iteration, recursion, Functions), Scope, Binding, Parameter passing, Elementary concepts of Object oriented, Functional and Logic Programming;

Algorithms for problem solving: Tree and graph traversals, Connected components, Spanning trees, Shortest paths; Hashing, Sorting, Searching; Design techniques (Greedy, Dynamic Programming, Divide-and-conquer);

Compiler Design: Lexical analysis, Parsing, Syntax directed translation, Runtime environment, Code generation, Linking (static and dynamic); Operating Systems: Classical concepts (concurrency, synchronization, deadlock), Processes, threads and Inter-process communication, CPU scheduling, Memory management, File systems, I/O systems, Protection and security.

Databases: Relational model (ER-model, relational algebra, tuple calculus), Database design (integrity constraints, normal forms), Query languages (SQL), File structures (sequential files, indexing, B+ trees), Transactions and concurrency control;

Computer Networks: ISO/OSI stack, sliding window protocol, LAN Technologies (Ethernet, Token ring), TCP/UDP, IP, Basic concepts of switches, gateways, and routers.

CH - CHEMISTRY

PHYSICAL CHEMISTRY

Structure: Quantum theory - principles and techniques; applications to particle in a box, harmonic oscillator, rigid rotor and hydrogen atom; valence bond and molecular orbital theories and Huckel approximation, approximate techniques: variation and perturbation; symmetry, point groups; rotational, vibrational, electronic, NMR and ESR spectroscopy.

Equilibrium: First law of thermodynamics, heat, energy and work; second law of thermodynamics and entropy; third law and absolute entropy; free energy; partial molar quantities; ideal and non-ideal solutions; phase transformation: phase rule and phase diagrams- one, two, and three component systems; activity, activity coefficient, fugacity and fugacity coefficient ; chemical equilibrium, response of chemical equilibrium to temperature and pressure; colligative properties; kinetic theory of gases; thermodynamics of electrochemical cells; standard electrode potentials: applications - corrosion and energy conversion; molecular partition function (translational, rotational, vibrational and electronic).

Kinetics: Rates of chemical reactions, theories of reaction rates, collision and transition state theory; temperature dependence of chemical reactions; elementary reactions, consecutive elementary reactions; steady state approximation, kinetics of photochemical reactions and free radical polymerization, homogenous and heterogeneous catalysis.

INORGANIC CHEMISTRY

Non-Transition Elements: General characteristics, structure and reactions of simple and industrially important compounds, boranes, carboranes, silicates, silicones, diamond and graphite; hydrides, oxides and oxoacids of N, P, S and halogens; boron nitride, borazines and phosphazenes; xenon compounds. Shapes of molecules, hard-soft acid base concept.

Transition Elements: General characteristics of d and f block elements; coordination chemistry: structure and isomerism, stability, theories of metal-ligand bonding (CFT and LFT), electronic spectra and magnetic properties of transition metal complexes and lanthanides; metal carbonyls, metal-metal bonds and metal atom clusters, metallocenes; transition metal complexes with bonds to hydrogen, alkyls, alkenes, and arenes; metal carbenes; use of organometallic compounds as catalysts in organic synthesis; mechanisms of substitution and electron transfer reactions of coordination complexes. Role of metals with special reference to Na, K, Mg, Ca, Fe, Co, Zn, and Mo in biological systems.

Solids: Crystal systems and lattices, Miller planes, crystal packing, crystal defects; Bragg's Law; ionic crystals, band theory, metals and semiconductors. Spinels.

Instrumental methods of analysis: atomic absorption, UV-visible spectrometry, chromatographic and electro-analytical methods.

ORGANIC CHEMISTRY

Synthesis, reactions and mechanisms involving the following: Alkenes, alkynes, arenes, alcohols, phenols, aldehydes, ketones, carboxylic acids and their derivatives; halides, nitro compounds and amines; stereochemical and conformational effects on reactivity and specificity; reactions with diborane and peracids. Michael reaction, Robinson annulation, reactivity umpolung, acyl anion equivalents; molecular rearrangements involving electron deficient atoms.

Photochemistry: Basic principles, photochemistry of olefins, carbonyl compounds, arenes, photo oxidation and reduction.

Pericyclic reactions: Cycloadditions, electrocyclic reactions, sigmatropic reactions; Woodward-Hoffmann rules.

Heterocycles: Structural properties and reactions of furan, pyrrole, thiophene, pyridine, indole.

Biomolecules: Structure, properties and reactions of mono- and di-saccharides, physico-chemical properties of amino acids, structural features of proteins and nucleic acids.

Spectroscopy: Principles and applications of IR, UV-visible, NMR and mass spectrometry in the determination of structures of organic compounds.

EC - ELECTRONICS AND COMMUNICATION ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix Algebra, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Mean value theorems, Theorems of integral calculus, Evaluation of definite and improper integrals, Partial Derivatives, Maxima and minima, Multiple integrals, Fourier series. Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equation (linear and nonlinear), Higher order linear differential equations with constant coefficients, Method of variation of parameters, Cauchy's and Euler's equations, Initial and boundary value problems, Partial Differential Equations and variable separable method.

Complex variables: Analytic functions, Cauchy's integral theorem and integral formula, Taylor's and Laurent' series, Residue theorem, solution integrals.

Probability and Statistics: Sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Discrete and continuous distributions, Poisson, Normal and Binomial distribution, Correlation and regression analysis.

Numerical Methods: Solutions of non-linear algebraic equations, single and multi-step methods for differential equations.

Transform Theory: Fourier transform, Laplace transform, Z-transform.

ELECTRONICS & COMMUNICATION ENGINEERING

Networks: Network graphs: matrices associated with graphs; incidence, fundamental cut set and fundamental circuit matrices. Solution methods: nodal and mesh analysis. Network theorems: superposition, Thevenin and Norton's maximum power transfer, Wye-Delta transformation. Steady state sinusoidal analysis using phasors. Linear constant coefficient differential equations; time domain analysis of simple RLC circuits, Solution of network equations using Laplace transform: frequency domain analysis of RLC circuits. 2-port network parameters: driving point and transfer functions. State equations for networks.

Electronic Devices: Energy bands in silicon, intrinsic and extrinsic silicon. Carrier transport in silicon: diffusion current, drift current, mobility, resistivity. Generation and recombination of carriers. p-n junction diode, Zener diode, tunnel diode, BJT, JFET, MOS capacitor, MOSFET, LED, p-I-n and avalanche photo diode, LASERs. Device technology: integrated circuits fabrication process, oxidation, diffusion, ion implantation, photolithography, n-tub, p-tub and twin-tub CMOS process.

Analog Circuits: Equivalent circuits (large and small-signal) of diodes, BJTs, JFETs, and MOSFETs. Simple diode circuits, clipping, clamping, rectifier. Biasing and bias stability of transistor and FET amplifiers. Amplifiers: single-and multi-stage, differential, operational, feedback and power. Analysis of amplifiers; frequency response of amplifiers. Simple op-amp circuits. Filters. Sinusoidal oscillators; criterion for oscillation; single-transistor and op-amp configurations. Function generators and wave-shaping circuits. Power supplies.

Digital circuits: Boolean algebra, minimization of Boolean functions; logic gates digital IC families (DTL, TTL, ECL, MOS, CMOS). Combinational circuits: arithmetic circuits, code converters, multiplexers and decoders. Sequential circuits: latches and flip-flops, counters and shift-registers. Sample and hold circuits, ADCs, DACs. Semiconductor memories. Microprocessor(8085): architecture, programming, memory and I/O interfacing.

Signals and Systems: Definitions and properties of Laplace transform, continuous-time and discrete-time Fourier series, continuous-time and discrete-time Fourier Transform, z-transform. Sampling theorems. Linear Time-Invariant (LTI) Systems: definitions and properties; casuality, stability, impulse response, convolution, poles and zeros frequency response, group delay, phase delay. Signal transmission through LTI systems. Random signals and noise: probability, random variables, probability density function, autocorrelation, power spectral density.

Controls Systems: Basic control system components; block diagrammatic description, reduction of block diagrams. Open loop and closed loop (feedback) systems and stability analysis of these systems. Signal flow graphs and their use in determining transfer functions of systems; transient and steady state analysis of LTI control systems and frequency response. Tools and techniques for LTI control system analysis: root loci, Routh-Hurwitz criterion, Bode and Nyquist plots. Control system compensators: elements of lead and lag compensation, elements of Proportional-Integral-Derivative(PID) control. State variable representation and solution of state equation of LTI control systems.

Communications: Analog communication systems: amplitude and angle modulation and demodulation systems, spectral analysis of these operations, superheterodyne receivers; elements of hardware, realizations of analog communication systems; signal-to-noise ratio (SNR) calculations for amplitude modulation (AM) and frequency modulation (FM) for low noise conditions. Digital communication systems: pulse code modulation (PCM), differential pulse code modulation (DPCM), delta modulation (DM); digital modulation schemes-amplitude, phase and frequency shift keying schemes (ASK, PSK, FSK), matched filter receivers, bandwith consideration and probability of error calculations for these schemes.

Electromagnetics: Elements of vector calculus: divergence and curl; Gauss' and Stokes' theorems, Maxwell's equations: differential and integral forms. Wave equation, Poynting vector. Plane waves: propagation through various media; reflection and refraction; phase and group velocity; skin depth. Transmission lines: characteristic impedance; impedance transformation; Smith chart; impedance matching; pulse excitation. Waveguides: modes in rectangular waveguides; boundary conditions; cut-off frequencies; dispersion relations. Antennas: Dipole antennas; antenna arrays; radiation pattern; reciprocity theorem, antenna gain.

EE - ELECTRICAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix Algebra, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Mean value theorems, Theorems of integral calculus, Evaluation of definite and improper integrals, Partial Derivatives, Maxima and minima, Multiple integrals, Fourier series. Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equation (linear and nonlinear), Higher order linear differential equations with constant coefficients, Method of variation of parameters, Cauchy's and Euler's equations, Initial and boundary value problems, Partial Differential Equations and variable separable method.

Complex variables: Analytic functions, Cauchy's integral theorem and integral formula, Taylor's and Laurent' series, Residue theorem, solution integrals.

Probability and Statistics: Sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Discrete and continuous distributions, Poisson, Normal and Binomial distribution, Correlation and regression analysis.

Numerical Methods: Solutions of non-linear algebraic equations, single and multi-step methods for differential equations.

Transform Theory: Fourier transform, Laplace transform, Z-transform.

ELECTRICAL ENGINEERING

Electrical Circuits and Fields: Network graph, KCL, KVL, node/ cut set, mesh/ tie set analysis, transient response of d.c. and a.c. networks; sinusoidal steady-state analysis; resonance in electrical circuits; concepts of ideal voltage and current sources, network theorems, driving point, immittance and transfer functions of two port networks, elementary concepts of filters; three phase circuits; Fourier series and its application; Gauss theorem, electric field intensity and potential due to point, line, plane and spherical charge distribution, dielectrics, capacitance calculations for simple configurations; Ampere's and Biot-Savart's law, inductance calculations for simple configurations.

Electrical Machines: Single phase transformer - equivalent circuit, phasor diagram, tests, regulation and efficiency; three phase transformers - connections, parallel operation; auto transformer and three-winding transformer; principles of energy conversion, windings of rotating machines: D. C. generators and motors - characteristics, starting and speed control, armature reaction and commutation; three phase induction motors-performance characteristics, starting and speed control; single-phase induction motors; synchronous generators-performance, regulation, parallel operation; synchronous motors - starting, characteristics, applications, synchronous condensers; fractional horse power motors; permanent magnet and stepper motors.

Power Systems: Electric power generation - thermal, hydro, nuclear; transmission line parameters; steady-state performance of overhead transmission lines and cables and surge propagation; distribution systems, insulators, bundle conductors, corona and radio interference effects; per-unit quantities; bus admittance and impedance matrices; load flow; voltage control and power factor correction; economic operation; symmetrical components, analysis of symmetrical and unsymmetrical faults; principles of over current, differential and distance protections; concept of solid state relays and digital protection; circuit breakers; concept of system stability-swing curves and equal area criterion; basic concepts of HVDC transmission.

Control Systems: Principles of feedback; transfer function; block diagrams: steady-state errors; stability-Routh and Nyquist criteria; Bode plots; compensation; root loci; elementary state variable formulation; state transition matrix and response for Linear Time Invariant systems.

Electrical and Electronic Measurements: Bridges and potentiometers, PMMC, moving iron, dynamometer and induction type instruments; measurement of voltage, current, power, energy and power factor; instrument transformers; digital voltmeters and multimeters; phase, time and frequency measurement; Q-meter, oscilloscopes, potentiometric recorders, error analysis.

Analog and Digital Electronics: Characteristics of diodes, BJT, FET, SCR; amplifiers-biasing, equivalent circuit and frequency response; oscillators and feedback amplifiers, operational amplifiers- characteristics and applications; simple active filters; VCOs and timers; combinational and sequential logic circuits, multiplexer, Schmitt trigger, multivibrators, sample and hold circuits, A/D and D/A converters; microprocessors and their applications.

Power Electronics and Electric Drives: Semiconductor power devices-diodes, transistors, thyristors, triacs, GTOs, MOSFETs and IGBTs - static characteristics and principles of operation; triggering circuits; phase control rectifiers; bridge converters-fully controlled and half controlled; principles of choppers and inverters, basic concepts of adjustable speed dc and ac drives.

GG - GEOLOGY AND GEOPHYSICS

PART - I

Earth and planetary system; size, shape, internal structure and composition of the earth; atmosphere and greenhouse effect; isostasy; elements of seismology; continents and continental processes; physical oceanography; palaeomagnetism, continental drift plate tectonics, geothermal energy.

Weathering; soil formation; action of river, wind and glacier; oceans and oceanic features; earthquakes, volcanoes, orogeny and mountain building; elements of structural geology; crystallography; classification, composition and properties of minerals and rocks; engineering properties of rocks and soils, role of geology in the construction of engineering structures.

Processes of ore formation, occurrence and distribution of ores on land and on ocean floor; coal and petroleum resources in India; ground water geology including well hydraulics, geological time scale and geochronology; stratigraphic principles and stratigraphy of India; basics concepts of gravity, magnetic and electrical prospecting for ores and ground water.

PART - IIA: GEOLOGY

Crystal symmetry, forms, twinning; crystal chemistry; optical mineralogy, classification of minerals, diagnostic properties of rock minerals.

Mineralogy, structure, texture and classification of igneous, sedimentary and metamorphic rock, their origin and evolution; application of thermodynamics; structure and petrology of sedimentary rocks; sedimentary processes and environments, sedimentary facies, basin studies; basement cover relationship;

Primary and secondary structures; geometry and genesis of folds, faults, joints, unconformities, cleavage, schistosity and lineation; methods of projection. Tectonites and their significance; shear zone; superposed folding.

Morphology, classification and geological significance of important invertebrates, vertebrates, microfossils and palaeoflora; stratigraphic principles and Indian stratigraphy; geomorphic processes and agents; development and evolution of landforms; slope and drainage; processes on deep oceanic and near-shore regions; quantitative and applied geomorphology; air photo interpretation and remote sensing; chemical and optical properties of ore minerals; formation and localization of ore deposits; prospecting and exploration of economic minerals; coal and petroleum geology; origin and distribution of mineral and fuel deposits in India; ore dressing and mineral economics.

Cosmic abundance; meteorites; geochemical evolution of the earth; geochemical cycles; distribution of major, minor and trace elements; isotope geochemistry; geochemistry of waters including solution equilibria and water rock interaction.

Engineering properties of rocks and soils; rocks as construction material; geology of dams, tunnels and excavation sites; natural hazards; the fly ash problem; ground water geology and exploration; water quality; impact of human activity; Remote sensing techniques for the interpretation of landforms and resource management.

PART - II B: GEOPHYSICS

The earth as a planet; different motions of the earth; gravity filed of the earth and its shape; geochronology; isostasy, seismology and interior of the earth; variation of density, velocity, pressure, temperature, electrical and magnetic properties inside the earth; earthquakes-causes and measurements; zonation and seismic hazards; geomagnetic field, palaeomagnetism; oceanic and continental lithosphere; plate tectonics; heat flow; upper and lower atmospheric phenomena.

Theories of scalar and vector potential fields; Laplace, Maxwell and Helmholtz equations for solution of different types of boundary value problems for Cartesian, cylindrical and spherical polar coordinates; Green's theorem; Image theory; integral equations and conformal transformations in potential theory; Eikonal equation and ray theory.

'G' and 'g' units of measurement, density of rocks, gravimeters, preparation, analysis and interpretation of gravity maps; derivative maps, analytical continuation; gravity anomaly type curves; calculation of mass.

Earth's magnetic field, units of measurement, magnetic susceptibility of rocks, magnetometers, corrections, preparation of magnetic maps, magnetic anomaly type curve, analytical continuation, interpretation and application; magnetic well logging.

Conduction of electricity through rocks, electrical conductivities of metals, metallic, non-metallic and rock forming minerals, D.C. resistivity units and methods of measurement, electrode configuration for sounding and profiling, application of filter theory, interpretation of resistivity field data, application; self potential origin, classification, field measurement, interpretation of induced polarization time frequency, phase domain; IP units and methods of measurement, interpretation and application; ground-water exploration.

Origin of electromagnetic field elliptic polarization, methods of measurement for different source-receiver configuration components in EM measurements, interpretation and applications; earth's natural electromagnetic field, tellurics, magneto-tellurics; geomagnetic depth sounding principles, methods of measurement, processing of data and interpretation.

Seismic methods of prospecting: Reflection, refraction and CDP surveys; land and marine seismic sources, generation and propagation of elastic waves, velocity increasing with depth, geophones, hydrophones, recording instruments (DFS), digital formats, field layouts, seismic noises and noise profile analysis, optimum geophone grouping, noise cancellation by shot and geophone arrays, 2D and 3D seismic data acquisition and processing, CDP stacking charts, binning, filtering, dip-moveout, static and dynamic corrections, deconvolution, migration, signal processing, Fourier and Hilbert transforms, attribute analysis, bright and dim spots, seismic stratigraphy, high resolution seismics, VSP.

Principles and techniques of geophysical well-logging, SP, resistivity, induction, micro gamma ray, neutron, density, sonic, temperature, dip meter, caliper, nuclear magnetic, cement bond logging. Quantitative evaluation of formations from well logs; well hydraulics and application of geophysical methods for groundwater study; application of bore hole geophysics in ground water, mineral and oil exploration. Remote sensing techniques and application of remote sensing methods in geophysics.

IN - INSTRUMENTATION ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix Algebra, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Mean value theorems, Theorems of integral calculus, Evaluation of definite and improper integrals, Partial Derivatives, Maxima and minima, Multiple integrals, Fourier series. Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equation (linear and nonlinear), Higher order linear differential equations with constant coefficients, Method of variation of parameters, Cauchy's and Euler's equations, Initial and boundary value problems, Partial Differential Equations and variable separable method.

Complex variables: Analytic functions, Cauchy's integral theorem and integral formula, Taylor's and Laurent' series, Residue theorem, solution integrals.

Probability and Statistics: Sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Discrete and continuous distributions, Poisson, Normal and Binomial distribution, Correlation and regression analysis.

Numerical Methods: Solutions of non-linear algebraic equations, single and multi-step methods for differential equations.

Transform Theory: Fourier transform, Laplace transform, Z-transform.

INSTRUMENTATION ENGINEERING

Measurement Basics and Metrology: Static and dynamic characteristics of measurement systems. Standards and calibration. Error and uncertainty analysis, statistical analysis of data, and curve fitting. Linear and angular measurements; Measurement of straightness, flatness, roundness and roughness.

Transducers, Mechanical Measurements and Industrial Instrumentation: Transducers - elastic, resistive, inductive, capacitive, thermo-electric, piezoelectric, photoelectric, electro-mechanical, electro-chemical, and ultrasonic. Measurement of displacement, velocity (linear and rotational), acceleration, shock, vibration, force, torque, power, strain, stress, pressure, flow, temperature, humidity, viscosity, and density. energy storing elements, suspension systems and dampers.

Analog Electronics: Characteristics of diodes, BJTs, JFETs and MOSFETs; Diode circuits; Amplifiers: single and multi-stage, feedback; Frequency response; Operational amplifiers - design, characteristic, linear and non-linear applications: difference amplifiers; instrumentation amplifiers; precision rectifiers, I-to-V converters, active filters, oscillators, comparators, signal generators, wave shaping circuits.

Digital Electronics: Combinational logic circuits, minimization of Boolean functions; IC families (TTL, MOS, CMOS), arithmetic circuits, multiplexer and decoders. Sequential circuits: flip-flops, counters, shift registers. Schmitt trigger, timers, and multivibrators. Analog switches, multiplexers, S/H circuits. Analog-to-digital and digital-to-analog converters. Basics of computer organization and architecture. 8-bit microprocessor (8085), applications, memory, I/O interfacing, and microcontrollers.

Signals and Systems: Vectors and matrices; Fourier series; Fourier transforms; Ordinary differential equations. Impulse and frequency responses of first and second order systems. Laplace transform and transfer function, convolution and correlation. Amplitude and frequency modulations and demodulations. Discrete time systems, difference equations, impulse and frequency responses; Z-transforms and transfer functions; IIR and FIR filters.

Electrical and Electronic Measurements: Measurement of R, L and C; bridges and potentiometers. Measurement of voltage, current, power, power factor, and energy; Instrument transformers; Q meter, waveform analyzers. Digital volt-meters and multi-meters.

Time, phase and frequency measurements; Oscilloscope. Noise and interference in instrumentation.

Control Systems & Process Control: Principles of feedback; transfer function, signal flow graphs. Stability criteria, Bode plots, root-loci, Routh and Nyquist criteria. Compensation techniques; State space analysis. System components: mechanical, hydraulic, pneumatic, electrical and electronic; Servos and synchros; Stepper motors. On-off, cascade, P, PI, PID and feed-forward controls. Controller tuning and general frequency response.

Analytical, Optical and Biomedical Instrumentation: Principles of spectrometry, UV, visible, IR mass spectrometry, X-ray methods; nuclear radiation measurements, gas, solid and semi conductor lasers and their characteristics, interferometers, basics of fibre optics, transducers in biomedical applications, cardiovascular system measurements, instrumentation for clinical laboratory.

MA - MATHEMATICS

Linear Algebra: Finite dimensional vector spaces. Linear transformations and their matrix representations, rank; systems of linear equations, eigenvalues and eigenvectors, minimal polynomial, Cayley-Hamilton theorem, diagonalisation, Hermitian, Skew-Hermitian and unitary matrices. Finite dimensional inner product spaces, self-adjoint and Normal linear operators, spectral theorem, Quadratic forms.

Complex Analysis: Analytic functions, conformal mappings, bilinear transformations, complex integration: Cauchy's integral theorem and formula, Liouville's theorem, maximum modulus principle, Taylor and Laurent's series, residue theorem and applications for evaluating real integrals.

Real Analysis: Sequences and series of functions, uniform convergence, power series, Fourier series, functions of several variables, maxima, minima, multiple integrals, line, surface and volume integrals, theorems of Green, Stokes and Gauss; metric spaces, completeness, Weierstrass approximation theorem, compactness. Lebesgue measure, measurable functions; Lebesgue integral, Fatou's lemma, dominated convergence theorem.

Ordinary Differential Equations: First order ordinary differential equations, existence and uniqueness theorems, systems of linear first order ordinary differential equations, linear ordinary differential equations of higher order with constant coefficients; linear second order ordinary differential equations with variable coefficients, method of Laplace transforms for solving ordinary differential equations, series solutions; Legendre and Bessel functions and their orthogonality, Sturm Liouville system, Greeen's functions.

Algebra: Normal subgroups and homomorphisms theorems, automorphisms. Group actions, sylow's theorems and their applications groups of order less than or equal to 20, Finite p-groups. Euclidean domains, Principal ideal domains and unique factorizations domains. Prime ideals and maximal ideals in commutative rings.

Functional Analysis: Banach spaces, Hahn-Banach theorems, open mapping and closed graph theorems, principle of uniform boundedness; Hilbert spaces, orthonormal sets, Riesz representation theorem, self-adjoint, unitary and normal linear operators on Hilbert Spaces.

Numerical Analysis: Numerical solution of algebraic and transcendental equations; bisection, secant method, Newton-Raphson method, fixed point iteration, interpolation: existence and error of polynomial interpolation, Lagrange, Newton, Hermite(osculatory)interpolations; numerical differentiation and integration, Trapezoidal and Simpson rules; Gaussian quadrature; (Gauss-Legendre and Gauss-Chebyshev), method of undetermined parameters, least square and orthonormal polynomial approximation; numerical solution of systems of linear equations: direct and iterative methods, (Jacobi Gauss-Seidel and SOR) with convergence; matrix eigenvalue problems: Jacobi and Given's methods, numerical solution of ordinary differential equations: initial value problems, Taylor series method, Runge-Kutta methods, predictor-corrector methods; convergence and stability.

Partial Differential Equations: Linear and quasilinear first order partial differential equations, method of characteristics; second order linear equations in two variables and their classification; Cauchy, Dirichlet and Neumann problems, Green's functions; solutions of Laplace, wave and diffusion equations in two variables Fourier series and transform methods of solutions of the above equations and applications to physical problems.

Mechanics: Forces in three dimensions, Poinsot central axis, virtual work, Lagrange's equations for holonomic systems, theory of small oscillations, Hamiltonian equations;

Topology: Basic concepts of topology, product topology, connectedness, compactness, countability and separation axioms, Urysohn's Lemma, Tietze extension theorem, metrization theorems, Tychonoff theorem on compactness of product spaces.

Probability and Statistics: Probability space, conditional probability, Bayes' theorem, independence, Random variables, joint and conditional distributions, standard probability distributions and their properties, expectation, conditional expectation, moments. Weak and strong law of large numbers, central limit theorem. Sampling distributions, UMVU estimators, sufficiency and consistency, maximum likelihood estimators. Testing of hypotheses, Neyman-Pearson tests, monotone likelihood ratio, likelihood ratio tests, standard parametric tests based on normal, X2 ,t, F-distributions. Linear regression and test for linearity of regression. Interval estimation.

Linear Programming: Linear programming problem and its formulation, convex sets their properties, graphical method, basic feasible solution, simplex method, big-M and two phase methods, infeasible and unbounded LPP's, alternate optima. Dual problem and duality theorems, dual simplex method and its application in post optimality analysis, interpretation of dual variables. Balanced and unbalanced transportation problems, unimodular property and u-v method for solving transportation problems. Hungarian method for solving assignment problems.

Calculus of Variations and Integral Equations: Variational problems with fixed boundaries; sufficient conditions for extremum, Linear integral equations of Fredholm and Volterra type, their iterative solutions. Fredholm alternative.

ME - MECHANICAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

APPLIED MECHANICS AND DESIGN

Engineering Mechanics: Equivalent force systems, free-body concepts, equations of equilibrium, trusses and frames, virtual work and minimum potential energy. Kinematics and dynamics of particles and rigid bodies, impulse and momentum (linear and angular), energy methods, central force motion.

Strength of Materials: Stress and strain, stress-strain relationship and elastic constants, Mohr's circle for plane stress and plane strain, shear force and bending moment diagrams, bending and shear stresses, deflection of beams, torsion of circular shafts, thin and thick cylinders, Euler's theory of columns, strain energy methods, thermal stresses.

Theory of Machines: Displacement, velocity and acceleration, analysis of plane mechanisms, dynamic analysis of slider-crank mechanism, planar cams and followers, gear tooth profiles, kinematics of gears, governors and flywheels, balancing of reciprocating and rotating masses.

Vibrations: Free and forced vibration of single degree freedom systems, effect of damping, vibration isolation, resonance, critical speed of rotors.

Design of Machine Elements: Design for static and dynamic loading, failure theories, fatigue strength; design of bolted, riveted and welded joints; design of shafts and keys; design of spur gears, rolling and sliding contact bearings; brakes and clutches; belt, rope and chain drives.

FLUID MECHANICS AND THERMAL SCIENCES

Fluid Mechanics: Fluid properties, fluid statics, manometry, buoyancy; control-volume analysis of mass, momentum and energy; fluid acceleration; differential equations of continuity and momentum; Bernoulli's equation; viscous flow of incompressible fluids; boundary layer; elementary turbulent flow; flow through pipes, head losses in pipes, bends etc.

Heat-Transfer: Modes of heat transfer; one dimensional heat conduction, resistance concept, electrical analogy, unsteady heat conduction, fins; dimensionless parameters in free and forced convective heat transfer, various correlations for heat transfer in flow over flat plates and through pipes; thermal boundary layer; effect of turbulence; radiative heat transfer, black and grey surfaces, shape factors, network analysis; heat exchanger performance, LMTD and NTU methods.

Thermodynamics: Zeroth, First and Second laws of thermodynamics; thermodynamic system and processes; irreversibility and availability; behaviour of ideal and real gases, properties of pure substances, calculation of work and heat in ideal processes; analysis of thermodynamic cycles related to energy conversion; Carnot, Rankine, Otto, Diesel, Brayton and vapour compression cycles.

Power Plant Engineering: Steam generators; steam power cycles; steam turbines; impulse and reaction principles, velocity diagrams, pressure and velocity compounding; reheating and reheat factor; condensers and feed heaters.

I.C. Engines: Requirements and suitability of fuels in IC engines, fuel ratings, fuel-air mixture requirements; normal combustion in SI and CI engines; engine performance calculations.

Refrigeration and air-conditioning: Refrigerant compressors, expansion devices, condensers and evaporators; properties of moist air, psychrometric chart, basic psychometric processes.

Turbomachinery: Components of gas turbines; compression processes, centrifugal and axial flow compressors; axial flow turbines, elementary theory; hydraulic turbines; Euler-turbine equation; specific speed, Pelton-wheel, Francis and Kaplan turbines; centrifugal pumps.

MANUFACTURING AND INDUSTRIAL ENGINEERING

Engineering Materials: Structure and properties of engineering materials and their applications, heat treatment.

Metal Casting: Casting processes (expendable and non-expendable) -pattern, moulds and cores, heating and pouring, solidification and cooling, gating design, design considerations, defects.

Forming Processes: Stress-strain diagrams for ductile and brittle material, Plastic deformation and yield criteria, fundamentals of hot and cold working processes, Bulk metal forming processes (forging, rolling, extrusion, drawing), sheet metal working processes (punching, blanking, bending, deep drawing, coining, spinning, load estimation using homogeneous deformation methods, defects). processing of powder metals- atomization, compaction, sintering, secondary and finishing operations. forming and shaping of plastics- extrusion, injection moulding.

Joining Processes: Physics of welding, fusion and non-fusion welding processes, brazing and soldering, adhesive bonding, design considerations in welding, weld quality defects.

Machining and Machine Tool Operations: Mechanics of machining, single and multi-point cutting tools, tool geometry and materials, tool life and wear, cutting fluids, machinability, economics of machining, non-traditional machining processes.

Metrology and Inspection: Limits, fits and tolerances, linear and angular measurements, comparators, gauge design, interferometry, form and finish measurement, measurement of screw threads, alignment and testing methods.

Tool Engineering: Principles of work holding, design of jigs and fixtures.

Computer Integrated Manufacturing: Basic concepts of CAD, CAM and their integration tools.

Manufacturing Analysis: Part-print analysis, tolerance analysis in manufacturing and assembly, time and cost analysis.

Work-Study: Method study, work measurement, time study, work sampling, job evaluation, merit rating.

Production Planning and Control: Forecasting models, aggregate production planning, master scheduling, materials requirements planning.

Inventory Control: Deterministic and probabilistic models, safety stock inventory control systems.

Operations Research: Linear programming, simplex and duplex method, transportation, assignment, network flow models, simple queuing models, PERT and CPM

MN - MINING ENGINEERING

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima;

Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

MINING ENGINEERING

Mechanics: Equivalent force systems, equations of equilibrium, two dimensional frames and trusses, free body diagrams, friction forces, particle kinematics and dynamics.

Mine Development, Geomechanics and Strata Control: Drivages for underground mine development, drilling methods and machines, explosives, blasting devices and practices, shaft sinking. Physico-mechanical properties of rocks, rock mass classification, ground control instrumentation and stress measurement techniques, theories of rock failure, ground vibrations, stress distribution around mine openings, subsidence, design of supports in roadways and workings, stability of open pits, slopes.

Mining Methods and Machinery: Surface mining - layout, development, loading, transportation and mechanization, continuous surface mining systems. Underground coal mining - bord and pillar system, longwall mining, thick seam mining methods. Underground metal mining: different stoping methods, stope mechanization, ore handling systems, mine filling. Generation and transmission of mechanical, hydraulic, and pneumatic power. Materials handling - haulages, conveyors, ropeways, face and development machinery, hoisting systems, and pumps.

Ventilation, Underground Hazards and Surface Environment: Underground atmosphere, heat load sources and thermal environment, air cooling, mechanics of air flow distribution, natural and mechanical ventilation, mine fans and their usage, auxiliary ventilation. Subsurface hazards from fires, explosions, gases, dust, and inundation, rescue apparatus and practices, safety in mines, accident analysis, noise, mine lighting. Air and water pollution: causes, dispersion, quality standards, and control.

Surveying, Mine Planning and Systems Engineering: Fundamentals of engineering surveying, Levels and levelling, Theodolite, tacheometry, triangulation, contouring, errors and adjustments, correlation, underground surveying, curves, photogrammetry, field astronomy, GPS fundamentals. Principles of planning - Sampling methods and practices, reserve estimation techniques, basics of geostatistics, optimization of facility location, cash flow concepts and mine valuation, open pit design. Work study, concepts of reliability, reliability of series and parallel systems. Linear programming, transportation and assignment problems, queueing, network analysis, inventory control.

MT - METALLURGICAL ENGINEERING

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima;

Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

METALLURGICAL ENGINEERING

Thermodynamics and Rate Processes: Laws of thermodynamics, activity, equilibrium constant, applications to metallurgical systems, solutions, phase equilibria, basic kinetic laws, order of reactions, rate constants and rate limiting steps principles of electro chemistry, aqueous, corrosion and protection of metals, oxidation and high temperature corrosion - characterization and control; momentum transfer - concepts of viscosity, shell balances, Bernoulli's equation; heat transfer - conduction, convection and heat transfer coefficient relations, radiation, mass transfer - diffusion and Fick's laws.

Extractive Metallurgy: Flotation, gravity and other methods of mineral processing; agglomeration, pyro-hydro-and electro-metallurgical processes; material and energy balances; principles and processes for the extraction of non-ferrous metals - aluminium, copper, zinc, lead, magnesium, nickel, titanium and other rare metals; iron and steel making - principles, blast furnace, direct reduction processes, primary and secondary steel making, deoxidation and inclusion in steel; ingot and continuous casting; stainless steel making, design of furnaces; fuels and refractories.

Physical Metallurgy: Crystal structure and bonding characteristics of metals, alloys, ceramics and polymers; solid solutions; solidification; phase transformation and binary phase diagrams; principles of heat treatment of steels, aluminum alloys and cast irons; recovery, recrystallization and grain growth; industrially important ferrous and non-ferrous alloys; elements of X-ray and electron diffraction; principles of scanning and transmission electron microscopy; elements of ceramics, composites and electronic materials; electronic basis of thermal, optical, electrical and magnetic properties of materials.

Mechanical Metallurgy: Elements of elasticity and plasticity; defects in crystals; elements of dislocation theory - types of dislocations, slip and twinning, stress fields of dislocations, dislocation interactions and reactions, methods of seeing dislocations; strengthening mechanisms; tensile, fatigue and creep behaviour; superplasticity; fracture - Griffith theory, ductile to brittle transition, fracture toughness; failure analysis; mechanical testing - tension, compression, torsion, hardness, impact, creep, fatigue, fracture toughness and formability tests.

Manufacturing Processes: Metal casting - patterns, moulds, melting, gating, feeding and casting processes, defects and castings, hot and cold working of metals; Metal forming - fundamentals of metal forming, rolling wire drawing, extrusion, forming, sheet metal forming processes, defects in forming; Metal joining - soldering, brazing and welding, common welding processes, welding metallurgy, problems associated with welding of steels and aluminium alloys, defects in welding, powder metallurgy; NDT methods - ultrasonic, radiography, eddy current, acoustic emission and magnetic.

PH - PHYSICS

Mathematical Physics: Linear vector space, matrices; vector calculus; linear differential equations; elements of complex analysis; Laplace transforms, Fourier analysis, elementary ideas about tensors.

Classical Mechanics: Conservation laws; central forces; collisions and scattering in laboratory and centre of mass reference frames; mechanics of system of particles; rigid body dynamics; moment of inertia tensor; noninertial frames and pseudo forces; variational principle; Lagrange's and Hamilton's formalisms; equation of motion, cyclic coordinates, Poisson bracket; periodic motion, small oscillations, normal modes; wave equation and wave propagation; special theory of relativity - Lorentz transformations, relativistic kinematics, mass-energy equivalence.

Electromagnetic Theory: Laplace and Poisson equations; conductors and dielectrics; boundary value problems; Ampere's and Biot-Savart's laws; Faraday's law; Maxwell's equations; scalar and vector potentials; Coulomb and Lorentz gauges; boundary conditions at interfaces; electromagnetic waves; interference, diffraction and polarization; radiation from moving charges.

Quantum Mechanics: Physical basis of quantum mechanics; uncertainty principle; Schrodinger equation; one and three dimensional potential problems; Particle in a box, harmonic oscillator, hydrogen atom; linear vectors and operators in Hilbert space; angular momentum and spin; addition of angular momentum; time independent perturbation theory; elementary scattering theory.

Atomic and Molecular Physics: Spectra of one-and many-electron atoms; LS and jj coupling; hyperfine structure; Zeeman and Stark effects; electric dipole transitions and selection rules; X-ray spectra; rotational and vibrational spectra of diatomic molecules; electronic transition in diatomic molecules, Franck-Condon principle; Raman effect; NMR and ESR; lasers.

Thermodynamics and Statistical Physics: Laws of thermodynamics; macrostates, phase space; probability ensembles; partition function, free energy, calculation of thermodynamic quantities; classical and quantum statistics; degenerate Fermi gas; black body radiation and Planck's distribution law; Bose-Einstein condensation; first and second order phase transitions, critical point.

Solid State Physics: Elements of crystallography; diffraction methods for structure determination; bonding in solids; elastic properties of solids; defects in crystals; lattice vibrations and thermal properties of solids; free electron theory; band theory of solids; metals, semiconductors and insulators; transport properties; optical, dielectric and magnetic properties of solids; elements of superconductivity.

Nuclear and Particle Physics: Rutheford scattering; basic properties of nuclei; radioactive decay; nuclear forces; two nucleon problem; nuclear reactions; conservation laws; fission and fusion; nuclear models; particle accelerators, detectors; elementary particles; photons, baryons, mesons and leptons; Quark model.

Electronics: Network analysis; semiconductor devices; bipolar transistors; FETs; power supplies, amplifier, oscillators; operational amplifiers; elements of digital electronics; logic circuits.

PI - PRODUCTION AND INDUSTRIAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

GENERAL ENGINEERING:

Engineering Materials: Structure and properties of engineering materials and their applications; effect of strain, strain rate and temperature on mechanical properties of metals and alloys; heat treatment of metals and alloys.

Applied Mechanics: Engineering mechanics - equivalent force systems, free body concepts, equations of equilibrium, virtual work and minimum potential energy; strength of materials-stress, strain and their relationship, Mohr's circle, deflection of beams, bending and shear stress, Euler's theory of columns.

Theory of Machines and Design: Analysis of planar mechanisms, plane cams and followers; governers and fly wheels; design of elements-failure theories; design of bolted, riveted and welded joints; design of shafts, keys, belt drives, brakes and clutches.

Thermal Engineering: Fluid machines - fluid statics, Bernoulli's equation, flow through pipes, equations of continuity and momentum; Thermodynamics - zeroth, First and Second laws of thermodynamics, thermodynamic system and processes, calculation of work and heat for systems and control volumes; Heat transfer - fundamentals of conduction, convection and radiation.

PRODUCTION ENGINEERING

Metal Casting: Casting processes; patterns-materials; allowances; moulds and cores - materials, making and testing; melting and founding of cast iron, steels and nonferrous metals and alloys; solidification; design of casting, gating and risering; casting defects and inspection.

Metal working: Stress-strain in elastic and plastic deformation; deformation mechanisms; hot and cold working-forging, rolling, extrusion, wire and tube drawing; sheet metal working; analysis of rolling, forging, extrusion and wire /rod drawing; metal working defects, high energy rate forming processes-explosive, magnetic, electro and electrohydraulic.

Metal Joining Processes: Welding processes - gas shielded metal arc, TIG, MIG, submerged arc, electroslag, thermit, resistance, pressure and forge welding; thermal cutting; other joining processes - soldering, brazing, braze welding; welding codes, welding symbols, design of welded joints, defects and inspection; introduction to modern welding processes - friction, ultrasonic, explosive, electron beam, laser and plasma.

Machining and Machine Tool Operations: Machining processes-turning, drilling, boring, milling, shaping, planing, sawing, gear cutting, thread production, broaching, grinding, lapping, honing super finishing; mechanics of cutting- Merchant's analysis, geometry of cutting tools, cutting forces, power requirements; selection of process parameters; tool materials, tool wear and tool life, cutting fluids, machinability; nontraditional machining processes and hybrid processes- EDM, CHM, ECM, USM, LBM, EBM, AJM, PAM AND WJM; economics of machining.

Metrology and Inspection: Limits and fits, linear and angular measurements by mechanical and optical methods, comparators; design of limit gauges; interferometry; measurement of straightness, flatness, roundness, squareness and symmetry; surface finish measurement; inspection of screw threads and gears; alignment testing.

Powder Metallurgy and Processing of Plastics: Production of powders, compaction, sintering; Polymers and composites; injection, compression and blow molding, extrusion, calendaring and thermoforming; molding of composites.

Tool Engineering: Work-holding-location and clamping; principles and methods; design of jigs and fixtures; design of press working tools, forging dies.

Manufacturing Analysis: Sources of errors in manufacturing; process capability; part-print analysis; tolerance analysis in manufacturing and assembly; process planning; parameter selection and comparison of production alternatives; time and cost analysis; Issues in choosing manufacturing technologies and strategies.

Computer Integrated Manufacturing: Basic concepts of CAD, CAM, CAPP, group technology, NC, CNC, DNC, FMS, Robotics and CIM.

INDUSTRIAL ENGINEERING

Product Design and Development: Principles of good product design, component and tolerance design; efficiency, quality and cost considerations; product life cycle; standardization, simplification, diversification, value analysis, concurrent engineering.

Engineering Economy and Costing: Financial statements; elementary cost accounting, methods of depreciation; break-even analysis, techniques for evaluation of capital investments.

Work System Design: Taylor's scientific management, Gilbreths's contributions; productivity concepts and measurements; method study, micro-motion study, principles of motion economy; human factors engineering, ergonomics; work measurement - time study, PMTS, work sampling; job evaluation, merit rating, wage administration, incentive systems; business process reengineering.

Logistics and Facility Design: Facility location factors, evaluation of alternatives, types of plant layout, evaluation; computer aided layout; assembly line balancing; material handling systems; supply chain management.

Production Planning and Inventory Control: Inventory Function costs, classifications - deterministic and probabilistic models; quantity discount; safety stock; inventory control system; Forecasting techniques - causal and time series models, moving average, exponential smoothing; trend and seasonality; aggregate production planning; master scheduling; bill of materials and material requirement planning; order control and flow control, routing, scheduling and priority dispatching; JIT; Kanban PULL systems; bottleneck scheduling and theory of constraints.

Operation Research: Linear programming - problem formulation, simplex method, duality and sensitivity analysis; transportation; assignment; network flow models, constrained optimization and Lagrange multipliers; simple queuing models; dynamic programming; simulation; PERT and CPM, time-cost trade-off, resource leveling.

Quality Control: Taguchi method; design of experiments; quality costs, statistical quality assurance, process control charts, acceptance sampling, zero defects; quality circles, total quality management.

Reliability and Maintenance: Reliability, availability and maintainability; probabilistic failure and repair times; system reliability; preventive maintenance and replacement, TPM.

Management Information System: Value of information; information storage and retrieval system - database and data structures; interactive systems; knowledge based systems.

Intellectual Property System: Definition of intellectual property, importance of IPR; TRIPS, and its implications, WIPO and Global IP structure, and IPS in India; patent, copyright, industrial design and trademark; meanings, rules and procedures, terms, infringements and remedies.

PY - PHARMACEUTICAL SCIENCES

Natural Products: Pharmacognosy & Phytochemistry - Chemistry, tests, isolation, characterization and estimation of phytopharmaceuticals belonging to the group of Alkaloids, Glycosides, Terpenoids, Steroids, Bioflavanoids, Purines, Guggul lipids. Pharmacognosy of crude drugs which contain the above constituents. Standardisation of raw materials and herbal products. WHO guide lines. Quantitative microscopy including modern techniques used for evaluation. Biotechnological principles and techniques for plant development Tissue culture.

Pharmacology: General pharmacological principles including Toxicology. Drug interaction. Pharmacology of drugs acting on Central nervous system, Cardiovascular system, Autonomic nervous system, Gastro intestinal system and Respiratory system. Pharmacology of Autocoids, Hormones, Chemotherapeutic agents including anticancer drugs. Bioassays. Immuno Pharmacology.

Medicinal Chemistry: Structure, nomenclature, classification, synthesis, SAR and metabolism of the following category of drugs which are official in Indian Pharmacopoeia and British Pharmacopoeia Hypnotics and Sedatives, Analgesics, NSAIDS, Neuroleptics, Antidepressants, Anxiolytics, Anticonvulsants, Antihistaminics, Local anaesthetics, Cardio Vascular drugs - Antianginal agents Vasodilators, Adrenergic & cholinergic drugs, Cardiotonic agents, Diuretics, Antihypertensive drugs, Hypoglycemic agents, Antilipedmic agents, Coagulants, Anticoagulants, Antiplatelet agents. Chemotherapeutic agents - Antibiotics, Antibacterials, Sulphadrugs. Antiproliozoal drugs, Antiviral, Antitubercular, Antimalarial, Anticancer, Antiamoebic drugs. Diagnostic agents. Preparation and storage and uses of official Radiopharmaceuticals. Vitamins and Hormones.

Pharmaceutics: Development, manufacturing standards, labeling, packing as per the pharmacopoeal requirements, Storage of different dosage forms and new drug delivery systems. Biopharmaceutics and Pharmacokinetics and their importance in formulation. Formulation and preparation of cosmetics - lipstick, shampoo, creams, nail preparations and dentifrices. Pharmaceutical calculations.

Pharmaceutical Jurisprudence: Legal aspects of manufacture, storage, sale of drugs. D and C act and rules. Pharmacy act.

Pharmaceutical Analysis: Principles, instrumentation and applications of the following. Absorption spectroscopy (UV, visible & IR), Fluorimetry, Flame photometry, Potentiometry, Conductometry and Plarography. Pharmacopoeial assays. Principles of NMR, ESR, Mass spectroscopy, X-ray diffraction analysis and different chromatographic methods.

Biochemistry and Clinical Pharmacy: Biochemical role of hormones, Vitamins, Enzymes, Nucleic acids. Bioenergetics. General principles of immunology. Immunological techniques. Adverse drug interaction.

Microbiology: Principles and methods of microbiological assays of the Pharmacopoeia. Methods of preparation of official sera and vaccines. Serological and diagnostic tests. Applications of microorganisms in Bio Conversions and in Pharmaceutical industry.

TF - TEXTILE ENGINEERING AND FIBRE SCIENCE

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

TEXTILE ENGINEERING & FIBRE SCIENCE

Textile Fibres: Classification of textile fibres according to their nature and origin; general characteristics of textile fibres-their chemical and physical structures and their properties; essential characteristics of fibre forming polymers; uses of natural and man-made fibres; physical and chemical methods of fibre and blend identification and blend analysis.

Melt Spinning processes with special reference to polyamide and polyester fibres; wet and dry spinning of viscose and acrylic fibres; post spinning operations-drawing, heat setting, texturing- false twist and air-jet, tow-to-top conversion. Methods of investigating fibre structure e.g. X-ray diffraction, birefringence, optical and electron microscopy, I.R. absorption, thermal methods; structure and morphology and principal natural and man-made fibres, mechanical properties of fibres, moisture sorption in fibres; fibre structure and property correlation.

Textile Testing: Sampling techniques, sample size and sampling errors; measurement of fibre length, fineness, crimp, strength and reflectance; measurement of cotton fibre maturity ad trash content; HVI and AFIS for fibre testing. Measurement of yarn count, twist and hairiness; tensile testing of fibres, yarn and fabrics; evenness testing of slivers, rovings and yarns; testing equipment for measurement test methods of fabric properties like thickness, compressibility, air permeability, drape, crease recovery, tear strength bursting strength and abrasion resistance. Correlation analysis, significance tests and analysis of variance; frequency distributions and control charts.

Yarn Manufacture and Yarn Structure: Modern methods of opening, cleaning and blending of fibrous materials; the technology of carding with particular reference to modern developments; causes of irregularity introduced by drafting, the development of modern drafting systems; principles and techniques of preparing material for combing; recent development in combers; functions and synchronization of various mechanisms concerned with roving production; forces acting on yarn and traveller, ring and traveller designs; causes of end breakages; properties of doubles yarns; new methods of yarn production such as rotor spinning, air jet spinning and friction spinning.

Yarn diameter; specific volume, packing coefficient; twist-strength relationship; fibre orientation in yarn; fibre migration.

Fabric Manufacture and Fabric Structure: Principles of cheese and cone winding processes and machines; random and precision winding; package faults and their remedies; yarn clearers and tensioners; different systems of yarn splicing; features of modern cone winding machines; different types of warping creels; features of modern beam and sectional warping machines; different sizing systems, sizing of spun and filament yarns, modern sizing machines; principles of pirn winding processes and machines; primary and secondary motions of loom, effect of their settings and timings on fabric formation, fabric appearance and weaving performance; dobby and jacquard shedding; mechanics of weft insertion with shuttle; warp and weft stop motions, warp protection, weft replenishment; functional principles of weft insertion systems of shuttleless weaving machines, principles of multiphase and circular looms. Principles of weft and warp knitting; basic weft and warp knitted structures; classification, production and areas of application of nonwoven fabrics.

Basic woven fabric constructions and their derivatives; crepe, cord, terry, gauze, lino and double cloth constructions.

Peirce's equations for fabric geometry; thickness, cover and maximum sett of woven fabrics

Textile Chemical Processing: Preparatory processes for natural-and and their blends; mercerization of cotton; machines for yarn and fabric mercerization.

Dyeing and printing of natural- and synthetic- fibre fabrics and their blends with different dye classes; dyeing and printing machines; styles of printing; fastness properties of dyed and printed textile materials.

Finishing of textile materials, wash and wear, durable press, soil release, water repellent, flame retardant and antistatic finishes; shrink-resistance finish for wool; heat setting of synthetic-fibre fabrics, finishing machines; energy efficient processes; pollution control.

XE - ENGINERING SCIENCES

The syllabi of the sections of this paper are as follows:

SECTION A. ENGINEERING MATHEMATICS (Compulsory)

Linear Algebra : Determinates, algebra of matrices, rank, inverse, system of linear equations, symmetric, skew-symmetric and orthogonal matrices. Hermitian, skew-hermitian and unitary matrices. eigenvalues and eigenvectors, diagonalisation of matrices, Cayley-Hamiltonian, quadratic forms.

Calculus : Functions of single variables, limit, continuity and differentiability, Mean value theorems, Intermediate forms and L'Hospital rule, Maxima and minima, Taylor's series, Fundamental and mean value-theorems of integral calculus. Evaluation of definite and improper integrals, Beta and Gamma functions, Functions of two variables, limit, continuity, partial derivatives, Euler's theorem for homogeneous functions, total derivatives, maxima and minima, Lagrange method of multipliers, double and triple integrals and their applications, sequence and series, tests for convergence, power series, Fourier Series, Fourier integrals.

Complex variable: Analytic functions, Cauchy's integral theorem and integral formula without proof. Taylor's and Laurent' series, Residue theorem (without proof) with application to the evaluation of real integarls.

Vector Calculus: Gradient, divergence and curl, vector identities, directional derivatives, line, surface and volume integrals, Stokes, Gauss and Green's theorems (without proofs) with applications.

Ordinary Differential Equations: First order equation (linear and nonlinear), higher order linear differential equations with constant coefficients, method of variation of paramaters, Cauchy's and Euler's equations, initial and boundary value problems, power series solutions, Legendre polynomials and Bessel's functions of the first kind.

Partial Differential Equations: Variables separable method, solutions of one dimensional heat, wave and Laplace equations.

Probability and Statistics: Definitions of probability and simple theorems, conditional probability, mean, mode and standard deviation, random variables, discrete and continuous distributions, Poisson, normal and Binomial distribution, correlation and regression

Numerical Methods: L-U decomposition for systems of linear equations,Newton-Raphson method, numerical integration(trapezoidal and Simpson's rule), numerical methods for first order differential equation (Euler method)

SECTION B. COMPUTATIONAL SCIENCE

Numerical Methods: Truncation errors, round off errors and their propagation; Interpolation; Lagrange, Newton's forward, backward and divided difference formulas, least square curve fitting, solution of non-linear equations of one variables using bisection, false position, secant and Newton Raphson methods; Rate of convergence of these methods, general iterative methods. Simple and multiple roots of polynomials. Solutions of system of linear algebraic equations using Gauss elimination methods, Jacobi and Gauss-Seidel iterative methods and their rate of convergence; ill conditioned and well conditioned system. eigen values and eigen vectors using power methods. Numerical integration using trapezoidal, Simpson's rule and other quadrature formulas. Numerical Differentiation. Solution of boundary value problems. Solution of initial value problems of ordinary differential equations using Euler's method, predictor corrector and Runge Kutta method.

Programming : Elementary concepts and terminology of a computer system and system software, Fortran77 and C programming.

Fortran : Program organization, arithmetic statements, transfer of control, Do loops, subscripted variables, functions and subroutines.

C language : Basic data types and declarations, flow of control- iterative statement, conditional statement, unconditional branching, arrays, functions and procedures.

SECTION C. ELECTRICAL SCIENCES

Electric Circuits: Ideal voltage and current sources; RLC circuits, steady state and transient analysis of DC circuits, network theorems; alternating currents and voltages, single-phase AC circuits, resonance; three-phase circuits.

Magnetic circuits: Mmf and flux, and their relationship with voltage and current; transformer, equivalent circuit of a practical transformer, three-phase transformer connections.

Electrical machines: Principle of operation, characteristics, efficiency and regulation of DC and synchronous machines; equivalent circuit and performance of three-phase and single-phase induction motors.

Electronic Circuits: Characteristics of p-n junction diodes, zener diodes, bipolar junction transistors (BJT) and junction field effect transistors (JFET); MOSFET's structure, characteristics, and operations; rectifiers, filters, and regulated power supplies; biasing circuits, different configurations of transistor amplifiers, class A, B and C of power amplifiers; linear applications of operational amplifiers; oscillators; tuned and phase shift types.

Digital circuits: Number systems, Boolean algebra; logic gates, combinational circuits, flip-flops (RS, JK, D and T) counters.

Measuring instruments: Moving coil, moving iron, and dynamometer type instruments; shunts, instrument transformers, cathode ray oscilloscopes; D/A and A/D converters.

SECTION D. FLUID MECHANICS

Fluid Properties: Relation between stress and strain rate for Newtonian fluids

Hydrostatics, buoyancy, manometry

Concept of local and convective accelerations; control volume analysis for mass, momentum and energy conservation.

Differential equations of continuity and momentum (Euler's equation of motion); concept of fluid rotation, stream function, potential function; Bernoulli's equation and its applications.

Qualitative ideas of boundary layers and its separation; streamlined and bluff bodies; drag and lift forces.

Fully-developed pipe flow; laminar and turbulent flows; friction factor; Darcy Weisbach relation; Moody's friction chart; losses in pipe fittings; flow measurements using venturimeter and orifice plates.

Dimensional analysis; similitude and concept of dynamic similarity; importance of dimensionless numbers in model studies.

SECTION E. MATERIALS SCIENCE

Atomic structure and bonding in materials: metals, ceramics and polymers.

Structure of materials: Crystal systems, unit cells and space lattice; determination of structures of simple crystals by X-ray diffraction; Miller indices for planes and directions. Packing geometry in metallic, ionic and covalent solids.

Concept of amorphous, single and polycrystalline structures and their effects on properties of materials.

Imperfections in crystalline solids and their role in influencing various properties.

Fick´s laws of diffusion and applications of diffusion in sintering, doping of semiconductors and surface hardening of metals.

Alloys: solid solution and solubility limit. Binary phase diagram, intermediate phases and intermetallic compounds; iron-iron carbide phase diagram. Phase transformation in steels. Cold and hot working of metals, recovery, recrystallization and grain growth.

Properties and applications of ferrous and nonferrous alloys.

Structure, properties, processing and applications of traditional and advanced ceramics.

Polymers: classification, polymerization, structure and properties, additives for polymer products, processing and application.

Composites: properties and application of various composites.

Corrosion and environmental degradation of materials (metals, ceramics and polymers).

Mechanical properties of materials: Stress-strain diagrams of metallic, ceramic and polymeric materials, modulus of elasticity, yield strength, plastic deformation and toughness, tensile strength and elongation at break; viscoelasticity, hardness, impact strength. ductile and brittle fracture. creep and fatigue properties of materials.

Heat capacity, thermal conductivity, thermal expansion of materials.

Concept of energy band diagram for materials; conductors, semiconductors and insulators in terms of energy bands. Electrical conductivity, effect of temperature on conductivity in materials, intrinsic and extrinsic semiconductors, dielectric properties of materials.

Refraction, reflection, absorption and transmission of electromagnetic radiation in solids.

Origin of magnetism in metallic and ceramic materials, paramagnetism, diamagnetism, antiferromagnetism, ferromagnetism, ferrimagnetism in materials and magnetic hysteresis.

Advanced materials: Smart materials exhibiting ferroelectric, piezoelectric, optoelectronic, semiconducting behaviour; lasers and optical fibers; photoconductivity and superconductivity in materials.

SECTION F. SOLID MECHANICS

Equivalent force systems; free-body diagrams; equilibrium equations; analysis of determinate and indeterminate trusses and frames; friction.

Simple relative motion of particles; force as function of position, time and speed; force acting on a body in motion; laws of motion; law of conservation of energy; law of conservation of momentum

Stresses and strains; principal stresses and strains; Mohr's circle; generalized Hooke's Law; equilibrium equations; compatibility conditions; yield criteria.

Axial, shear and bending moment diagrams; axial, shear and bending stresses; deflection (for symmetric bending); torsion in circular shafts; thin cylinders; energy methods (Castigliano's Theorems); Euler buckling.

SECTION G. THERMODYNAMICS

Basic Concepts: Continuum, macroscopic approach, thermodynamic system (closed and open or control volume); thermodynamic properties and equilibrium; state of a system, state diagram, path and process; different modes of work; Zeroth law of thermodynamics; concept of temperature; heat.

First Law of Thermodynamics: Energy, enthalpy, specific heats, first law applied to systems and control volumes, steady and unsteady flow analysis.

Second Law of Thermodynamics: Kelvin-Planck and Clausius statements, reversible and irreversible processes, Carnot theorems, thermodynamic temperature scale, Clausius inequality and concept of entropy, principle of increase of entropy; availability and irreversibility.

Properties of Pure Substances: Thermodynamic properties of pure substances in solid, liquid and vapour phases, P-V-T behaviour of simple compressible substances, phase rule, thermodynamic property tables and charts, ideal and real gases, equations of state, compressibility chart.

Thermodynamic Relations: T-ds relations, Maxwell equations, Joule-Thomson coefficient, coefficient of volume expansion, adiabatic and isothermal compressibilities, Clapeyron equation.

Ideal Gas Mixtures: Dalton's and Amagat's laws, calculations of properties, air-water vapour mixtures.

XL - LIFE SCIENCES

The syllabi of the Sections of this paper are as follows:

SECTION H. CHEMISTRY (Compulsory)

Atomic structure and periodicity: Quantum chemistry; Planck's quantum theory, wave particle duality, uncertainty principle, quantum mechanical model of hydrogen atom; electronic configuration of atoms; periodic table and periodic properties; ionization energy, election affinity, electronegativity, atomic size.

Structure and bonding: Ionic and covalent bonding M.O. and V.B. approaches for diatomic molecules, VSEPR theory and shape of molecules, hybridisation, resonance, dipole moment, structure parameters such as bond length, bond angle and bond energy, hydrogen bonding, van der Waals interactions. Ionic solids; ionic radii, lattice energy (Born-Haber Cycle).

s.p. and d Block Elements: Oxides, halides and hydrides of alkali and alkaline earth metals, B, Al, S, N, P and S, silicones, general characteristics of 3d elements, coordination complexes: valence bond and crystal field theory, color, geometry and magnetic properties.

Chemical Equilibria: Colligative properties of solutions, ionic equilibria in solution, solubility product, common ion effect, hydrolysis of salts, pH, buffer and their applications in chemical analysis.

Electrochemistry: Conductance, Kohlrausch law, Half Cell potentials, emf, Nernst equation, galvanic cells, thermodynamic aspects and their applications.

Reaction Kinetics: Rate constant, order of reaction, molecularity, activation energy, zero, first and second order kinetics, equilibrium constants (Kc, Kp and Kx) for homogeneous reactions, catalysis and elementary enzyme reactions.

Thermodynamics: First law, reversible and irreversible processes, internal energy, enthalpy, Kirchoff's equation, heat of reaction, Hess law, heat of formation, Second law, entropy, free energy, and work function. Gibbs-Helmholtz equation, Clausius-Clapeyron equation, free energy change and equilibrium constant, Troutons rule, Third law of thermodynamics.

Mechanistic Basis of Organic Reactions: Elementary treatment of SN1, SN2, E1 and E2 reactions, Hoffmann and Saytzeff rules, Addition reactions, Markonikoff rule and Kharash effect, Diels-Alder reaction, aromatic electrophilic substitution, orientation effect as exemplified by various functional groups.

Structure-Reactivity Correlations: Acids and bases, electronic and steric effects, optical and geometrical isomerism, tautomerism, concept of aromaticity

SECTION I. BIOCHEMISTRY

Organization of life. Importance of water. Cell structure and organelles. Structure and function of biomolecules: Carbohydrates, Lipids, Proteins and Nucleic acids. Biochemical separation techniques. Spectroscopic methods; UV-visible and fluorescence. Protein structure, folding and function: Myoglobin, Hemoglobin, Lysozyme, ribonuclease A, Carboxypeptidase and Chymotrypsin. Enzyme kinetics and regulation, Coenzymes.

Metabolism and bioenergitics. Generation and utilization of ATP. Photosynthesis. Major metabolic pathways and their regulation. Biological membranes. Transport across membranes. Signal transduction; hormones and neurotransmitters.

DNA replication, transcription and translation. Biochemical regulation of gene expression. Recombinant DNA technology and applications. Genomics and Proteomics.

The immune system. Active and passive immunity. Complement system. Antobody structure, function and diversity. Cells of the immune system: T, B and macrophages. T and B cell activation. Major histocompatibilty complex. T cell receptor. Immunological techniques: Immunodiffusion, immunoelectrophoresis, RIA and ELISA.

SECTION J. BIOTECHNOLOGY

Recombinant DNA technology for the production of therapeutic proteins. Micro array technology. Heterologous protein expression systems in bacteria, yeast etc.

Architecture of plant genome; plant tissue culture techniques; methods of gene transfer into plant cells; manipulation of phenotypic traits in plants; plant cell fermentations and production of secondary metabolites using suspension/ immobilized cell culture; methods for plant micro propagation; crop improvement and development of transgenic plants. Expression of animal proteins in plants.

Animal cell metabolism and regulation; cell cycle; primary cell culture; nutritional requirements for animal cell culture; techniques for the mass culture of animal cell lines; production of vaccines; growth hormones and interferons using animal cell culture; cytokines-production and therapeutic uses; hybridoma technology; vectors for gene transfer and expression in animal cells. Transgenic animals and molecular pharming.

Microbial production of industrial enzymes; methods for immobilization of enzymes; kinetics of soluble and immobilized enzymes; application of soluble and immobilized enzymes; enzyme-based sensors.

Microbial growth kinetics; batch, fed batch and continuous culture of microbial cells; media for industrial fermentations; sterilization of air and media; design features and operation of stirred tank, air-lift and fluidized bed reactors; aeration and agitation in aerobic fermentations; recovery and purification of fermentation products- filtration, centrifugation, cell disintegration, solvent extraction and chromatographic separations; industrial fermentations for the production of ethanol, citric acid, lysine, penicillin and other biomolecules; simple calculations based on material and energy balance of fermentation processes; application of microbes in the management of domestic and industrial wastes.

SECTION K. BOTANY

Anatomy: Roots, stem and leaves of land plants, meristems, vascular system, their ontogeny, structure and functions. Plant cell structure, organisation, organelles, cytoskeleton, cell wall and membranes.

Development: Cell cycle, cell division, senescence, hormonal regulation of growth; life cycle of an angiosperm, pollination, fertilization, embryogenesis, seed formation, seed storage proteins, seed dormancy and germination. Concept of cellular totipotency, organogenesis and somatic embryogenesis, somaclonal variation, embryo culture, in vitro fertilization.

Physiology and Biochemistry: Plant water relations, transport of minerals and solutes, N_2 metabolism, proteins and nucleic acid, respiration, photophysiology, photosynthesis, photorespiration; biosynthesis, mechanism of action and physiological effects of plant growth regulators.

Genetics: Principles of Mendelian inheritance, linkage, recombination and genetic mapping; extrachromosomal inheritance; eukaryotic genome organization (chromatin structure) and regulation of gene expression, gene mutation, chromosome aberrations (numerical and structural), transposons.

Plant Breeding: Principles, methods - selection, hybridization, heterosis; male sterility, self and inter-specific incompatibility; haploidy; somatic cell hybridization; molecular marker-assisted selection; gene transfer methods viz. direct and vector-mediated, transgenic plants and their applications in agriculture.

Economic Botany: Economically important plants - cereals, pulses, plants yielding fiber, timber, sugar, beverages, oils, rubber, dyes, gums, drugs and narcotics - a general account.

Systematics: Systems of classification (non-phylogenetic vs. phylogenetic - outline), plant groups, molecular systematics.

Plant Pathology: Nature and classification of plant diseases, diseases of important crops caused by fungi, bacteria and viruses, and their control measures, mechanism(s) of pathogenesis and resistance, molecular detection of pathogens; plant-microbe beneficial interactions.

Ecology and Plant Geography: Ecosystems - types, dynamics, degradation, ecological succession; food chains; vegetation types of the world; pollution and global warming; speciation and extinction, conservation strategies, cryopreservation.

SECTION L. MICROBIOLOGY

Historical perspective - Discovery of the microbial world; Controversy over spontaneous generation; Role of microorganisms in transformation of organic matter and in the causation of diseases.

Methods in microbiology - Pure culture techniques; Theory and practice of sterilization; Principles of microbial nutrition; Construction of culture media; Enrichment culture techniques for isolation of chemoautotrophs, chemoheterotrophs and photosynthetic microorganisms.

Microbial evolution, systematics and taxonomy - Evolution of earth and earliest life forms; Primitive organisms and their metabolic strategies; New approaches to bacterial taxonomic classification including ribotyping; Nomenclature.

Microbial diversity - Bacteria, archea and their broad classification; Eukaryotic microbes, yeast, fungi, slime mold and protozoa; Viruses and their classification.

Microbial growth -The definition of growth, mathematical expression of growth, growth curve, measurement of growth and growth yields; Synchronous growth; Continuous culture.

Nutrition and metabolism - Overview of metabolism; Microbial nutrition; Energy classes of microorganisms; Culture media; Energetics, modes of ATP generation; ATP generation by heterotrophs; Fermentation; Glycolysis; Respiration; The citric acid cycle; Electron transport systems; Alternate modes of energy generation; Pathways (anabolism) in the biosynthesis of amino acids, purines, pyrimidines and fatty acids.

Metabolic diversity among microorganisms - Photosynthesis in microorganisms; Role of chlorophylls, carotenoids and phycobilins; Calvin cycle; Chemolithotrophy; Hydrogen- iron-nitrite-oxidizing bacteria; Nitrate and sulfate reduction; Methanogenesis and acetogenesis.

Prokaryotic cells: structure-function - Cells walls of eubacteria (peptidoglycan) and related molecules; Outer-membrane of gram-negative bacteria; Cell wall and cell membrane synthesis; Flagella and motility; Cell inclusions like endospores, gas vesicles.

Microbial diseases and host parasite relationships - Normal microflora of skin; Oral cavity; Gastrointestinal tract; Entry of pathogens into the host; Infectious disease transmission; Respiratory infections caused by bacteria and viruses; Tuberculosis; Sexually transmitted diseases including AIDS; Diseases transmitted by animals (Rabies, plague), insects and ticks (rikettsias, Lyme disease, malaria); Food and water borne diseases; Public health and water quality; Pahtogenic fungi; Emerging and resurgent infectious diseases.

Chemotherapy/Antibiotics - Antimicrobial agents; Sulfa drugs; Antibiotics; Pencillins and cephalosporins; Broad-spectrum antibiotics; Antibiotics from prokaryotes; Antifungal antibiotics; Mode of action; Resistance to antibiotics.

Microbial genetics - Genes, mutation and mutagenesis - UV and chemical mutagnes; Types of mutations; Ames test for mutagenesis; Methods of genetic analysis. Bacterial genetic system - Transformation; Conjugation; Transduction; Recombination; Plasmids and Transposons; Bacterial genetic map with reference to E. coli. Viruses and their genetic system - Phage ? and its life cycle; RNA phages; RNA viruses; Retroviruses; Genetic systems of yeast and Neurospora; Extrachromosomal inheritance and mitochondrial genetics; Basic concept of genomics.

SECTION M. ZOOLOGY

Animal world: Animal diversity, distribution, systematic and classification of animals, the phylogenetic relationship.

Evolution: Origin of life, history of life on earth, evolutionary theories, natural selection, adaptation, speciation.

Genetics: Principles of inheritance, molecular basis of heredity, the genetic material, transmission of genetic material, mutations, cytoplasmic inheritance.

Biochemistry and Molecular Biology: Nucleic acids, proteins and other biological macromolecules. Replication, transcription and translation, regulation of gene expression, organization of genome, Kreb's cycle, glycolysis, enzyme catalysis, hormones and their action.

Cell Biology: Structure of cell, cellular organelles and their structure and function, cell cycle, cell division, cellular differentiation, chromosome and chromatin structure. Eukaryotic gene organisation and expression.

Animal Anatomy and Physiology: Comparative physiology, the respiratory system, circulatory system, digestive system, the nervous system, the excretory system, the endocrine system, the reproductive system, the skeletal system, osmoregulation.

Parasitology and Immunology: Nature of parasite, host-parasite relation, protozoan and helminthic parasites, the immune response, cellular and humoral immune response, evolution of the immune system.

Development Biology: Embryonic development, cellular differentiation, organogenesis, metamorphosis, genetic basis of development.

Ecology: The ecosystem, habitats the food chain, population dynamics, species diversity, zoogeography, biogeochemical cycles, conservation biology.

Animal Behaviour: Types of behaviours, courtship, mating and territoriality, instinct, learning and memory, social behaviour across the animal taxa, communication, pheromones, evolution of animal behaviour.

IT - INFORMATION TECHNOLOGY

ENGINEERING MATHEMATICS

Mathematical Logic: Propositional Logic; First Order Logic.

Probability: Conditional Probability; Mean, Median, Mode and Standard Deviation; Random Variables; Distributions; uniform, normal, exponential, Poisson, Binomial.

Set Theory & Algebra: Sets; Relations; Functions; Groups; Partial Orders; Lattice; Boolean Algebra.

Combinatorics: Permutations; Combinations; Counting; Summation; generating functions; recurrence relations; asymptotics.

Graph Theory: Connectivity; spanning trees; Cut vertices & edges; covering; matching; independent sets; Colouring; Planarity; Isomorphism.

Linear Algebra: Algebra of matrices, determinants, systems of linear equations, Eigen values and Eigen vectors.

Numerical Methods: LU decomposition for systems of linear equations; numerical solutions of non linear algebraic equations by Secant, Bisection and Newton-Raphson Methods; Numerical integration by trapezoidal and Simpson's rules.

Calculus: Limit, Continuity & differentiability, Mean value Theorems, Theorems of integral calculus, evaluation of definite & improper integrals, Partial derivatives, Total derivatives, maxima & minima.

FORMAL LANGUAGES AND AUTOMATA

Regular Languages: finite automata, regular expressions, regular grammar.

Context free languages: push down automata, context free grammars

COMPUTER HARDWARE

Digital Logic: Logic functions, minimization, design and synthesis of combinatorial and sequential circuits, number representation and computer arithmetic (fixed and floating point)

Computer organization: Machine instructions and addressing modes, ALU and data path, hardwired and microprogrammed control, memory interface, I/O interface (interrupt and DMA mode), serial communication interface, instruction pipelining, cache, main and secondary storage

SOFTWARE SYSTEMS

Data structures and Algorithms: the notion of abstract data types, stack, queue, list, set, string, tree, binary search tree, heap, graph, tree and graph traversals, connected components, spanning trees, shortest paths, hashing, sorting, searching, design techniques (greedy, dynamic, divide and conquer), asymptotic analysis (best, worst, average cases) of time and space, upper and lower bounds, intractability

Programming Methodology: C programming, program control (iteration, recursion, functions), scope, binding, parameter passing, elementary concepts of object oriented programming

Operating Systems (in the context of Unix): classical concepts (concurrency, synchronization, deadlock), processes, threads and interprocess communication, CPU scheduling, memory management, file systems, I/O systems, protection and security

Information Systems and Software Engineering: information gathering, requirement and feasibility analysis, data flow diagrams, process specifications, input/output design, process life cycle, planning and managing the project, design, coding, testing, implementation, maintenance.

Databases: relational model, database design, integrity constraints, normal forms, query languages (SQL), file structures (sequential, indexed), b-trees, transaction and concurrency control

Data Communication: data encoding and transmission, data link control, multiplexing, packet switching, LAN architecture, LAN systems (Ethernet, token ring), Network devices: switches, gateways, routers

Networks: ISO/OSI stack, sliding window protocols, routing protocols, TCP/UDP, application layer protocols & systems (http, smtp, dns, ftp), network security

Web technologies: three tier web based architecture; JSP, ASP, J2EE, .NET systems; html, XML

AG - AGRICULTURAL ENGINEERING

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

FARM MACHINERY AND POWER:

Sources of power on the farm-human, animal, mechanical, electrical, wind, solar and biomass; design and selection of machine elements - gears, pulleys, chains and sprockets and belts; overload safety devices used in farm machinery; measurement of force, torque, speed, displacement and acceleration on machine elements.

Soil tillage; forces acting on a tillage tool; hitch systems and hitching of tillage implements; functional requirements, principles of working, construction and operation of manual, animal and power operated equipment for tillage. sowing, planting, fertilizer application, inter-cultivation, spraying, mowing, chaff cutting, harvesting, threshing and transport; testing of agricultural machinery and equipment; calculation of performance parameters -field capacity, efficiency, application rate and losses; cost analysis of implements and tractors.

Thermodynamic principles of I.C. engines; I.C. engine cycles; engine components; fuels and combustion; lubricants and their properties; I.C. engine systems - fuel, cooling, lubrication, ignition, electrical, intake and exhaust; selection, operation, maintenance and repair of I.C. engines; power efficiencies and measurement; calculation of power, torque, fuel consumption, heat load and power losses.

Tractors and power tillers - type, selection, maintenance and repair; tractor clutches and brakes; power transmission systems - gear trains, differential, final drives and power take-off; mechanics of tractor chassis; traction theory; three point hitches- free link and restrained link operations; mechanical steering and hydraulic control systems used in tractors; human engineering and safety in tractor design; tractor tests and performance.

SOIL AND WATER CONSERVATION ENGINEERING:

Ideal and real fluids, properties of fluids; hydrostatic pressure and its measurement; hydrostatic forces on plane and curved surface; continuity equation; Bernoulli's theorem; laminar and turbulent flow in pipes, Darcy-Weisbach and Hazen-Williams equations, Moody's diagram; flow through orifices and notches; flow in open channels.

Engineering properties of soils, fundamental definitions and relationships; index properties of soils; permeability and seepage analysis; shear strength, Mohr's circle of stresses; active and passive earth pressures; stability of slopes.

Hydrological cycle; precipitation measurement, analysis of precipitation data; abstraction from precipitation; runoff; hydrograph analysis, unit hydrograph theory and application; stream flow measurement; flood routing, hydrological reservoir and channel routing.

Mechanics of soil erosion, factors affecting erosion; soil loss estimation; biological and engineering measures to control erosion, terraces and bunds; vegetative waterways; gully control structures, drop, drop inlet and chute spillways; farm ponds; earthen dams; principles of watershed management.

Water requirement of crops; consumptive use and evapo-transpiration; irrigation scheduling; irrigation efficiencies; design of prismatic and silt loaded channels; methods of irrigation water application; design and evaluation of irrigation methods; drainage coefficient; surface and subsurface drainage systems; leaching requirement and salinity control; irrigation and drainage water quality; classification of pumps; pump characteristics; pump selection; types of aquifer; evaluation of aquifer properties; well hydraulics; ground water recharge.

AGRICULTURAL PROCESSING AND FOOD ENGINEERING:

Steady state heat transfer in conduction, convection and radiation; transient heat transfer in simple geometry; condensation and boiling heat transfer; working principles of heat exchangers; diffusive and convective mass transfer; simultaneous heat and mass transfer in agricultural processing operations.

Material and energy balances in food processing systems; water activity, sorption and desorption isotherms; centrifugal separation of solids, liquids and gases; kinetics of microbial death - pasteurisation and sterilization of liquid foods; preservation of food by cooling and freezing; psychrometry - properties of air-vapour mixture; concentration and dehydration of liquid foods - evaporators, tray, drum and spray dryers.

Mechanics and energy requirement in size reduction of granular solids; particle size analysis for comminuted solids; size separation by screening; fluidisation of granular solids; cleaning and grading efficiency and effectiveness of grain cleaners; conditioning and hydrothermal treatments for grains; dehydration of food grains; processes and machines for processing of cereals, pulses and oilseeds; design considerations for grain silos.

AR - ARCHITECTURE AND PLANNING

City planning: Historical development of cities; principles of city planning; new towns; survey methods, site planning, planning regulations and building bye-laws.

Housing: Concept of shelter; housing policies and design; community planning; role of government agencies; finance and management.

Landscape Design: Principles of landscape design and site planning; history and landscape styles; landscape elements and materials; planting design.

Computer Aided Design: Application of computers in architecture and planning; understanding elements of hardware and software; computer graphics; programming languages - C and Visual Basic and usage of packages such as AutoCAD.

Environmental and Building Science: Elements of environmental science; ecological principles concerning environment; role of micro-climate in design; climatic control through design elements; thermal comfort; elements of solar architecture; principles of lighting and illumination; basic principles of architectural acoustics; air pollution, noise pollution and their control.

Visual and Urban Design: Principles of visual composition; proportion, scale, rhythm, symmetry, harmony, balance, form and colour; sense of place and space, division of space; focal point, vista, imageability, visual survey.

History of Architecture: Indian - Indus valley, Vedic, Buddhist, Indo-Aryan, Dravidian and Mughal periods; European - Egyptian, Greek, Roman, medieval and renaissance periods.

Development of Contemporary Architecture: Architectural developments and impacts on society since industrial revolution; influence of modern art on architecture; works of national and international architects; post modernism in architecture.

Building Services: Water supply, Sewerage and Drainage systems; Sanitary fittings and fixtures; principles of electrification of buildings; elevators, their standards and uses; air-conditioning systems; fire fighting systems.

Building Construction and Management: Building construction techniques, methods and details; building systems and prefabrication of building elements; principles of modular coordination; estimation, specification, valuation, professional practice; project management, PERT, CPM.

Materials and Structural Systems: Behavioural characteristics of all types of building materials e.g. mud, timber, bamboo, brick, concrete, steel, glass, FRP; principles of strength of materials; design of structural elements in wood, steel and RCC; elastic and limit state design; complex structural systems; principles of pre-stressing.

Planning Theory: Planning process; multilevel planning; comprehensive planning; central place theory; settlement pattern; land use and land utilization.

Techniques of Planning: Planning surveys; Preparation of urban and regional structure plans, development plans, action plans; site planning principles and design; statistical methods; application of remote sensing techniques in urban and regional planning.

Traffic and Transportation Planning: Principles of traffic engineering and transportation planning; methods of conducting surveys; design of roads, intersections and parking areas; hierarchy of roads and levels of services; traffic and transport management in urban areas; traffic safety and traffic laws; public transportation planning; modes of transportation.

Services and Amenities: Principles and design of water supply systems, sewerage systems, solid waste disposal systems, power supply and communication systems; Health, education, recreation and demography related standards at various levels of the settlements.

Development Administration and Management: Planning laws; development control and zoning regulations; laws relating to land acquisition; development enforcements, land ceiling; regional and urban plan preparations; planning and municipal administration; taxation, revenue resources and fiscal management; public participation and role of NGO.

CE - CIVIL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

STRUCTURAL ENGINEERING

Mechanics: Bending moments and shear forces in statically determinate beams; simple stress and strain: relationship; stress and strain in two dimensions, principal stresses, stress transformation, Mohr's circle; simple bending theory; flexural shear stress; thin-walled pressure vessels; uniform torsion.

Structural Analysis: Analysis of statically determinate trusses, arches and frames; displacements in statically determinate structures and analysis of statically indeterminate structures by force/energy methods; analysis by displacement methods (slope-deflection and moment-distribution methods); influence lines for determinate and indeterminate structures; basic concepts of matrix methods of structural analysis.

Concrete Structures: Basic working stress and limit states design concepts; analysis of ultimate load capacity and design of members subject to flexure, shear, compression and torsion (beams, columns and isolated footings); basic elements of prestressed concrete: analysis of beam sections at transfer and service loads.

Steel Structures: Analysis and design of tension and compression members, beams and beam-columns, column bases; connections - simple and eccentric, beam-column connections, plate girders and trusses; plastic analysis of beams and frames.

GEOTECHNICAL ENGINEERING

Soil Mechanics: Origin of soils; soil classification; three-phase system, fundamental definitions, relationship and inter-relationships; permeability and seepage; effective stress principle: consolidation, compaction; shear strength.

Foundation Engineering: Sub-surface investigation - scope, drilling bore holes, sampling, penetrometer tests, plate load test; earth pressure theories, effect of water table, layered soils; stability of slopes - infinite slopes, finite slopes; foundation types - foundation design requirements; shallow foundations; bearing capacity, effect of shape, water table and other factors, stress distribution, settlement analysis in sands and clays; deep foundations - pile types, dynamic and static formulae, load capacity of piles in sands and clays.

WATER RESOURCES ENGINEERING

Fluid Mechanics and Hydraulics: Hydrostatics, applications of Bernoulli equation, laminar and

turbulent flow in pipes, pipe networks; concept of boundary layer and its growth; uniform flow, critical flow and gradually varied flow in channels, specific energy concept, hydraulic jump; forces on immersed bodies; flow measurement in channels; tanks and pipes; dimensional analysis and hydraulic modeling. Applications of momentum equation, potential flow, kinematics of flow; velocity triangles and specific speed of pumps and turbines.

Hydrology: Hydrologic cycle; rainfall; evaporation infiltration, unit hydrographs, flood estimation, reservoir design, reservoir and channel routing, well hydraulics.

Irrigation: Duty, delta, estimation of evapo-transpiration; crop water requirements; design of lined and unlined canals; waterways; head works, gravity dams and Ogee spillways. Designs of weirs on permeable foundation, irrigation methods.

ENVIRONMENTAL ENGINEERING

Water requirements; quality and standards, basic unit processes and operations for water treatment, distribution of water. Sewage and sewerage treatment: quantity and characteristic of waste water sewerage; primary and secondary treatment of waste water; sludge disposal; effluent discharge standards.

TRANSPORTATION ENGINEERING

Highway planning; geometric design of highways; testing and specifications of paving materials; design of flexible and rigid pavements.

CH - CHEMICAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

CHEMICAL ENGINEERING

Process Calculations and Thermodynamics: Laws of conservation of mass and energy; use of tie components; recycle, bypass and purge calculations; degree of freedom analysis.

First and Second laws of thermodynamics and their applications; equations of state and thermodynamic properties of real systems; phase equilibria; fugacity, excess properties and

correlations of activity coefficients; chemical reaction equilibria.

Fluid Mechanics and Mechanical Operations: Fluid statics, Newtonian and non-Newtonian fluids, Bernoulli equation, Macroscopic friction factors, energy balance, dimensional analysis, shell balances, flow through pipeline systems, flow meters, pumps and compressors, packed and fluidized beds, elementary boundary layer theory, size reduction and size separation; free and hindered settling; centrifuge and cyclones; thickening and classification, filtration, mixing and agitation; conveying of solids.

Heat Transfer: Conduction, convection and radiation, heat transfer coefficients, steady and unsteady heat conduction, boiling, condensation and evaporation; types of heat exchangers and evaporators and their design.

Mass Transfer: Fick's law, molecular diffusion in fluids, mass transfer coefficients, film, penetration and surface renewal theories; momentum, heat and mass transfer analogies; stagewise and continuous contacting and stage efficiencies; HTU & NTU concepts design and operation of equipment for distillation, absorption, leaching, liquid-liquid extraction, crystallization, drying, humidification, dehumidification and adsorption.

Chemical Reaction Engineering: Theories of reaction rates; kinetics of homogeneous reactions, interpretation of kinetic data, single and multiple reactions in ideal reactors, non-ideal reactors; residence time; non-isothermal reactors; kinetics of heterogeneous catalytic reactions; diffusion effects in catalysis.

Instrumentation and Process Control: Measurement of process variables; sensors, transducers and their dynamics, dynamics of simple systems, dynamics such as CSTRs, transfer functions and responses of simple systems, process reaction curve, controller modes (P, PI, and PID); control valves; analysis of closed loop systems including stability, frequency response (including Bode plots) and controller tuning, cascade, feed forward control.

Plant Design and Economics: Design and sizing of chemical engineering equipment such as compressors, heat exchangers, multistage contactors; principles of process economics and cost estimation including total annualized cost, cost indexes, rate of return, payback period, discounted cash flow, optimization in Design.

Chemical Technology: Inorganic chemical industries; sulfuric acid, NaOH, fertilizers (Ammonia, Urea, SSP and TSP); natural products industries (Pulp and Paper, Sugar, Oil, and Fats); petroleum refining and petrochemicals; polymerization industries; polyethylene, polypropylene, PVC and polyester synthetic fibers.

CS - COMPUTER SCIENCE AND ENGINEERING

ENGINEERING MATHEMATICS

Mathematical Logic: Propositional Logic; First Order Logic.

Probability: Conditional Probability; Mean, Median, Mode and Standard Deviation; Random Variables; Distributions; uniform, normal, exponential, Poisson, Binomial.

Set Theory & Algebra: Sets; Relations; Functions; Groups; Partial Orders; Lattice; Boolean Algebra.

Combinatorics: Permutations; Combinations; Counting; Summation; generating functions; recurrence relations; asymptotics.

Graph Theory: Connectivity; spanning trees; Cut vertices & edges; covering; matching; independent sets; Colouring; Planarity; Isomorphism.

Linear Algebra: Algebra of matrices, determinants, systems of linear equations, Eigen values

and Eigen vectors.

Numerical Methods: LU decomposition for systems of linear equations; numerical solutions of non linear algebraic equations by Secant, Bisection and Newton-Raphson Methods; Numerical integration by trapezoidal and Simpson's rules.

Calculus: Limit, Continuity & differentiability, Mean value Theorems, Theorems of integral calculus, evaluation of definite & improper integrals, Partial derivatives, Total derivatives, maxima & minima.

THEORY OF COMPUTATION

Formal Languages and Automata Theory: Regular languages and finite automata, Context free languages and Push-down automata, Recursively enumerable sets and Turing machines, Un-decidability;

Analysis of Algorithms and Computational Complexity: Asymptotic analysis (best, worst, average case) of time and space, Upper and lower bounds on the complexity of specific problems, NP-completeness.

COMPUTER HARDWARE

Digital Logic: Logic functions, Minimization, Design and synthesis of Combinational and Sequential circuits; Number representation and Computer Arithmetic (fixed and floating point);

Computer Organization: Machine instructions and addressing modes, ALU and Data-path, hardwired and micro-programmed control, Memory interface, I/O interface (Interrupt and DMA mode), Serial communication interface, Instruction pipelining, Cache, main and secondary storage.

SOFTWARE SYSTEMS

Data structures: Notion of abstract data types, Stack, Queue, List, Set, String, Tree, Binary search tree, Heap, Graph;

Programming Methodology: C programming, Program control (iteration, recursion, Functions), Scope, Binding, Parameter passing, Elementary concepts of Object oriented, Functional and Logic Programming;

Algorithms for problem solving: Tree and graph traversals, Connected components, Spanning trees, Shortest paths; Hashing, Sorting, Searching; Design techniques (Greedy, Dynamic Programming, Divide-and-conquer);

Compiler Design: Lexical analysis, Parsing, Syntax directed translation, Runtime environment, Code generation, Linking (static and dynamic); Operating Systems: Classical concepts (concurrency, synchronization, deadlock), Processes, threads and Inter-process communication, CPU scheduling, Memory management, File systems, I/O systems, Protection and security.

Databases: Relational model (ER-model, relational algebra, tuple calculus), Database design (integrity constraints, normal forms), Query languages (SQL), File structures (sequential files, indexing, B+ trees), Transactions and concurrency control;

Computer Networks: ISO/OSI stack, sliding window protocol, LAN Technologies (Ethernet, Token ring), TCP/UDP, IP, Basic concepts of switches, gateways, and routers.

CH - CHEMISTRY

PHYSICAL CHEMISTRY

Structure: Quantum theory - principles and techniques; applications to particle in a box, harmonic oscillator, rigid rotor and hydrogen atom; valence bond and molecular orbital theories and Huckel approximation, approximate techniques: variation and perturbation; symmetry, point groups; rotational, vibrational, electronic, NMR and ESR spectroscopy.

Equilibrium: First law of thermodynamics, heat, energy and work; second law of thermodynamics and entropy; third law and absolute entropy; free energy; partial molar quantities; ideal and non-ideal solutions; phase transformation: phase rule and phase diagrams- one, two, and three component systems; activity, activity coefficient, fugacity and fugacity coefficient ; chemical equilibrium, response of chemical equilibrium to temperature and pressure; colligative properties; kinetic theory of gases; thermodynamics of electrochemical cells; standard electrode potentials: applications - corrosion and energy conversion; molecular partition function (translational, rotational, vibrational and electronic).

Kinetics: Rates of chemical reactions, theories of reaction rates, collision and transition state theory; temperature dependence of chemical reactions; elementary reactions, consecutive elementary reactions; steady state approximation, kinetics of photochemical reactions and free radical polymerization, homogenous and heterogeneous catalysis.

INORGANIC CHEMISTRY

Non-Transition Elements: General characteristics, structure and reactions of simple and industrially important compounds, boranes, carboranes, silicates, silicones, diamond and graphite; hydrides, oxides and oxoacids of N, P, S and halogens; boron nitride, borazines and phosphazenes; xenon compounds. Shapes of molecules, hard-soft acid base concept.

Transition Elements: General characteristics of d and f block elements; coordination chemistry: structure and isomerism, stability, theories of metal-ligand bonding (CFT and LFT), electronic spectra and magnetic properties of transition metal complexes and lanthanides; metal carbonyls, metal-metal bonds and metal atom clusters, metallocenes; transition metal complexes with bonds to hydrogen, alkyls, alkenes, and arenes; metal carbenes; use of organometallic compounds as catalysts in organic synthesis; mechanisms of substitution and electron transfer reactions of coordination complexes. Role of metals with special reference to Na, K, Mg, Ca, Fe, Co, Zn, and Mo in biological systems.

Solids: Crystal systems and lattices, Miller planes, crystal packing, crystal defects; Bragg's Law; ionic crystals, band theory, metals and semiconductors. Spinels.

Instrumental methods of analysis: atomic absorption, UV-visible spectrometry, chromatographic and electro-analytical methods.

ORGANIC CHEMISTRY

Synthesis, reactions and mechanisms involving the following: Alkenes, alkynes, arenes, alcohols, phenols, aldehydes, ketones, carboxylic acids and their derivatives; halides, nitro compounds and amines; stereochemical and conformational effects on reactivity and specificity; reactions with diborane and peracids. Michael reaction, Robinson annulation, reactivity umpolung, acyl anion equivalents; molecular rearrangements involving electron deficient atoms.

Photochemistry: Basic principles, photochemistry of olefins, carbonyl compounds, arenes, photo oxidation and reduction.

Pericyclic reactions: Cycloadditions, electrocyclic reactions, sigmatropic reactions; Woodward-Hoffmann rules.

Heterocycles: Structural properties and reactions of furan, pyrrole, thiophene, pyridine, indole.

Biomolecules: Structure, properties and reactions of mono- and di-saccharides, physico-chemical properties of amino acids, structural features of proteins and nucleic acids.

Spectroscopy: Principles and applications of IR, UV-visible, NMR and mass spectrometry in the determination of structures of organic compounds.

EC - ELECTRONICS AND COMMUNICATION ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix Algebra, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Mean value theorems, Theorems of integral calculus, Evaluation of definite and improper integrals, Partial Derivatives, Maxima and minima, Multiple integrals, Fourier series. Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equation (linear and nonlinear), Higher order linear differential equations with constant coefficients, Method of variation of parameters, Cauchy's and Euler's equations, Initial and boundary value problems, Partial Differential Equations and variable separable method.

Complex variables: Analytic functions, Cauchy's integral theorem and integral formula, Taylor's and Laurent' series, Residue theorem, solution integrals.

Probability and Statistics: Sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Discrete and continuous distributions, Poisson, Normal and Binomial distribution, Correlation and regression analysis.

Numerical Methods: Solutions of non-linear algebraic equations, single and multi-step methods for differential equations.

Transform Theory: Fourier transform, Laplace transform, Z-transform.

ELECTRONICS & COMMUNICATION ENGINEERING

Networks: Network graphs: matrices associated with graphs; incidence, fundamental cut set and fundamental circuit matrices. Solution methods: nodal and mesh analysis. Network theorems: superposition, Thevenin and Norton's maximum power transfer, Wye-Delta transformation. Steady state sinusoidal analysis using phasors. Linear constant coefficient differential equations; time domain analysis of simple RLC circuits, Solution of network equations using Laplace transform: frequency domain analysis of RLC circuits. 2-port network parameters: driving point and transfer functions. State equations for networks.

Electronic Devices: Energy bands in silicon, intrinsic and extrinsic silicon. Carrier transport in silicon: diffusion current, drift current, mobility, resistivity. Generation and recombination of carriers. p-n junction diode, Zener diode, tunnel diode, BJT, JFET, MOS capacitor, MOSFET, LED, p-I-n and avalanche photo diode, LASERs. Device technology: integrated circuits fabrication process, oxidation, diffusion, ion implantation, photolithography, n-tub, p-tub and twin-tub CMOS process.

Analog Circuits: Equivalent circuits (large and small-signal) of diodes, BJTs, JFETs, and MOSFETs. Simple diode circuits, clipping, clamping, rectifier. Biasing and bias stability of transistor and FET amplifiers. Amplifiers: single-and multi-stage, differential, operational, feedback and power. Analysis of amplifiers; frequency response of amplifiers. Simple op-amp circuits. Filters. Sinusoidal oscillators; criterion for oscillation; single-transistor and op-amp configurations. Function generators and wave-shaping circuits. Power supplies.

Digital circuits: Boolean algebra, minimization of Boolean functions; logic gates digital IC families (DTL, TTL, ECL, MOS, CMOS). Combinational circuits: arithmetic circuits, code converters, multiplexers and decoders. Sequential circuits: latches and flip-flops, counters and shift-registers. Sample and hold circuits, ADCs, DACs. Semiconductor memories. Microprocessor(8085): architecture, programming, memory and I/O interfacing.

Signals and Systems: Definitions and properties of Laplace transform, continuous-time and discrete-time Fourier series, continuous-time and discrete-time Fourier Transform, z-transform. Sampling theorems. Linear Time-Invariant (LTI) Systems: definitions and properties; casuality, stability, impulse response, convolution, poles and zeros frequency response, group delay, phase delay. Signal transmission through LTI systems. Random signals and noise: probability, random variables, probability density function, autocorrelation, power spectral density.

Controls Systems: Basic control system components; block diagrammatic description, reduction of block diagrams. Open loop and closed loop (feedback) systems and stability analysis of these systems. Signal flow graphs and their use in determining transfer functions of systems; transient and steady state analysis of LTI control systems and frequency response. Tools and techniques for LTI control system analysis: root loci, Routh-Hurwitz criterion, Bode and Nyquist plots. Control system compensators: elements of lead and lag compensation, elements of Proportional-Integral-Derivative(PID) control. State variable representation and solution of state equation of LTI control systems.

Communications: Analog communication systems: amplitude and angle modulation and demodulation systems, spectral analysis of these operations, superheterodyne receivers; elements of hardware, realizations of analog communication systems; signal-to-noise ratio (SNR) calculations for amplitude modulation (AM) and frequency modulation (FM) for low noise conditions. Digital communication systems: pulse code modulation (PCM), differential pulse code modulation (DPCM), delta modulation (DM); digital modulation schemes-amplitude, phase and frequency shift keying schemes (ASK, PSK, FSK), matched filter receivers, bandwith consideration and probability of error calculations for these schemes.

Electromagnetics: Elements of vector calculus: divergence and curl; Gauss' and Stokes' theorems, Maxwell's equations: differential and integral forms. Wave equation, Poynting vector. Plane waves: propagation through various media; reflection and refraction; phase and group velocity; skin depth. Transmission lines: characteristic impedance; impedance transformation; Smith chart; impedance matching; pulse excitation. Waveguides: modes in rectangular waveguides; boundary conditions; cut-off frequencies; dispersion relations. Antennas: Dipole antennas; antenna arrays; radiation pattern; reciprocity theorem, antenna gain.

EE - ELECTRICAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix Algebra, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Mean value theorems, Theorems of integral calculus, Evaluation of definite and improper integrals, Partial Derivatives, Maxima and minima, Multiple integrals, Fourier series. Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equation (linear and nonlinear), Higher order linear differential equations with constant coefficients, Method of variation of parameters, Cauchy's and Euler's equations, Initial and boundary value problems, Partial Differential Equations and variable separable method.

Complex variables: Analytic functions, Cauchy's integral theorem and integral formula, Taylor's and Laurent' series, Residue theorem, solution integrals.

Probability and Statistics: Sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Discrete and continuous distributions, Poisson, Normal and Binomial distribution, Correlation and regression analysis.

Numerical Methods: Solutions of non-linear algebraic equations, single and multi-step methods for differential equations.

Transform Theory: Fourier transform, Laplace transform, Z-transform.

ELECTRICAL ENGINEERING

Electrical Circuits and Fields: Network graph, KCL, KVL, node/ cut set, mesh/ tie set analysis, transient response of d.c. and a.c. networks; sinusoidal steady-state analysis; resonance in electrical circuits; concepts of ideal voltage and current sources, network theorems, driving point, immittance and transfer functions of two port networks, elementary concepts of filters; three phase circuits; Fourier series and its application; Gauss theorem, electric field intensity and potential due to point, line, plane and spherical charge distribution, dielectrics, capacitance calculations for simple configurations; Ampere's and Biot-Savart's law, inductance calculations for simple configurations.

Electrical Machines: Single phase transformer - equivalent circuit, phasor diagram, tests, regulation and efficiency; three phase transformers - connections, parallel operation; auto transformer and three-winding transformer; principles of energy conversion, windings of rotating machines: D. C. generators and motors - characteristics, starting and speed control, armature reaction and commutation; three phase induction motors-performance characteristics, starting and speed control; single-phase induction motors; synchronous generators-performance, regulation, parallel operation; synchronous motors - starting, characteristics, applications, synchronous condensers; fractional horse power motors; permanent magnet and stepper motors.

Power Systems: Electric power generation - thermal, hydro, nuclear; transmission line parameters; steady-state performance of overhead transmission lines and cables and surge propagation; distribution systems, insulators, bundle conductors, corona and radio interference effects; per-unit quantities; bus admittance and impedance matrices; load flow; voltage control and power factor correction; economic operation; symmetrical components, analysis of symmetrical and unsymmetrical faults; principles of over current, differential and distance protections; concept of solid state relays and digital protection; circuit breakers; concept of system stability-swing curves and equal area criterion; basic concepts of HVDC transmission.

Control Systems: Principles of feedback; transfer function; block diagrams: steady-state errors; stability-Routh and Nyquist criteria; Bode plots; compensation; root loci; elementary state variable formulation; state transition matrix and response for Linear Time Invariant systems.

Electrical and Electronic Measurements: Bridges and potentiometers, PMMC, moving iron, dynamometer and induction type instruments; measurement of voltage, current, power, energy and power factor; instrument transformers; digital voltmeters and multimeters; phase, time and frequency measurement; Q-meter, oscilloscopes, potentiometric recorders, error analysis.

Analog and Digital Electronics: Characteristics of diodes, BJT, FET, SCR; amplifiers-biasing, equivalent circuit and frequency response; oscillators and feedback amplifiers, operational amplifiers- characteristics and applications; simple active filters; VCOs and timers; combinational and sequential logic circuits, multiplexer, Schmitt trigger, multivibrators, sample and hold circuits, A/D and D/A converters; microprocessors and their applications.

Power Electronics and Electric Drives: Semiconductor power devices-diodes, transistors,

thyristors, triacs, GTOs, MOSFETs and IGBTs - static characteristics and principles of operation; triggering circuits; phase control rectifiers; bridge converters-fully controlled and half controlled; principles of choppers and inverters, basic concepts of adjustable speed dc and ac drives.

GG - GEOLOGY AND GEOPHYSICS

PART - I

Earth and planetary system; size, shape, internal structure and composition of the earth; atmosphere and greenhouse effect; isostasy; elements of seismology; continents and continental processes; physical oceanography; palaeomagnetism, continental drift plate tectonics, geothermal energy.

Weathering; soil formation; action of river, wind and glacier; oceans and oceanic features; earthquakes, volcanoes, orogeny and mountain building; elements of structural geology; crystallography; classification, composition and properties of minerals and rocks; engineering properties of rocks and soils, role of geology in the construction of engineering structures.

Processes of ore formation, occurrence and distribution of ores on land and on ocean floor; coal and petroleum resources in India; ground water geology including well hydraulics, geological time scale and geochronology; stratigraphic principles and stratigraphy of India; basics concepts of gravity, magnetic and electrical prospecting for ores and ground water.

PART - IIA: GEOLOGY

Crystal symmetry, forms, twinning; crystal chemistry; optical mineralogy, classification of minerals, diagnostic properties of rock minerals.

Mineralogy, structure, texture and classification of igneous, sedimentary and metamorphic rock, their origin and evolution; application of thermodynamics; structure and petrology of sedimentary rocks; sedimentary processes and environments, sedimentary facies, basin studies; basement cover relationship;

Primary and secondary structures; geometry and genesis of folds, faults, joints, unconformities, cleavage, schistosity and lineation; methods of projection. Tectonites and their significance; shear zone; superposed folding.

Morphology, classification and geological significance of important invertebrates, vertebrates, microfossils and palaeoflora; stratigraphic principles and Indian stratigraphy; geomorphic processes and agents; development and evolution of landforms; slope and drainage; processes on deep oceanic and near-shore regions; quantitative and applied geomorphology; air photo interpretation and remote sensing; chemical and optical properties of ore minerals; formation and localization of ore deposits; prospecting and exploration of economic minerals; coal and petroleum geology; origin and distribution of mineral and fuel deposits in India; ore dressing and mineral economics.

Cosmic abundance; meteorites; geochemical evolution of the earth; geochemical cycles; distribution of major, minor and trace elements; isotope geochemistry; geochemistry of waters including solution equilibria and water rock interaction.

Engineering properties of rocks and soils; rocks as construction material; geology of dams, tunnels and excavation sites; natural hazards; the fly ash problem; ground water geology and exploration; water quality; impact of human activity; Remote sensing techniques for the interpretation of landforms and resource management.

PART - II B: GEOPHYSICS

The earth as a planet; different motions of the earth; gravity filed of the earth and its shape;

geochronology; isostasy, seismology and interior of the earth; variation of density, velocity, pressure, temperature, electrical and magnetic properties inside the earth; earthquakes-causes and measurements; zonation and seismic hazards; geomagnetic field, palaeomagnetism; oceanic and continental lithosphere; plate tectonics; heat flow; upper and lower atmospheric phenomena.

Theories of scalar and vector potential fields; Laplace, Maxwell and Helmholtz equations for solution of different types of boundary value problems for Cartesian, cylindrical and spherical polar coordinates; Green's theorem; Image theory; integral equations and conformal transformations in potential theory; Eikonal equation and ray theory.

'G' and 'g' units of measurement, density of rocks, gravimeters, preparation, analysis and interpretation of gravity maps; derivative maps, analytical continuation; gravity anomaly type curves; calculation of mass.

Earth's magnetic field, units of measurement, magnetic susceptibility of rocks, magnetometers, corrections, preparation of magnetic maps, magnetic anomaly type curve, analytical continuation, interpretation and application; magnetic well logging.

Conduction of electricity through rocks, electrical conductivities of metals, metallic, non-metallic and rock forming minerals, D.C. resistivity units and methods of measurement, electrode configuration for sounding and profiling, application of filter theory, interpretation of resistivity field data, application; self potential origin, classification, field measurement, interpretation of induced polarization time frequency, phase domain; IP units and methods of measurement, interpretation and application; ground-water exploration.

Origin of electromagnetic field elliptic polarization, methods of measurement for different source-receiver configuration components in EM measurements, interpretation and applications; earth's natural electromagnetic field, tellurics, magneto-tellurics; geomagnetic depth sounding principles, methods of measurement, processing of data and interpretation.

Seismic methods of prospecting: Reflection, refraction and CDP surveys; land and marine seismic sources, generation and propagation of elastic waves, velocity increasing with depth, geophones, hydrophones, recording instruments (DFS), digital formats, field layouts, seismic noises and noise profile analysis, optimum geophone grouping, noise cancellation by shot and geophone arrays, 2D and 3D seismic data acquisition and processing, CDP stacking charts, binning, filtering, dip-moveout, static and dynamic corrections, deconvolution, migration, signal processing, Fourier and Hilbert transforms, attribute analysis, bright and dim spots, seismic stratigraphy, high resolution seismics, VSP.

Principles and techniques of geophysical well-logging, SP, resistivity, induction, micro gamma ray, neutron, density, sonic, temperature, dip meter, caliper, nuclear magnetic, cement bond logging. Quantitative evaluation of formations from well logs; well hydraulics and application of geophysical methods for groundwater study; application of bore hole geophysics in ground water, mineral and oil exploration. Remote sensing techniques and application of remote sensing methods in geophysics.

IN - INSTRUMENTATION ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix Algebra, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Mean value theorems, Theorems of integral calculus, Evaluation of definite and improper integrals, Partial Derivatives, Maxima and minima, Multiple integrals, Fourier series. Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equation (linear and nonlinear), Higher order linear

differential equations with constant coefficients, Method of variation of parameters, Cauchy's and Euler's equations, Initial and boundary value problems, Partial Differential Equations and variable separable method.

Complex variables: Analytic functions, Cauchy's integral theorem and integral formula, Taylor's and Laurent' series, Residue theorem, solution integrals.

Probability and Statistics: Sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Discrete and continuous distributions, Poisson, Normal and Binomial distribution, Correlation and regression analysis.

Numerical Methods: Solutions of non-linear algebraic equations, single and multi-step methods for differential equations.

Transform Theory: Fourier transform, Laplace transform, Z-transform.

INSTRUMENTATION ENGINEERING

Measurement Basics and Metrology: Static and dynamic characteristics of measurement systems. Standards and calibration. Error and uncertainty analysis, statistical analysis of data, and curve fitting. Linear and angular measurements; Measurement of straightness, flatness, roundness and roughness.

Transducers, Mechanical Measurements and Industrial Instrumentation: Transducers - elastic, resistive, inductive, capacitive, thermo-electric, piezoelectric, photoelectric, electro-mechanical, electro-chemical, and ultrasonic. Measurement of displacement, velocity (linear and rotational), acceleration, shock, vibration, force, torque, power, strain, stress, pressure, flow, temperature, humidity, viscosity, and density. energy storing elements, suspension systems and dampers.

Analog Electronics: Characteristics of diodes, BJTs, JFETs and MOSFETs; Diode circuits; Amplifiers: single and multi-stage, feedback; Frequency response; Operational amplifiers - design, characteristic, linear and non-linear applications: difference amplifiers; instrumentation amplifiers; precision rectifiers, I-to-V converters, active filters, oscillators, comparators, signal generators, wave shaping circuits.

Digital Electronics: Combinational logic circuits, minimization of Boolean functions; IC families (TTL, MOS, CMOS), arithmetic circuits, multiplexer and decoders. Sequential circuits: flip-flops, counters, shift registers. Schmitt trigger, timers, and multivibrators. Analog switches, multiplexers, S/H circuits. Analog-to-digital and digital-to-analog converters. Basics of computer organization and architecture. 8-bit microprocessor (8085), applications, memory, I/O interfacing, and microcontrollers.

Signals and Systems: Vectors and matrices; Fourier series; Fourier transforms; Ordinary differential equations. Impulse and frequency responses of first and second order systems. Laplace transform and transfer function, convolution and correlation. Amplitude and frequency modulations and demodulations. Discrete time systems, difference equations, impulse and frequency responses; Z-transforms and transfer functions; IIR and FIR filters.

Electrical and Electronic Measurements: Measurement of R, L and C; bridges and potentiometers. Measurement of voltage, current, power, power factor, and energy; Instrument transformers; Q meter, waveform analyzers. Digital volt-meters and multi-meters. Time, phase and frequency measurements; Oscilloscope. Noise and interference in instrumentation.

Control Systems & Process Control: Principles of feedback; transfer function, signal flow graphs. Stability criteria, Bode plots, root-loci, Routh and Nyquist criteria. Compensation techniques; State space analysis. System components: mechanical, hydraulic, pneumatic, electrical and electronic; Servos and synchros; Stepper motors. On-off, cascade, P, PI, PID

and feed-forward controls. Controller tuning and general frequency response.

Analytical, Optical and Biomedical Instrumentation: Principles of spectrometry, UV, visible, IR mass spectrometry, X-ray methods; nuclear radiation measurements, gas, solid and semi conductor lasers and their characteristics, interferometers, basics of fibre optics, transducers in biomedical applications, cardiovascular system measurements, instrumentation for clinical laboratory.

MA - MATHEMATICS

Linear Algebra: Finite dimensional vector spaces. Linear transformations and their matrix representations, rank; systems of linear equations, eigenvalues and eigenvectors, minimal polynomial, Cayley-Hamilton theorem, diagonalisation, Hermitian, Skew-Hermitian and unitary matrices. Finite dimensional inner product spaces, self-adjoint and Normal linear operators, spectral theorem, Quadratic forms.

Complex Analysis: Analytic functions, conformal mappings, bilinear transformations, complex integration: Cauchy's integral theorem and formula, Liouville's theorem, maximum modulus principle, Taylor and Laurent's series, residue theorem and applications for evaluating real integrals.

Real Analysis: Sequences and series of functions, uniform convergence, power series, Fourier series, functions of several variables, maxima, minima, multiple integrals, line, surface and volume integrals, theorems of Green, Stokes and Gauss; metric spaces, completeness, Weierstrass approximation theorem, compactness. Lebesgue measure, measurable functions; Lebesgue integral, Fatou's lemma, dominated convergence theorem.

Ordinary Differential Equations: First order ordinary differential equations, existence and uniqueness theorems, systems of linear first order ordinary differential equations, linear ordinary differential equations of higher order with constant coefficients; linear second order ordinary differential equations with variable coefficients, method of Laplace transforms for solving ordinary differential equations, series solutions; Legendre and Bessel functions and their orthogonality, Sturm Liouville system, Greeen's functions.

Algebra: Normal subgroups and homomorphisms theorems, automorphisms. Group actions, sylow's theorems and their applications groups of order less than or equal to 20, Finite p-groups. Euclidean domains, Principal ideal domains and unique factorizations domains. Prime ideals and maximal ideals in commutative rings.

Functional Analysis: Banach spaces, Hahn-Banach theorems, open mapping and closed graph theorems, principle of uniform boundedness; Hilbert spaces, orthonormal sets, Riesz representation theorem, self-adjoint, unitary and normal linear operators on Hilbert Spaces.

Numerical Analysis: Numerical solution of algebraic and transcendental equations; bisection, secant method, Newton-Raphson method, fixed point iteration, interpolation: existence and error of polynomial interpolation, Lagrange, Newton, Hermite(osculatory)interpolations; numerical differentiation and integration, Trapezoidal and Simpson rules; Gaussian quadrature; (Gauss-Legendre and Gauss-Chebyshev), method of undetermined parameters, least square and orthonormal polynomial approximation; numerical solution of systems of linear equations: direct and iterative methods, (Jacobi Gauss-Seidel and SOR) with convergence; matrix eigenvalue problems: Jacobi and Given's methods, numerical solution of ordinary differential equations: initial value problems, Taylor series method, Runge-Kutta methods, predictor-corrector methods; convergence and stability.

Partial Differential Equations: Linear and quasilinear first order partial differential equations, method of characteristics; second order linear equations in two variables and their classification; Cauchy, Dirichlet and Neumann problems, Green's functions; solutions of Laplace, wave and diffusion equations in two variables Fourier series and transform methods of solutions of the above equations and applications to physical problems.

Mechanics: Forces in three dimensions, Poinsot central axis, virtual work, Lagrange's equations for holonomic systems, theory of small oscillations, Hamiltonian equations;

Topology: Basic concepts of topology, product topology, connectedness, compactness, countability and separation axioms, Urysohn's Lemma, Tietze extension theorem, metrization theorems, Tychonoff theorem on compactness of product spaces.

Probability and Statistics: Probability space, conditional probability, Bayes' theorem, independence, Random variables, joint and conditional distributions, standard probability distributions and their properties, expectation, conditional expectation, moments. Weak and strong law of large numbers, central limit theorem. Sampling distributions, UMVU estimators, sufficiency and consistency, maximum likelihood estimators. Testing of hypotheses, Neyman-Pearson tests, monotone likelihood ratio, likelihood ratio tests, standard parametric tests based on normal, X2 ,t, F-distributions. Linear regression and test for linearity of regression. Interval estimation.

Linear Programming: Linear programming problem and its formulation, convex sets their properties, graphical method, basic feasible solution, simplex method, big-M and two phase methods, infeasible and unbounded LPP's, alternate optima. Dual problem and duality theorems, dual simplex method and its application in post optimality analysis, interpretation of dual variables. Balanced and unbalanced transportation problems, unimodular property and u-v method for solving transportation problems. Hungarian method for solving assignment problems.

Calculus of Variations and Integral Equations: Variational problems with fixed boundaries; sufficient conditions for extremum, Linear integral equations of Fredholm and Volterra type, their iterative solutions. Fredholm alternative.

ME - MECHANICAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

APPLIED MECHANICS AND DESIGN

Engineering Mechanics: Equivalent force systems, free-body concepts, equations of

equilibrium, trusses and frames, virtual work and minimum potential energy. Kinematics and dynamics of particles and rigid bodies, impulse and momentum (linear and angular), energy methods, central force motion.

Strength of Materials: Stress and strain, stress-strain relationship and elastic constants, Mohr's circle for plane stress and plane strain, shear force and bending moment diagrams, bending and shear stresses, deflection of beams, torsion of circular shafts, thin and thick cylinders, Euler's theory of columns, strain energy methods, thermal stresses.

Theory of Machines: Displacement, velocity and acceleration, analysis of plane mechanisms, dynamic analysis of slider-crank mechanism, planar cams and followers, gear tooth profiles, kinematics of gears, governors and flywheels, balancing of reciprocating and rotating masses.

Vibrations: Free and forced vibration of single degree freedom systems, effect of damping, vibration isolation, resonance, critical speed of rotors.

Design of Machine Elements: Design for static and dynamic loading, failure theories, fatigue strength; design of bolted, riveted and welded joints; design of shafts and keys; design of spur gears, rolling and sliding contact bearings; brakes and clutches; belt, rope and chain drives.

FLUID MECHANICS AND THERMAL SCIENCES

Fluid Mechanics: Fluid properties, fluid statics, manometry, buoyancy; control-volume analysis of mass, momentum and energy; fluid acceleration; differential equations of continuity and momentum; Bernoulli's equation; viscous flow of incompressible fluids; boundary layer; elementary turbulent flow; flow through pipes, head losses in pipes, bends etc.

Heat-Transfer: Modes of heat transfer; one dimensional heat conduction, resistance concept, electrical analogy, unsteady heat conduction, fins; dimensionless parameters in free and forced convective heat transfer, various correlations for heat transfer in flow over flat plates and through pipes; thermal boundary layer; effect of turbulence; radiative heat transfer, black and grey surfaces, shape factors, network analysis; heat exchanger performance, LMTD and NTU methods.

Thermodynamics: Zeroth, First and Second laws of thermodynamics; thermodynamic system and processes; irreversibility and availability; behaviour of ideal and real gases, properties of pure substances, calculation of work and heat in ideal processes; analysis of thermodynamic cycles related to energy conversion; Carnot, Rankine, Otto, Diesel, Brayton and vapour compression cycles.

Power Plant Engineering: Steam generators; steam power cycles; steam turbines; impulse and reaction principles, velocity diagrams, pressure and velocity compounding; reheating and reheat factor; condensers and feed heaters.

I.C. Engines: Requirements and suitability of fuels in IC engines, fuel ratings, fuel-air mixture requirements; normal combustion in SI and CI engines; engine performance calculations.

Refrigeration and air-conditioning: Refrigerant compressors, expansion devices, condensers and evaporators; properties of moist air, psychrometric chart, basic psychometric processes.

Turbomachinery: Components of gas turbines; compression processes, centrifugal and axial flow compressors; axial flow turbines, elementary theory; hydraulic turbines; Euler-turbine equation; specific speed, Pelton-wheel, Francis and Kaplan turbines; centrifugal pumps.

MANUFACTURING AND INDUSTRIAL ENGINEERING

Engineering Materials: Structure and properties of engineering materials and their applications, heat treatment.

Metal Casting: Casting processes (expendable and non-expendable) -pattern, moulds and cores, heating and pouring, solidification and cooling, gating design, design considerations, defects.

Forming Processes: Stress-strain diagrams for ductile and brittle material, Plastic deformation and yield criteria, fundamentals of hot and cold working processes, Bulk metal forming processes (forging, rolling, extrusion, drawing), sheet metal working processes (punching, blanking, bending, deep drawing, coining, spinning, load estimation using homogeneous deformation methods, defects). processing of powder metals- atomization, compaction, sintering, secondary and finishing operations. forming and shaping of plastics- extrusion, injection moulding.

Joining Processes: Physics of welding, fusion and non-fusion welding processes, brazing and soldering, adhesive bonding, design considerations in welding, weld quality defects.

Machining and Machine Tool Operations: Mechanics of machining, single and multi-point cutting tools, tool geometry and materials, tool life and wear, cutting fluids, machinability, economics of machining, non-traditional machining processes.

Metrology and Inspection: Limits, fits and tolerances, linear and angular measurements, comparators, gauge design, interferometry, form and finish measurement, measurement of screw threads, alignment and testing methods.

Tool Engineering: Principles of work holding, design of jigs and fixtures.

Computer Integrated Manufacturing: Basic concepts of CAD, CAM and their integration tools.

Manufacturing Analysis: Part-print analysis, tolerance analysis in manufacturing and assembly, time and cost analysis.

Work-Study: Method study, work measurement, time study, work sampling, job evaluation, merit rating.

Production Planning and Control: Forecasting models, aggregate production planning, master scheduling, materials requirements planning.

Inventory Control: Deterministic and probabilistic models, safety stock inventory control systems.

Operations Research: Linear programming, simplex and duplex method, transportation, assignment, network flow models, simple queuing models, PERT and CPM

MN - MINING ENGINEERING

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace,

heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

MINING ENGINEERING

Mechanics: Equivalent force systems, equations of equilibrium, two dimensional frames and trusses, free body diagrams, friction forces, particle kinematics and dynamics.

Mine Development, Geomechanics and Strata Control: Drivages for underground mine development, drilling methods and machines, explosives, blasting devices and practices, shaft sinking. Physico-mechanical properties of rocks, rock mass classification, ground control instrumentation and stress measurement techniques, theories of rock failure, ground vibrations, stress distribution around mine openings, subsidence, design of supports in roadways and workings, stability of open pits, slopes.

Mining Methods and Machinery: Surface mining - layout, development, loading, transportation and mechanization, continuous surface mining systems. Underground coal mining - bord and pillar system, longwall mining, thick seam mining methods. Underground metal mining: different stoping methods, stope mechanization, ore handling systems, mine filling. Generation and transmission of mechanical, hydraulic, and pneumatic power. Materials handling - haulages, conveyors, ropeways, face and development machinery, hoisting systems, and pumps.

Ventilation, Underground Hazards and Surface Environment: Underground atmosphere, heat load sources and thermal environment, air cooling, mechanics of air flow distribution, natural and mechanical ventilation, mine fans and their usage, auxiliary ventilation. Subsurface hazards from fires, explosions, gases, dust, and inundation, rescue apparatus and practices, safety in mines, accident analysis, noise, mine lighting. Air and water pollution: causes, dispersion, quality standards, and control.

Surveying, Mine Planning and Systems Engineering: Fundamentals of engineering surveying, Levels and levelling, Theodolite, tacheometry, triangulation, contouring, errors and adjustments, correlation, underground surveying, curves, photogrammetry, field astronomy, GPS fundamentals. Principles of planning - Sampling methods and practices, reserve estimation techniques, basics of geostatistics, optimization of facility location, cash flow concepts and mine valuation, open pit design. Work study, concepts of reliability, reliability of series and parallel systems. Linear programming, transportation and assignment problems, queueing, network analysis, inventory control.

MT - METALLURGICAL ENGINEERING

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace,

heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

METALLURGICAL ENGINEERING

Thermodynamics and Rate Processes: Laws of thermodynamics, activity, equilibrium constant, applications to metallurgical systems, solutions, phase equilibria, basic kinetic laws, order of reactions, rate constants and rate limiting steps principles of electro chemistry, aqueous, corrosion and protection of metals, oxidation and high temperature corrosion - characterization and control; momentum transfer - concepts of viscosity, shell balances, Bernoulli's equation; heat transfer - conduction, convection and heat transfer coefficient relations, radiation, mass transfer - diffusion and Fick's laws.

Extractive Metallurgy: Flotation, gravity and other methods of mineral processing; agglomeration, pyro-hydro-and electro-metallurgical processes; material and energy balances; principles and processes for the extraction of non-ferrous metals - aluminium, copper, zinc, lead, magnesium, nickel, titanium and other rare metals; iron and steel making - principles, blast furnace, direct reduction processes, primary and secondary steel making, deoxidation and inclusion in steel; ingot and continuous casting; stainless steel making, design of furnaces; fuels and refractories.

Physical Metallurgy: Crystal structure and bonding characteristics of metals, alloys, ceramics and polymers; solid solutions; solidification; phase transformation and binary phase diagrams; principles of heat treatment of steels, aluminum alloys and cast irons; recovery, recrystallization and grain growth; industrially important ferrous and non-ferrous alloys; elements of X-ray and electron diffraction; principles of scanning and transmission electron microscopy; elements of ceramics, composites and electronic materials; electronic basis of thermal, optical, electrical and magnetic properties of materials.

Mechanical Metallurgy: Elements of elasticity and plasticity; defects in crystals; elements of dislocation theory - types of dislocations, slip and twinning, stress fields of dislocations, dislocation interactions and reactions, methods of seeing dislocations; strengthening mechanisms; tensile, fatigue and creep behaviour; superplasticity; fracture - Griffith theory, ductile to brittle transition, fracture toughness; failure analysis; mechanical testing - tension, compression, torsion, hardness, impact, creep, fatigue, fracture toughness and formability tests.

Manufacturing Processes: Metal casting - patterns, moulds, melting, gating, feeding and casting processes, defects and castings, hot and cold working of metals; Metal forming - fundamentals of metal forming, rolling wire drawing, extrusion, forming, sheet metal forming processes, defects in forming; Metal joining - soldering, brazing and welding, common welding processes, welding metallurgy, problems associated with welding of steels and aluminium alloys, defects in welding, powder metallurgy; NDT methods - ultrasonic, radiography, eddy current, acoustic emission and magnetic.

PH - PHYSICS

Mathematical Physics: Linear vector space, matrices; vector calculus; linear differential equations; elements of complex analysis; Laplace transforms, Fourier analysis, elementary ideas about tensors.

Classical Mechanics: Conservation laws; central forces; collisions and scattering in laboratory and centre of mass reference frames; mechanics of system of particles; rigid body dynamics; moment of inertia tensor; noninertial frames and pseudo forces; variational principle;

Lagrange's and Hamilton's formalisms; equation of motion, cyclic coordinates, Poisson bracket; periodic motion, small oscillations, normal modes; wave equation and wave propagation; special theory of relativity - Lorentz transformations, relativistic kinematics, mass-energy equivalence.

Electromagnetic Theory: Laplace and Poisson equations; conductors and dielectrics; boundary value problems; Ampere's and Biot-Savart's laws; Faraday's law; Maxwell's equations; scalar and vector potentials; Coulomb and Lorentz gauges; boundary conditions at interfaces; electromagnetic waves; interference, diffraction and polarization; radiation from moving charges.

Quantum Mechanics: Physical basis of quantum mechanics; uncertainty principle; Schrodinger equation; one and three dimensional potential problems; Particle in a box, harmonic oscillator, hydrogen atom; linear vectors and operators in Hilbert space; angular momentum and spin; addition of angular momentum; time independent perturbation theory; elementary scattering theory.

Atomic and Molecular Physics: Spectra of one-and many-electron atoms; LS and jj coupling; hyperfine structure; Zeeman and Stark effects; electric dipole transitions and selection rules; X-ray spectra; rotational and vibrational spectra of diatomic molecules; electronic transition in diatomic molecules, Franck-Condon principle; Raman effect; NMR and ESR; lasers.

Thermodynamics and Statistical Physics: Laws of thermodynamics; macrostates, phase space; probability ensembles; partition function, free energy, calculation of thermodynamic quantities; classical and quantum statistics; degenerate Fermi gas; black body radiation and Planck's distribution law; Bose-Einstein condensation; first and second order phase transitions, critical point.

Solid State Physics: Elements of crystallography; diffraction methods for structure determination; bonding in solids; elastic properties of solids; defects in crystals; lattice vibrations and thermal properties of solids; free electron theory; band theory of solids; metals, semiconductors and insulators; transport properties; optical, dielectric and magnetic properties of solids; elements of superconductivity.

Nuclear and Particle Physics: Rutheford scattering; basic properties of nuclei; radioactive decay; nuclear forces; two nucleon problem; nuclear reactions; conservation laws; fission and fusion; nuclear models; particle accelerators, detectors; elementary particles; photons, baryons, mesons and leptons; Quark model.

Electronics: Network analysis; semiconductor devices; bipolar transistors; FETs; power supplies, amplifier, oscillators; operational amplifiers; elements of digital electronics; logic circuits.

PI - PRODUCTION AND INDUSTRIAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

GENERAL ENGINEERING:

Engineering Materials: Structure and properties of engineering materials and their applications; effect of strain, strain rate and temperature on mechanical properties of metals and alloys; heat treatment of metals and alloys.

Applied Mechanics: Engineering mechanics - equivalent force systems, free body concepts, equations of equilibrium, virtual work and minimum potential energy; strength of materials- stress, strain and their relationship, Mohr's circle, deflection of beams, bending and shear stress, Euler's theory of columns.

Theory of Machines and Design: Analysis of planar mechanisms, plane cams and followers; governers and fly wheels; design of elements-failure theories; design of bolted, riveted and welded joints; design of shafts, keys, belt drives, brakes and clutches.

Thermal Engineering: Fluid machines - fluid statics, Bernoulli's equation, flow through pipes, equations of continuity and momentum; Thermodynamics - zeroth, First and Second laws of thermodynamics, thermodynamic system and processes, calculation of work and heat for systems and control volumes; Heat transfer - fundamentals of conduction, convection and radiation.

PRODUCTION ENGINEERING

Metal Casting: Casting processes; patterns-materials; allowances; moulds and cores - materials, making and testing; melting and founding of cast iron, steels and nonferrous metals and alloys; solidification; design of casting, gating and risering; casting defects and inspection.

Metal working: Stress-strain in elastic and plastic deformation; deformation mechanisms; hot and cold working-forging, rolling, extrusion, wire and tube drawing; sheet metal working; analysis of rolling, forging, extrusion and wire /rod drawing; metal working defects, high energy rate forming processes-explosive, magnetic, electro and electrohydraulic.

Metal Joining Processes: Welding processes - gas shielded metal arc, TIG, MIG, submerged arc, electroslag, thermit, resistance, pressure and forge welding; thermal cutting; other joining processes - soldering, brazing, braze welding; welding codes, welding symbols, design of welded joints, defects and inspection; introduction to modern welding processes - friction, ultrasonic, explosive, electron beam, laser and plasma.

Machining and Machine Tool Operations: Machining processes-turning, drilling, boring, milling, shaping, planing, sawing, gear cutting, thread production, broaching, grinding, lapping, honing super finishing; mechanics of cutting- Merchant's analysis, geometry of cutting tools, cutting forces, power requirements; selection of process parameters; tool materials, tool wear and tool life, cutting fluids, machinability; nontraditional machining processes and hybrid processes- EDM, CHM, ECM, USM, LBM, EBM, AJM, PAM AND WJM; economics of machining.

Metrology and Inspection: Limits and fits, linear and angular measurements by mechanical and optical methods, comparators; design of limit gauges; interferometry; measurement of straightness, flatness, roundness, squareness and symmetry; surface finish measurement; inspection of screw threads and gears; alignment testing.

Powder Metallurgy and Processing of Plastics: Production of powders, compaction, sintering; Polymers and composites; injection, compression and blow molding, extrusion, calendaring and thermoforming; molding of composites.

Tool Engineering: Work-holding-location and clamping; principles and methods; design of jigs and fixtures; design of press working tools, forging dies.

Manufacturing Analysis: Sources of errors in manufacturing; process capability; part-print analysis; tolerance analysis in manufacturing and assembly; process planning; parameter selection and comparison of production alternatives; time and cost analysis; Issues in choosing manufacturing technologies and strategies.

Computer Integrated Manufacturing: Basic concepts of CAD, CAM, CAPP, group technology, NC, CNC, DNC, FMS, Robotics and CIM.

INDUSTRIAL ENGINEERING

Product Design and Development: Principles of good product design, component and tolerance design; efficiency, quality and cost considerations; product life cycle; standardization, simplification, diversification, value analysis, concurrent engineering.

Engineering Economy and Costing: Financial statements; elementary cost accounting, methods of depreciation; break-even analysis, techniques for evaluation of capital investments.

Work System Design: Taylor's scientific management, Gilbreths's contributions; productivity concepts and measurements; method study, micro-motion study, principles of motion economy; human factors engineering, ergonomics; work measurement - time study, PMTS, work sampling; job evaluation, merit rating, wage administration, incentive systems; business process reengineering.

Logistics and Facility Design: Facility location factors, evaluation of alternatives, types of plant layout, evaluation; computer aided layout; assembly line balancing; material handling systems; supply chain management.

Production Planning and Inventory Control: Inventory Function costs, classifications - deterministic and probabilistic models; quantity discount; safety stock; inventory control system; Forecasting techniques - causal and time series models, moving average, exponential smoothing; trend and seasonality; aggregate production planning; master scheduling; bill of materials and material requirement planning; order control and flow control, routing, scheduling and priority dispatching; JIT; Kanban PULL systems; bottleneck scheduling and theory of constraints.

Operation Research: Linear programming - problem formulation, simplex method, duality and sensitivity analysis; transportation; assignment; network flow models, constrained optimization and Lagrange multipliers; simple queuing models; dynamic programming; simulation; PERT and CPM, time-cost trade-off, resource leveling.

Quality Control: Taguchi method; design of experiments; quality costs, statistical quality assurance, process control charts, acceptance sampling, zero defects; quality circles, total quality management.

Reliability and Maintenance: Reliability, availability and maintainability; probabilistic failure and repair times; system reliability; preventive maintenance and replacement, TPM.

Management Information System: Value of information; information storage and retrieval system - database and data structures; interactive systems; knowledge based systems.

Intellectual Property System: Definition of intellectual property, importance of IPR; TRIPS, and its implications, WIPO and Global IP structure, and IPS in India; patent, copyright, industrial design and trademark; meanings, rules and procedures, terms, infringements and remedies.

PY - PHARMACEUTICAL SCIENCES

Natural Products: Pharmacognosy & Phytochemistry - Chemistry, tests, isolation, characterization and estimation of phytopharmaceuticals belonging to the group of Alkaloids, Glycosides, Terpenoids, Steroids, Bioflavanoids, Purines, Guggul lipids. Pharmacognosy of crude drugs which contain the above constituents. Standardisation of raw materials and herbal products. WHO guide lines. Quantitative microscopy including modern techniques used for evaluation. Biotechnological principles and techniques for plant development Tissue culture.

Pharmacology: General pharmacological principles including Toxicology. Drug interaction. Pharmacology of drugs acting on Central nervous system, Cardiovascular system, Autonomic nervous system, Gastro intestinal system and Respiratory system. Pharmacology of Autocoids, Hormones, Chemotherapeutic agents including anticancer drugs. Bioassays. Immuno Pharmacology.

Medicinal Chemistry: Structure, nomenclature, classification, synthesis, SAR and metabolism of the following category of drugs which are official in Indian Pharmacopoeia and British Pharmacopoeia Hypnotics and Sedatives, Analgesics, NSAIDS, Neuroleptics, Antidepressants, Anxiolytics, Anticonvulsants, Antihistaminics, Local anaesthetics, Cardio Vascular drugs - Antianginal agents Vasodilators, Adrenergic & cholinergic drugs, Cardiotonic agents, Diuretics, Antihypertensive drugs, Hypoglycemic agents, Antilipedmic agents, Coagulants, Anticoagulants, Antiplatelet agents. Chemotherapeutic agents - Antibiotics, Antibacterials, Sulphadrugs. Antiproliozoal drugs, Antiviral, Antitubercular, Antimalarial, Anticancer, Antiamoebic drugs. Diagnostic agents. Preparation and storage and uses of official Radiopharmaceuticals. Vitamins and Hormones.

Pharmaceutics: Development, manufacturing standards, labeling, packing as per the pharmacopoeal requirements, Storage of different dosage forms and new drug delivery systems. Biopharmaceutics and Pharmacokinetics and their importance in formulation. Formulation and preparation of cosmetics - lipstick, shampoo, creams, nail preparations and dentifrices. Pharmaceutical calculations.

Pharmaceutical Jurisprudence: Legal aspects of manufacture, storage, sale of drugs. D and C act and rules. Pharmacy act.

Pharmaceutical Analysis: Principles, instrumentation and applications of the following. Absorption spectroscopy (UV, visible & IR), Fluorimetry, Flame photometry, Potentiometry, Conductometry and Plarography. Pharmacopoeial assays. Principles of NMR, ESR, Mass spectroscopy, X-ray diffraction analysis and different chromatographic methods.

Biochemistry and Clinical Pharmacy: Biochemical role of hormones, Vitamins, Enzymes, Nucleic acids. Bioenergetics. General principles of immunology. Immunological techniques. Adverse drug interaction.

Microbiology: Principles and methods of microbiological assays of the Pharmacopoeia. Methods of preparation of official sera and vaccines. Serological and diagnostic tests. Applications of microorganisms in Bio Conversions and in Pharmaceutical industry.

TF - TEXTILE ENGINEERING AND FIBRE SCIENCE

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

TEXTILE ENGINEERING & FIBRE SCIENCE

Textile Fibres: Classification of textile fibres according to their nature and origin; general characteristics of textile fibres-their chemical and physical structures and their properties; essential characteristics of fibre forming polymers; uses of natural and man-made fibres; physical and chemical methods of fibre and blend identification and blend analysis.

Melt Spinning processes with special reference to polyamide and polyester fibres; wet and dry spinning of viscose and acrylic fibres; post spinning operations-drawing, heat setting, texturing- false twist and air-jet, tow-to-top conversion. Methods of investigating fibre structure e.g. X-ray diffraction, birefringence, optical and electron microscopy, I.R. absorption, thermal methods; structure and morphology and principal natural and man-made fibres, mechanical properties of fibres, moisture sorption in fibres; fibre structure and property correlation.

Textile Testing: Sampling techniques, sample size and sampling errors; measurement of fibre length, fineness, crimp, strength and reflectance; measurement of cotton fibre maturity ad trash content; HVI and AFIS for fibre testing. Measurement of yarn count, twist and hairiness; tensile testing of fibres, yarn and fabrics; evenness testing of slivers, rovings and yarns; testing equipment for measurement test methods of fabric properties like thickness, compressibility, air permeability, drape, crease recovery, tear strength bursting strength and abrasion resistance. Correlation analysis, significance tests and analysis of variance; frequency distributions and control charts.

Yarn Manufacture and Yarn Structure: Modern methods of opening, cleaning and blending of fibrous materials; the technology of carding with particular reference to modern developments; causes of irregularity introduced by drafting, the development of modern drafting systems; principles and techniques of preparing material for combing; recent development in combers; functions and synchronization of various mechanisms concerned with roving production; forces acting on yarn and traveller, ring and traveller designs; causes of end breakages; properties of doubles yarns; new methods of yarn production such as rotor spinning, air jet spinning and friction spinning.

Yarn diameter; specific volume, packing coefficient; twist-strength relationship; fibre orientation in yarn; fibre migration.

Fabric Manufacture and Fabric Structure: Principles of cheese and cone winding processes and machines; random and precision winding; package faults and their remedies; yarn clearers and tensioners; different systems of yarn splicing; features of modern cone winding machines; different types of warping creels; features of modern beam and sectional warping machines; different sizing systems, sizing of spun and filament yarns, modern sizing machines; principles of pirn winding processes and machines; primary and secondary motions of loom, effect of their settings and timings on fabric formation, fabric appearance and weaving performance;

dobby and jacquard shedding; mechanics of weft insertion with shuttle; warp and weft stop motions, warp protection, weft replenishment; functional principles of weft insertion systems of shuttleless weaving machines, principles of multiphase and circular looms. Principles of weft and warp knitting; basic weft and warp knitted structures; classification, production and areas of application of nonwoven fabrics.

Basic woven fabric constructions and their derivatives; crepe, cord, terry, gauze, lino and double cloth constructions.

Peirce's equations for fabric geometry; thickness, cover and maximum sett of woven fabrics

Textile Chemical Processing: Preparatory processes for natural-and and their blends; mercerization of cotton; machines for yarn and fabric mercerization.

Dyeing and printing of natural- and synthetic- fibre fabrics and their blends with different dye classes; dyeing and printing machines; styles of printing; fastness properties of dyed and printed textile materials.

Finishing of textile materials, wash and wear, durable press, soil release, water repellent, flame retardant and antistatic finishes; shrink-resistance finish for wool; heat setting of synthetic-fibre fabrics, finishing machines; energy efficient processes; pollution control.

XE - ENGINERING SCIENCES

The syllabi of the sections of this paper are as follows:

SECTION A. ENGINEERING MATHEMATICS (Compulsory)

Linear Algebra : Determinates, algebra of matrices, rank, inverse, system of linear equations, symmetric, skew-symmetric and orthogonal matrices. Hermitian, skew-hermitian and unitary matrices. eigenvalues and eigenvectors, diagonalisation of matrices, Cayley-Hamiltonian, quadratic forms.

Calculus : Functions of single variables, limit, continuity and differentiability, Mean value theorems, Intermediate forms and L'Hospital rule, Maxima and minima, Taylor's series, Fundamental and mean value-theorems of integral calculus. Evaluation of definite and improper integrals, Beta and Gamma functions, Functions of two variables, limit, continuity, partial derivatives, Euler's theorem for homogeneous functions, total derivatives, maxima and minima, Lagrange method of multipliers, double and triple integrals and their applications, sequence and series, tests for convergence, power series, Fourier Series, Fourier integrals.

Complex variable: Analytic functions, Cauchy's integral theorem and integral formula without proof. Taylor's and Laurent' series, Residue theorem (without proof) with application to the evaluation of real integarls.

Vector Calculus: Gradient, divergence and curl, vector identities, directional derivatives, line, surface and volume integrals, Stokes, Gauss and Green's theorems (without proofs) with applications.

Ordinary Differential Equations: First order equation (linear and nonlinear), higher order linear differential equations with constant coefficients, method of variation of paramaters, Cauchy's and Euler's equations, initial and boundary value problems, power series solutions, Legendre polynomials and Bessel's functions of the first kind.

Partial Differential Equations: Variables separable method, solutions of one dimensional heat, wave and Laplace equations.

Probability and Statistics: Definitions of probability and simple theorems, conditional probability, mean, mode and standard deviation, random variables, discrete and continuous

distributions, Poisson, normal and Binomial distribution, correlation and regression

Numerical Methods: L-U decomposition for systems of linear equations,Newton-Raphson method, numerical integration(trapezoidal and Simpson's rule), numerical methods for first order differential equation (Euler method)

SECTION B. COMPUTATIONAL SCIENCE

Numerical Methods: Truncation errors, round off errors and their propagation; Interpolation; Lagrange, Newton's forward, backward and divided difference formulas, least square curve fitting, solution of non-linear equations of one variables using bisection, false position, secant and Newton Raphson methods; Rate of convergence of these methods, general iterative methods. Simple and multiple roots of polynomials. Solutions of system of linear algebraic equations using Gauss elimination methods, Jacobi and Gauss-Seidel iterative methods and their rate of convergence; ill conditioned and well conditioned system. eigen values and eigen vectors using power methods. Numerical integration using trapezoidal, Simpson's rule and other quadrature formulas. Numerical Differentiation. Solution of boundary value problems. Solution of initial value problems of ordinary differential equations using Euler's method, predictor corrector and Runge Kutta method.

Programming : Elementary concepts and terminology of a computer system and system software, Fortran77 and C programming.

Fortran : Program organization, arithmetic statements, transfer of control, Do loops, subscripted variables, functions and subroutines.

C language : Basic data types and declarations, flow of control- iterative statement, conditional statement, unconditional branching, arrays, functions and procedures.

SECTION C. ELECTRICAL SCIENCES

Electric Circuits: Ideal voltage and current sources; RLC circuits, steady state and transient analysis of DC circuits, network theorems; alternating currents and voltages, single-phase AC circuits, resonance; three-phase circuits.

Magnetic circuits: Mmf and flux, and their relationship with voltage and current; transformer, equivalent circuit of a practical transformer, three-phase transformer connections.

Electrical machines: Principle of operation, characteristics, efficiency and regulation of DC and synchronous machines; equivalent circuit and performance of three-phase and single-phase induction motors.

Electronic Circuits: Characteristics of p-n junction diodes, zener diodes, bipolar junction transistors (BJT) and junction field effect transistors (JFET); MOSFET's structure, characteristics, and operations; rectifiers, filters, and regulated power supplies; biasing circuits, different configurations of transistor amplifiers, class A, B and C of power amplifiers; linear applications of operational amplifiers; oscillators; tuned and phase shift types.

Digital circuits: Number systems, Boolean algebra; logic gates, combinational circuits, flip-flops (RS, JK, D and T) counters.

Measuring instruments: Moving coil, moving iron, and dynamometer type instruments; shunts, instrument transformers, cathode ray oscilloscopes; D/A and A/D converters.

SECTION D. FLUID MECHANICS

Fluid Properties: Relation between stress and strain rate for Newtonian fluids

Hydrostatics, buoyancy, manometry

Concept of local and convective accelerations; control volume analysis for mass, momentum and energy conservation.

Differential equations of continuity and momentum (Euler's equation of motion); concept of fluid rotation, stream function, potential function; Bernoulli's equation and its applications.

Qualitative ideas of boundary layers and its separation; streamlined and bluff bodies; drag and lift forces.

Fully-developed pipe flow; laminar and turbulent flows; friction factor; Darcy Weisbach relation; Moody's friction chart; losses in pipe fittings; flow measurements using venturimeter and orifice plates.

Dimensional analysis; similitude and concept of dynamic similarity; importance of dimensionless numbers in model studies.

SECTION E. MATERIALS SCIENCE

Atomic structure and bonding in materials: metals, ceramics and polymers.

Structure of materials: Crystal systems, unit cells and space lattice; determination of structures of simple crystals by X-ray diffraction; Miller indices for planes and directions. Packing geometry in metallic, ionic and covalent solids.

Concept of amorphous, single and polycrystalline structures and their effects on properties of materials.

Imperfections in crystalline solids and their role in influencing various properties.

Fick´s laws of diffusion and applications of diffusion in sintering, doping of semiconductors and surface hardening of metals.

Alloys: solid solution and solubility limit. Binary phase diagram, intermediate phases and intermetallic compounds; iron-iron carbide phase diagram. Phase transformation in steels. Cold and hot working of metals, recovery, recrystallization and grain growth.

Properties and applications of ferrous and nonferrous alloys.

Structure, properties, processing and applications of traditional and advanced ceramics.

Polymers: classification, polymerization, structure and properties, additives for polymer products, processing and application.

Composites: properties and application of various composites.

Corrosion and environmental degradation of materials (metals, ceramics and polymers).

Mechanical properties of materials: Stress-strain diagrams of metallic, ceramic and polymeric materials, modulus of elasticity, yield strength, plastic deformation and toughness, tensile strength and elongation at break; viscoelasticity, hardness, impact strength. ductile and brittle fracture. creep and fatigue properties of materials.

Heat capacity, thermal conductivity, thermal expansion of materials.

Concept of energy band diagram for materials; conductors, semiconductors and insulators in terms of energy bands. Electrical conductivity, effect of temperature on conductivity in materials, intrinsic and extrinsic semiconductors, dielectric properties of materials.

Refraction, reflection, absorption and transmission of electromagnetic radiation in solids.

Origin of magnetism in metallic and ceramic materials, paramagnetism, diamagnetism, antiferromagnetism, ferromagnetism, ferrimagnetism in materials and magnetic hysteresis.

Advanced materials: Smart materials exhibiting ferroelectric, piezoelectric, optoelectronic, semiconducting behaviour; lasers and optical fibers; photoconductivity and superconductivity in materials.

SECTION F. SOLID MECHANICS

Equivalent force systems; free-body diagrams; equilibrium equations; analysis of determinate and indeterminate trusses and frames; friction.

Simple relative motion of particles; force as function of position, time and speed; force acting on a body in motion; laws of motion; law of conservation of energy; law of conservation of momentum

Stresses and strains; principal stresses and strains; Mohr's circle; generalized Hooke's Law; equilibrium equations; compatibility conditions; yield criteria.

Axial, shear and bending moment diagrams; axial, shear and bending stresses; deflection (for symmetric bending); torsion in circular shafts; thin cylinders; energy methods (Castigliano's Theorems); Euler buckling.

SECTION G. THERMODYNAMICS

Basic Concepts: Continuum, macroscopic approach, thermodynamic system (closed and open or control volume); thermodynamic properties and equilibrium; state of a system, state diagram, path and process; different modes of work; Zeroth law of thermodynamics; concept of temperature; heat.

First Law of Thermodynamics: Energy, enthalpy, specific heats, first law applied to systems and control volumes, steady and unsteady flow analysis.

Second Law of Thermodynamics: Kelvin-Planck and Clausius statements, reversible and irreversible processes, Carnot theorems, thermodynamic temperature scale, Clausius inequality and concept of entropy, principle of increase of entropy; availability and irreversibility.

Properties of Pure Substances: Thermodynamic properties of pure substances in solid, liquid and vapour phases, P-V-T behaviour of simple compressible substances, phase rule, thermodynamic property tables and charts, ideal and real gases, equations of state, compressibility chart.

Thermodynamic Relations: T-ds relations, Maxwell equations, Joule-Thomson coefficient, coefficient of volume expansion, adiabatic and isothermal compressibilities, Clapeyron equation.

Ideal Gas Mixtures: Dalton's and Amagat's laws, calculations of properties, air-water vapour mixtures.

XL - LIFE SCIENCES

The syllabi of the Sections of this paper are as follows:

SECTION H. CHEMISTRY (Compulsory)

Atomic structure and periodicity: Quantum chemistry; Planck's quantum theory, wave particle

duality, uncertainty principle, quantum mechanical model of hydrogen atom; electronic configuration of atoms; periodic table and periodic properties; ionization energy, election affinity, electronegativity, atomic size.

Structure and bonding: Ionic and covalent bonding M.O. and V.B. approaches for diatomic molecules, VSEPR theory and shape of molecules, hybridisation, resonance, dipole moment, structure parameters such as bond length, bond angle and bond energy, hydrogen bonding, van der Waals interactions. Ionic solids; ionic radii, lattice energy (Born-Haber Cycle).

s.p. and d Block Elements: Oxides, halides and hydrides of alkali and alkaline earth metals, B, Al, S, N, P and S, silicones, general characteristics of 3d elements, coordination complexes: valence bond and crystal field theory, color, geometry and magnetic properties.

Chemical Equilibria: Colligative properties of solutions, ionic equilibria in solution, solubility product, common ion effect, hydrolysis of salts, pH, buffer and their applications in chemical analysis.

Electrochemistry: Conductance, Kohlrausch law, Half Cell potentials, emf, Nernst equation, galvanic cells, thermodynamic aspects and their applications.

Reaction Kinetics: Rate constant, order of reaction, molecularity, activation energy, zero, first and second order kinetics, equilibrium constants (Kc, Kp and Kx) for homogeneous reactions, catalysis and elementary enzyme reactions.

Thermodynamics: First law, reversible and irreversible processes, internal energy, enthalpy, Kirchoff's equation, heat of reaction, Hess law, heat of formation, Second law, entropy, free energy, and work function. Gibbs-Helmholtz equation, Clausius-Clapeyron equation, free energy change and equilibrium constant, Troutons rule, Third law of thermodynamics.

Mechanistic Basis of Organic Reactions: Elementary treatment of SN1, SN2, E1 and E2 reactions, Hoffmann and Saytzeff rules, Addition reactions, Markonikoff rule and Kharash effect, Diels-Alder reaction, aromatic electrophilic substitution, orientation effect as exemplified by various functional groups.

Structure-Reactivity Correlations: Acids and bases, electronic and steric effects, optical and geometrical isomerism, tautomerism, concept of aromaticity

SECTION I. BIOCHEMISTRY

Organization of life. Importance of water. Cell structure and organelles. Structure and function of biomolecules: Carbohydrates, Lipids, Proteins and Nucleic acids. Biochemical separation techniques. Spectroscopic methods; UV-visible and fluorescence. Protein structure, folding and function: Myoglobin, Hemoglobin, Lysozyme, ribonuclease A, Carboxypeptidase and Chymotrypsin. Enzyme kinetics and regulation, Coenzymes.

Metabolism and bioenergitics. Generation and utilization of ATP. Photosynthesis. Major metabolic pathways and their regulation. Biological membranes. Transport across membranes. Signal transduction; hormones and neurotransmitters.

DNA replication, transcription and translation. Biochemical regulation of gene expression. Recombinant DNA technology and applications. Genomics and Proteomics.

The immune system. Active and passive immunity. Complement system. Antobody structure, function and diversity. Cells of the immune system: T, B and macrophages. T and B cell activation. Major histocompatibilty complex. T cell receptor. Immunological techniques: Immunodiffusion, immunoelectrophoresis, RIA and ELISA.

SECTION J. BIOTECHNOLOGY

Recombinant DNA technology for the production of therapeutic proteins. Micro array technology. Heterologous protein expression systems in bacteria, yeast etc.

Architecture of plant genome; plant tissue culture techniques; methods of gene transfer into plant cells; manipulation of phenotypic traits in plants; plant cell fermentations and production of secondary metabolites using suspension/ immobilized cell culture; methods for plant micro propagation; crop improvement and development of transgenic plants. Expression of animal proteins in plants.

Animal cell metabolism and regulation; cell cycle; primary cell culture; nutritional requirements for animal cell culture; techniques for the mass culture of animal cell lines; production of vaccines; growth hormones and interferons using animal cell culture; cytokines-production and therapeutic uses; hybridoma technology; vectors for gene transfer and expression in animal cells. Transgenic animals and molecular pharming.

Microbial production of industrial enzymes; methods for immobilization of enzymes; kinetics of soluble and immobilized enzymes; application of soluble and immobilized enzymes; enzyme-based sensors.

Microbial growth kinetics; batch, fed batch and continuous culture of microbial cells; media for industrial fermentations; sterilization of air and media; design features and operation of stirred tank, air-lift and fluidized bed reactors; aeration and agitation in aerobic fermentations; recovery and purification of fermentation products- filtration, centrifugation, cell disintegration, solvent extraction and chromatographic separations; industrial fermentations for the production of ethanol, citric acid, lysine, penicillin and other biomolecules; simple calculations based on material and energy balance of fermentation processes; application of microbes in the management of domestic and industrial wastes.

SECTION K. BOTANY

Anatomy: Roots, stem and leaves of land plants, meristems, vascular system, their ontogeny, structure and functions. Plant cell structure, organisation, organelles, cytoskeleton, cell wall and membranes.

Development: Cell cycle, cell division, senescence, hormonal regulation of growth; life cycle of an angiosperm, pollination, fertilization, embryogenesis, seed formation, seed storage proteins, seed dormancy and germination. Concept of cellular totipotency, organogenesis and somatic embryogenesis, somaclonal variation, embryo culture, in vitro fertilization.

Physiology and Biochemistry: Plant water relations, transport of minerals and solutes, N2 metabolism, proteins and nucleic acid, respiration, photophysiology, photosynthesis, photorespiration; biosynthesis, mechanism of action and physiological effects of plant growth regulators.

Genetics: Principles of Mendelian inheritance, linkage, recombination and genetic mapping; extrachromosomal inheritance; eukaryotic genome organization (chromatin structure) and regulation of gene expression, gene mutation, chromosome aberrations (numerical and structural), transposons.

Plant Breeding: Principles, methods - selection, hybridization, heterosis; male sterility, self and inter-specific incompatibility; haploidy; somatic cell hybridization; molecular marker-assisted selection; gene transfer methods viz. direct and vector-mediated, transgenic plants and their applications in agriculture.

Economic Botany: Economically important plants - cereals, pulses, plants yielding fiber, timber, sugar, beverages, oils, rubber, dyes, gums, drugs and narcotics - a general account.

Systematics: Systems of classification (non-phylogenetic vs. phylogenetic - outline), plant groups, molecular systematics.

Plant Pathology: Nature and classification of plant diseases, diseases of important crops caused by fungi, bacteria and viruses, and their control measures, mechanism(s) of pathogenesis and resistance, molecular detection of pathogens; plant-microbe beneficial interactions.

Ecology and Plant Geography: Ecosystems - types, dynamics, degradation, ecological succession; food chains; vegetation types of the world; pollution and global warming; speciation and extinction, conservation strategies, cryopreservation.

SECTION L. MICROBIOLOGY

Historical perspective - Discovery of the microbial world; Controversy over spontaneous generation; Role of microorganisms in transformation of organic matter and in the causation of diseases.

Methods in microbiology - Pure culture techniques; Theory and practice of sterilization; Principles of microbial nutrition; Construction of culture media; Enrichment culture techniques for isolation of chemoautotrophs, chemoheterotrophs and photosynthetic microorganisms.

Microbial evolution, systematics and taxonomy - Evolution of earth and earliest life forms; Primitive organisms and their metabolic strategies; New approaches to bacterial taxonomic classification including ribotyping; Nomenclature.

Microbial diversity - Bacteria, archea and their broad classification; Eukaryotic microbes, yeast, fungi, slime mold and protozoa; Viruses and their classification.

Microbial growth -The definition of growth, mathematical expression of growth, growth curve, measurement of growth and growth yields; Synchronous growth; Continuous culture.

Nutrition and metabolism - Overview of metabolism; Microbial nutrition; Energy classes of microorganisms; Culture media; Energetics, modes of ATP generation; ATP generation by heterotrophs; Fermentation; Glycolysis; Respiration; The citric acid cycle; Electron transport systems; Alternate modes of energy generation; Pathways (anabolism) in the biosynthesis of amino acids, purines, pyrimidines and fatty acids.

Metabolic diversity among microorganisms - Photosynthesis in microorganisms; Role of chlorophylls, carotenoids and phycobilins; Calvin cycle; Chemolithotrophy; Hydrogen- iron- nitrite-oxidizing bacteria; Nitrate and sulfate reduction; Methanogenesis and acetogenesis.

Prokaryotic cells: structure-function - Cells walls of eubacteria (peptidoglycan) and related molecules; Outer-membrane of gram-negative bacteria; Cell wall and cell membrane synthesis; Flagella and motility; Cell inclusions like endospores, gas vesicles.

Microbial diseases and host parasite relationships - Normal microflora of skin; Oral cavity; Gastrointestinal tract; Entry of pathogens into the host; Infectious disease transmission; Respiratory infections caused by bacteria and viruses; Tuberculosis; Sexually transmitted diseases including AIDS; Diseases transmitted by animals (Rabies, plague), insects and ticks (rikettsias, Lyme disease, malaria); Food and water borne diseases; Public health and water quality; Pahtogenic fungi; Emerging and resurgent infectious diseases.

Chemotherapy/Antibiotics - Antimicrobial agents; Sulfa drugs; Antibiotics; Pencillins and cephalosporins; Broad-spectrum antibiotics; Antibiotics from prokaryotes; Antifungal antibiotics; Mode of action; Resistance to antibiotics.

Microbial genetics - Genes, mutation and mutagenesis - UV and chemical mutagnes; Types of mutations; Ames test for mutagenesis; Methods of genetic analysis. Bacterial genetic system - Transformation; Conjugation; Transduction; Recombination; Plasmids and Transposons; Bacterial genetic map with reference to E. coli. Viruses and their genetic system - Phage ? and

its life cycle; RNA phages; RNA viruses; Retroviruses; Genetic systems of yeast and Neurospora; Extrachromosomal inheritance and mitochondrial genetics; Basic concept of genomics.

SECTION M. ZOOLOGY

Animal world: Animal diversity, distribution, systematic and classification of animals, the phylogenetic relationship.

Evolution: Origin of life, history of life on earth, evolutionary theories, natural selection, adaptation, speciation.

Genetics: Principles of inheritance, molecular basis of heredity, the genetic material, transmission of genetic material, mutations, cytoplasmic inheritance.

Biochemistry and Molecular Biology: Nucleic acids, proteins and other biological macromolecules. Replication, transcription and translation, regulation of gene expression, organization of genome, Kreb's cycle, glycolysis, enzyme catalysis, hormones and their action.

Cell Biology: Structure of cell, cellular organelles and their structure and function, cell cycle, cell division, cellular differentiation, chromosome and chromatin structure. Eukaryotic gene organisation and expression.

Animal Anatomy and Physiology: Comparative physiology, the respiratory system, circulatory system, digestive system, the nervous system, the excretory system, the endocrine system, the reproductive system, the skeletal system, osmoregulation.

Parasitology and Immunology: Nature of parasite, host-parasite relation, protozoan and helminthic parasites, the immune response, cellular and humoral immune response, evolution of the immune system.

Development Biology: Embryonic development, cellular differentiation, organogenesis, metamorphosis, genetic basis of development.

Ecology: The ecosystem, habitats the food chain, population dynamics, species diversity, zoogeography, biogeochemical cycles, conservation biology.

Animal Behaviour: Types of behaviours, courtship, mating and territoriality, instinct, learning and memory, social behaviour across the animal taxa, communication, pheromones, evolution of animal behaviour.

IT - INFORMATION TECHNOLOGY

ENGINEERING MATHEMATICS

Mathematical Logic: Propositional Logic; First Order Logic.

Probability: Conditional Probability; Mean, Median, Mode and Standard Deviation; Random Variables; Distributions; uniform, normal, exponential, Poisson, Binomial.

Set Theory & Algebra: Sets; Relations; Functions; Groups; Partial Orders; Lattice; Boolean Algebra.

Combinatorics: Permutations; Combinations; Counting; Summation; generating functions; recurrence relations; asymptotics.

Graph Theory: Connectivity; spanning trees; Cut vertices & edges; covering; matching; independent sets; Colouring; Planarity; Isomorphism.

Linear Algebra: Algebra of matrices, determinants, systems of linear equations, Eigen values and Eigen vectors.

Numerical Methods: LU decomposition for systems of linear equations; numerical solutions of non linear algebraic equations by Secant, Bisection and Newton-Raphson Methods; Numerical integration by trapezoidal and Simpson's rules.

Calculus: Limit, Continuity & differentiability, Mean value Theorems, Theorems of integral calculus, evaluation of definite & improper integrals, Partial derivatives, Total derivatives, maxima & minima.

FORMAL LANGUAGES AND AUTOMATA

Regular Languages: finite automata, regular expressions, regular grammar.

Context free languages: push down automata, context free grammars

COMPUTER HARDWARE

Digital Logic: Logic functions, minimization, design and synthesis of combinatorial and sequential circuits, number representation and computer arithmetic (fixed and floating point)

Computer organization: Machine instructions and addressing modes, ALU and data path, hardwired and microprogrammed control, memory interface, I/O interface (interrupt and DMA mode), serial communication interface, instruction pipelining, cache, main and secondary storage

SOFTWARE SYSTEMS

Data structures and Algorithms: the notion of abstract data types, stack, queue, list, set, string, tree, binary search tree, heap, graph, tree and graph traversals, connected components, spanning trees, shortest paths, hashing, sorting, searching, design techniques (greedy, dynamic, divide and conquer), asymptotic analysis (best, worst, average cases) of time and space, upper and lower bounds, intractability

Programming Methodology: C programming, program control (iteration, recursion, functions), scope, binding, parameter passing, elementary concepts of object oriented programming

Operating Systems (in the context of Unix): classical concepts (concurrency, synchronization, deadlock), processes, threads and interprocess communication, CPU scheduling, memory management, file systems, I/O systems, protection and security

Information Systems and Software Engineering: information gathering, requirement and feasibility analysis, data flow diagrams, process specifications, input/output design, process life cycle, planning and managing the project, design, coding, testing, implementation, maintenance.

Databases: relational model, database design, integrity constraints, normal forms, query languages (SQL), file structures (sequential, indexed), b-trees, transaction and concurrency control

Data Communication: data encoding and transmission, data link control, multiplexing, packet switching, LAN architecture, LAN systems (Ethernet, token ring), Network devices: switches, gateways, routers

Networks: ISO/OSI stack, sliding window protocols, routing protocols, TCP/UDP, application layer protocols & systems (http, smtp, dns, ftp), network security

Web technologies: three tier web based architecture; JSP, ASP, J2EE, .NET systems; html, XML

AG - AGRICULTURAL ENGINEERING

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

FARM MACHINERY AND POWER:

Sources of power on the farm-human, animal, mechanical, electrical, wind, solar and biomass; design and selection of machine elements - gears, pulleys, chains and sprockets and belts; overload safety devices used in farm machinery; measurement of force, torque, speed, displacement and acceleration on machine elements.

Soil tillage; forces acting on a tillage tool; hitch systems and hitching of tillage implements; functional requirements, principles of working, construction and operation of manual, animal and power operated equipment for tillage. sowing, planting, fertilizer application, inter-cultivation, spraying, mowing, chaff cutting, harvesting, threshing and transport; testing of agricultural machinery and equipment; calculation of performance parameters -field capacity, efficiency, application rate and losses; cost analysis of implements and tractors.

Thermodynamic principles of I.C. engines; I.C. engine cycles; engine components; fuels and combustion; lubricants and their properties; I.C. engine systems - fuel, cooling, lubrication, ignition, electrical, intake and exhaust; selection, operation, maintenance and repair of I.C. engines; power efficiencies and measurement; calculation of power, torque, fuel consumption, heat load and power losses.

Tractors and power tillers - type, selection, maintenance and repair; tractor clutches and brakes; power transmission systems - gear trains, differential, final drives and power take-off; mechanics of tractor chassis; traction theory; three point hitches- free link and restrained link operations; mechanical steering and hydraulic control systems used in tractors; human engineering and safety in tractor design; tractor tests and performance.

SOIL AND WATER CONSERVATION ENGINEERING:

Ideal and real fluids, properties of fluids; hydrostatic pressure and its measurement; hydrostatic forces on plane and curved surface; continuity equation; Bernoulli's theorem; laminar and turbulent flow in pipes, Darcy-Weisbach and Hazen-Williams equations, Moody's diagram; flow through orifices and notches; flow in open channels.

Engineering properties of soils, fundamental definitions and relationships; index properties of soils; permeability and seepage analysis; shear strength, Mohr's circle of stresses; active and passive earth pressures; stability of slopes.

Hydrological cycle; precipitation measurement, analysis of precipitation data; abstraction from precipitation; runoff; hydrograph analysis, unit hydrograph theory and application; stream flow measurement; flood routing, hydrological reservoir and channel routing.

Mechanics of soil erosion, factors affecting erosion; soil loss estimation; biological and engineering measures to control erosion, terraces and bunds; vegetative waterways; gully control structures, drop, drop inlet and chute spillways; farm ponds; earthen dams; principles of watershed management.

Water requirement of crops; consumptive use and evapo-transpiration; irrigation scheduling; irrigation efficiencies; design of prismatic and silt loaded channels; methods of irrigation water application; design and evaluation of irrigation methods; drainage coefficient; surface and subsurface drainage systems; leaching requirement and salinity control; irrigation and drainage water quality; classification of pumps; pump characteristics; pump selection; types of aquifer; evaluation of aquifer properties; well hydraulics; ground water recharge.

AGRICULTURAL PROCESSING AND FOOD ENGINEERING:

Steady state heat transfer in conduction, convection and radiation; transient heat transfer in simple geometry; condensation and boiling heat transfer; working principles of heat exchangers; diffusive and convective mass transfer; simultaneous heat and mass transfer in agricultural processing operations.

Material and energy balances in food processing systems; water activity, sorption and desorption isotherms; centrifugal separation of solids, liquids and gases; kinetics of microbial death - pasteurisation and sterilization of liquid foods; preservation of food by cooling and freezing; psychrometry - properties of air-vapour mixture; concentration and dehydration of liquid foods - evaporators, tray, drum and spray dryers.

Mechanics and energy requirement in size reduction of granular solids; particle size analysis for comminuted solids; size separation by screening; fluidisation of granular solids; cleaning and grading efficiency and effectiveness of grain cleaners; conditioning and hydrothermal treatments for grains; dehydration of food grains; processes and machines for processing of cereals, pulses and oilseeds; design considerations for grain silos.

AR - ARCHITECTURE AND PLANNING

City planning: Historical development of cities; principles of city planning; new towns; survey methods, site planning, planning regulations and building bye-laws.

Housing: Concept of shelter; housing policies and design; community planning; role of government agencies; finance and management.

Landscape Design: Principles of landscape design and site planning; history and landscape styles; landscape elements and materials; planting design.

Computer Aided Design: Application of computers in architecture and planning; understanding elements of hardware and software; computer graphics; programming languages - C and Visual Basic and usage of packages such as AutoCAD.

Environmental and Building Science: Elements of environmental science; ecological principles concerning environment; role of micro-climate in design; climatic control through design elements; thermal comfort; elements of solar architecture; principles of lighting and illumination; basic principles of architectural acoustics; air pollution, noise pollution and their control.

Visual and Urban Design: Principles of visual composition; proportion, scale, rhythm, symmetry, harmony, balance, form and colour; sense of place and space, division of space; focal point, vista, imageability, visual survey.

History of Architecture: Indian - Indus valley, Vedic, Buddhist, Indo-Aryan, Dravidian and Mughal periods; European - Egyptian, Greek, Roman, medieval and renaissance periods.

Development of Contemporary Architecture: Architectural developments and impacts on society since industrial revolution; influence of modern art on architecture; works of national and international architects; post modernism in architecture.

Building Services: Water supply, Sewerage and Drainage systems; Sanitary fittings and fixtures; principles of electrification of buildings; elevators, their standards and uses; air-conditioning systems; fire fighting systems.

Building Construction and Management: Building construction techniques, methods and details; building systems and prefabrication of building elements; principles of modular coordination; estimation, specification, valuation, professional practice; project management, PERT, CPM.

Materials and Structural Systems: Behavioural characteristics of all types of building materials e.g. mud, timber, bamboo, brick, concrete, steel, glass, FRP; principles of strength of materials; design of structural elements in wood, steel and RCC; elastic and limit state design; complex structural systems; principles of pre-stressing.

Planning Theory: Planning process; multilevel planning; comprehensive planning; central place theory; settlement pattern; land use and land utilization.

Techniques of Planning: Planning surveys; Preparation of urban and regional structure plans, development plans, action plans; site planning principles and design; statistical methods; application of remote sensing techniques in urban and regional planning.

Traffic and Transportation Planning: Principles of traffic engineering and transportation planning; methods of conducting surveys; design of roads, intersections and parking areas; hierarchy of roads and levels of services; traffic and transport management in urban areas; traffic safety and traffic laws; public transportation planning; modes of transportation.

Services and Amenities: Principles and design of water supply systems, sewerage systems, solid waste disposal systems, power supply and communication systems; Health, education, recreation and demography related standards at various levels of the settlements.

Development Administration and Management: Planning laws; development control and zoning regulations; laws relating to land acquisition; development enforcements, land ceiling; regional and urban plan preparations; planning and municipal administration; taxation, revenue resources and fiscal management; public participation and role of NGO.

CE - CIVIL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

STRUCTURAL ENGINEERING

Mechanics: Bending moments and shear forces in statically determinate beams; simple stress and strain: relationship; stress and strain in two dimensions, principal stresses, stress transformation, Mohr's circle; simple bending theory; flexural shear stress; thin-walled pressure vessels; uniform torsion.

Structural Analysis: Analysis of statically determinate trusses, arches and frames; displacements in statically determinate structures and analysis of statically indeterminate structures by force/energy methods; analysis by displacement methods (slope-deflection and moment-distribution methods); influence lines for determinate and indeterminate structures; basic concepts of matrix methods of structural analysis.

Concrete Structures: Basic working stress and limit states design concepts; analysis of ultimate load capacity and design of members subject to flexure, shear, compression and torsion (beams, columns and isolated footings); basic elements of prestressed concrete: analysis of beam sections at transfer and service loads.

Steel Structures: Analysis and design of tension and compression members, beams and beam-columns, column bases; connections - simple and eccentric, beam-column connections, plate girders and trusses; plastic analysis of beams and frames.

GEOTECHNICAL ENGINEERING

Soil Mechanics: Origin of soils; soil classification; three-phase system, fundamental definitions, relationship and inter-relationships; permeability and seepage; effective stress principle: consolidation, compaction; shear strength.

Foundation Engineering: Sub-surface investigation - scope, drilling bore holes, sampling, penetrometer tests, plate load test; earth pressure theories, effect of water table, layered soils; stability of slopes - infinite slopes, finite slopes; foundation types - foundation design requirements; shallow foundations; bearing capacity, effect of shape, water table and other factors, stress distribution, settlement analysis in sands and clays; deep foundations - pile types, dynamic and static formulae, load capacity of piles in sands and clays.

WATER RESOURCES ENGINEERING

Fluid Mechanics and Hydraulics: Hydrostatics, applications of Bernoulli equation, laminar and turbulent flow in pipes, pipe networks; concept of boundary layer and its growth; uniform flow, critical flow and gradually varied flow in channels, specific energy concept, hydraulic jump; forces on immersed bodies; flow measurement in channels; tanks and pipes; dimensional analysis and hydraulic modeling. Applications of momentum equation, potential flow, kinematics of flow; velocity triangles and specific speed of pumps and turbines.

Hydrology: Hydrologic cycle; rainfall; evaporation infiltration, unit hydrographs, flood estimation, reservoir design, reservoir and channel routing, well hydraulics.

Irrigation: Duty, delta, estimation of evapo-transpiration; crop water requirements; design of lined and unlined canals; waterways; head works, gravity dams and Ogee spillways. Designs of weirs on permeable foundation, irrigation methods.

ENVIRONMENTAL ENGINEERING

Water requirements; quality and standards, basic unit processes and operations for water treatment, distribution of water. Sewage and sewerage treatment: quantity and characteristic of waste water sewerage; primary and secondary treatment of waste water; sludge disposal; effluent discharge standards.

TRANSPORTATION ENGINEERING

Highway planning; geometric design of highways; testing and specifications of paving materials; design of flexible and rigid pavements.

CH - CHEMICAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

CHEMICAL ENGINEERING

Process Calculations and Thermodynamics: Laws of conservation of mass and energy; use of tie components; recycle, bypass and purge calculations; degree of freedom analysis.

First and Second laws of thermodynamics and their applications; equations of state and thermodynamic properties of real systems; phase equilibria; fugacity, excess properties and correlations of activity coefficients; chemical reaction equilibria.

Fluid Mechanics and Mechanical Operations: Fluid statics, Newtonian and non-Newtonian fluids, Bernoulli equation, Macroscopic friction factors, energy balance, dimensional analysis, shell balances, flow through pipeline systems, flow meters, pumps and compressors, packed and fluidized beds, elementary boundary layer theory, size reduction and size separation; free and hindered settling; centrifuge and cyclones; thickening and classification, filtration, mixing and agitation; conveying of solids.

Heat Transfer: Conduction, convection and radiation, heat transfer coefficients, steady and unsteady heat conduction, boiling, condensation and evaporation; types of heat exchangers and evaporators and their design.

Mass Transfer: Fick's law, molecular diffusion in fluids, mass transfer coefficients, film, penetration and surface renewal theories; momentum, heat and mass transfer analogies; stagewise and continuous contacting and stage efficiencies; HTU & NTU concepts design and operation of equipment for distillation, absorption, leaching, liquid-liquid extraction, crystallization, drying, humidification, dehumidification and adsorption.

Chemical Reaction Engineering: Theories of reaction rates; kinetics of homogeneous reactions, interpretation of kinetic data, single and multiple reactions in ideal reactors, non-ideal reactors; residence time; non-isothermal reactors; kinetics of heterogeneous catalytic reactions; diffusion effects in catalysis.

Instrumentation and Process Control: Measurement of process variables; sensors, transducers and their dynamics, dynamics of simple systems, dynamics such as CSTRs, transfer functions and responses of simple systems, process reaction curve, controller modes (P, PI, and PID); control valves; analysis of closed loop systems including stability, frequency response (including Bode plots) and controller tuning, cascade, feed forward control.

Plant Design and Economics: Design and sizing of chemical engineering equipment such as compressors, heat exchangers, multistage contactors; principles of process economics and cost estimation including total annualized cost, cost indexes, rate of return, payback period, discounted cash flow, optimization in Design.

Chemical Technology: Inorganic chemical industries; sulfuric acid, NaOH, fertilizers (Ammonia, Urea, SSP and TSP); natural products industries (Pulp and Paper, Sugar, Oil, and Fats); petroleum refining and petrochemicals; polymerization industries; polyethylene, polypropylene, PVC and polyester synthetic fibers.

CS - COMPUTER SCIENCE AND ENGINEERING

ENGINEERING MATHEMATICS

Mathematical Logic: Propositional Logic; First Order Logic.

Probability: Conditional Probability; Mean, Median, Mode and Standard Deviation; Random Variables; Distributions; uniform, normal, exponential, Poisson, Binomial.

Set Theory & Algebra: Sets; Relations; Functions; Groups; Partial Orders; Lattice; Boolean Algebra.

Combinatorics: Permutations; Combinations; Counting; Summation; generating functions; recurrence relations; asymptotics.

Graph Theory: Connectivity; spanning trees; Cut vertices & edges; covering; matching; independent sets; Colouring; Planarity; Isomorphism.

Linear Algebra: Algebra of matrices, determinants, systems of linear equations, Eigen values and Eigen vectors.

Numerical Methods: LU decomposition for systems of linear equations; numerical solutions of non linear algebraic equations by Secant, Bisection and Newton-Raphson Methods; Numerical integration by trapezoidal and Simpson's rules.

Calculus: Limit, Continuity & differentiability, Mean value Theorems, Theorems of integral calculus, evaluation of definite & improper integrals, Partial derivatives, Total derivatives, maxima & minima.

THEORY OF COMPUTATION

Formal Languages and Automata Theory: Regular languages and finite automata, Context free languages and Push-down automata, Recursively enumerable sets and Turing machines, Un-decidability;

Analysis of Algorithms and Computational Complexity: Asymptotic analysis (best, worst, average case) of time and space, Upper and lower bounds on the complexity of specific problems, NP-completeness.

COMPUTER HARDWARE

Digital Logic: Logic functions, Minimization, Design and synthesis of Combinational and Sequential circuits; Number representation and Computer Arithmetic (fixed and floating point);

Computer Organization: Machine instructions and addressing modes, ALU and Data-path, hardwired and micro-programmed control, Memory interface, I/O interface (Interrupt and DMA mode), Serial communication interface, Instruction pipelining, Cache, main and secondary storage.

SOFTWARE SYSTEMS

Data structures: Notion of abstract data types, Stack, Queue, List, Set, String, Tree, Binary search tree, Heap, Graph;

Programming Methodology: C programming, Program control (iteration, recursion, Functions), Scope, Binding, Parameter passing, Elementary concepts of Object oriented, Functional and Logic Programming;

Algorithms for problem solving: Tree and graph traversals, Connected components, Spanning trees, Shortest paths; Hashing, Sorting, Searching; Design techniques (Greedy, Dynamic Programming, Divide-and-conquer);

Compiler Design: Lexical analysis, Parsing, Syntax directed translation, Runtime environment, Code generation, Linking (static and dynamic); Operating Systems: Classical concepts (concurrency, synchronization, deadlock), Processes, threads and Inter-process communication, CPU scheduling, Memory management, File systems, I/O systems, Protection and security.

Databases: Relational model (ER-model, relational algebra, tuple calculus), Database design (integrity constraints, normal forms), Query languages (SQL), File structures (sequential files, indexing, B+ trees), Transactions and concurrency control;

Computer Networks: ISO/OSI stack, sliding window protocol, LAN Technologies (Ethernet, Token ring), TCP/UDP, IP, Basic concepts of switches, gateways, and routers.

CH - CHEMISTRY

PHYSICAL CHEMISTRY

Structure: Quantum theory - principles and techniques; applications to particle in a box, harmonic oscillator, rigid rotor and hydrogen atom; valence bond and molecular orbital theories and Huckel approximation, approximate techniques: variation and perturbation; symmetry, point groups; rotational, vibrational, electronic, NMR and ESR spectroscopy.

Equilibrium: First law of thermodynamics, heat, energy and work; second law of thermodynamics and entropy; third law and absolute entropy; free energy; partial molar quantities; ideal and non-ideal solutions; phase transformation: phase rule and phase diagrams- one, two, and three component systems; activity, activity coefficient, fugacity and fugacity coefficient ; chemical equilibrium, response of chemical equilibrium to temperature and pressure; colligative properties; kinetic theory of gases; thermodynamics of electrochemical cells; standard electrode potentials: applications - corrosion and energy conversion; molecular partition function (translational, rotational, vibrational and electronic).

Kinetics: Rates of chemical reactions, theories of reaction rates, collision and transition state theory; temperature dependence of chemical reactions; elementary reactions, consecutive elementary reactions; steady state approximation, kinetics of photochemical reactions and free radical polymerization, homogenous and heterogeneous catalysis.

INORGANIC CHEMISTRY

Non-Transition Elements: General characteristics, structure and reactions of simple and industrially important compounds, boranes, carboranes, silicates, silicones, diamond and graphite; hydrides, oxides and oxoacids of N, P, S and halogens; boron nitride, borazines and phosphazenes; xenon compounds. Shapes of molecules, hard-soft acid base concept.

Transition Elements: General characteristics of d and f block elements; coordination chemistry: structure and isomerism, stability, theories of metal-ligand bonding (CFT and LFT), electronic spectra and magnetic properties of transition metal complexes and lanthanides; metal carbonyls, metal-metal bonds and metal atom clusters, metallocenes; transition metal complexes with bonds to hydrogen, alkyls, alkenes, and arenes; metal carbenes; use of organometallic compounds as catalysts in organic synthesis; mechanisms of substitution and electron transfer reactions of coordination complexes. Role of metals with special reference to Na, K, Mg, Ca, Fe, Co, Zn, and Mo in biological systems.

Solids: Crystal systems and lattices, Miller planes, crystal packing, crystal defects; Bragg's Law; ionic crystals, band theory, metals and semiconductors. Spinels.

Instrumental methods of analysis: atomic absorption, UV-visible spectrometry, chromatographic and electro-analytical methods.

ORGANIC CHEMISTRY

Synthesis, reactions and mechanisms involving the following: Alkenes, alkynes, arenes, alcohols, phenols, aldehydes, ketones, carboxylic acids and their derivatives; halides, nitro compounds and amines; stereochemical and conformational effects on reactivity and specificity; reactions with diborane and peracids. Michael reaction, Robinson annulation, reactivity umpolung, acyl anion equivalents; molecular rearrangements involving electron deficient atoms.

Photochemistry: Basic principles, photochemistry of olefins, carbonyl compounds, arenes, photo oxidation and reduction.

Pericyclic reactions: Cycloadditions, electrocyclic reactions, sigmatropic reactions; Woodward-Hoffmann rules.

Heterocycles: Structural properties and reactions of furan, pyrrole, thiophene, pyridine, indole.

Biomolecules: Structure, properties and reactions of mono- and di-saccharides, physico-chemical properties of amino acids, structural features of proteins and nucleic acids.

Spectroscopy: Principles and applications of IR, UV-visible, NMR and mass spectrometry in the determination of structures of organic compounds.

EC - ELECTRONICS AND COMMUNICATION ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix Algebra, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Mean value theorems, Theorems of integral calculus, Evaluation of definite and improper integrals, Partial Derivatives, Maxima and minima, Multiple integrals, Fourier series. Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equation (linear and nonlinear), Higher order linear differential equations with constant coefficients, Method of variation of parameters, Cauchy's and Euler's equations, Initial and boundary value problems, Partial Differential Equations and variable separable method.

Complex variables: Analytic functions, Cauchy's integral theorem and integral formula, Taylor's and Laurent' series, Residue theorem, solution integrals.

Probability and Statistics: Sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Discrete and continuous distributions, Poisson, Normal and Binomial distribution, Correlation and regression analysis.

Numerical Methods: Solutions of non-linear algebraic equations, single and multi-step methods for differential equations.

Transform Theory: Fourier transform, Laplace transform, Z-transform.

ELECTRONICS & COMMUNICATION ENGINEERING

Networks: Network graphs: matrices associated with graphs; incidence, fundamental cut set and fundamental circuit matrices. Solution methods: nodal and mesh analysis. Network theorems: superposition, Thevenin and Norton's maximum power transfer, Wye-Delta transformation. Steady state sinusoidal analysis using phasors. Linear constant coefficient differential equations; time domain analysis of simple RLC circuits, Solution of network equations using Laplace transform: frequency domain analysis of RLC circuits. 2-port network parameters: driving point and transfer functions. State equations for networks.

Electronic Devices: Energy bands in silicon, intrinsic and extrinsic silicon. Carrier transport in silicon: diffusion current, drift current, mobility, resistivity. Generation and recombination of carriers. p-n junction diode, Zener diode, tunnel diode, BJT, JFET, MOS capacitor, MOSFET, LED, p-I-n and avalanche photo diode, LASERs. Device technology: integrated circuits fabrication process, oxidation, diffusion, ion implantation, photolithography, n-tub, p-tub and twin-tub CMOS process.

Analog Circuits: Equivalent circuits (large and small-signal) of diodes, BJTs, JFETs, and MOSFETs. Simple diode circuits, clipping, clamping, rectifier. Biasing and bias stability of transistor and FET amplifiers. Amplifiers: single-and multi-stage, differential, operational, feedback and power. Analysis of amplifiers; frequency response of amplifiers. Simple op-amp circuits. Filters. Sinusoidal oscillators; criterion for oscillation; single-transistor and op-amp configurations. Function generators and wave-shaping circuits. Power supplies.

Digital circuits: Boolean algebra, minimization of Boolean functions; logic gates digital IC families (DTL, TTL, ECL, MOS, CMOS). Combinational circuits: arithmetic circuits, code converters, multiplexers and decoders. Sequential circuits: latches and flip-flops, counters and shift-registers. Sample and hold circuits, ADCs, DACs. Semiconductor memories. Microprocessor(8085): architecture, programming, memory and I/O interfacing.

Signals and Systems: Definitions and properties of Laplace transform, continuous-time and discrete-time Fourier series, continuous-time and discrete-time Fourier Transform, z-transform. Sampling theorems. Linear Time-Invariant (LTI) Systems: definitions and properties; casuality, stability, impulse response, convolution, poles and zeros frequency response, group delay, phase delay. Signal transmission through LTI systems. Random signals and noise: probability, random variables, probability density function, autocorrelation, power spectral density.

Controls Systems: Basic control system components; block diagrammatic description, reduction of block diagrams. Open loop and closed loop (feedback) systems and stability analysis of these systems. Signal flow graphs and their use in determining transfer functions of systems; transient and steady state analysis of LTI control systems and frequency response. Tools and techniques for LTI control system analysis: root loci, Routh-Hurwitz criterion, Bode and Nyquist plots. Control system compensators: elements of lead and lag compensation, elements of Proportional-Integral-Derivative(PID) control. State variable representation and solution of state equation of LTI control systems.

Communications: Analog communication systems: amplitude and angle modulation and demodulation systems, spectral analysis of these operations, superheterodyne receivers; elements of hardware, realizations of analog communication systems; signal-to-noise ratio (SNR) calculations for amplitude modulation (AM) and frequency modulation (FM) for low noise conditions. Digital communication systems: pulse code modulation (PCM), differential pulse code modulation (DPCM), delta modulation (DM); digital modulation schemes-amplitude, phase and frequency shift keying schemes (ASK, PSK, FSK), matched filter receivers, bandwith consideration and probability of error calculations for these schemes.

Electromagnetics: Elements of vector calculus: divergence and curl; Gauss' and Stokes' theorems, Maxwell's equations: differential and integral forms. Wave equation, Poynting vector. Plane waves: propagation through various media; reflection and refraction; phase and group velocity; skin depth. Transmission lines: characteristic impedance; impedance transformation; Smith chart; impedance matching; pulse excitation. Waveguides: modes in rectangular waveguides; boundary conditions; cut-off frequencies; dispersion relations. Antennas: Dipole antennas; antenna arrays; radiation pattern; reciprocity theorem, antenna gain.

EE - ELECTRICAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix Algebra, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Mean value theorems, Theorems of integral calculus, Evaluation of definite and improper integrals, Partial Derivatives, Maxima and minima, Multiple integrals, Fourier series. Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equation (linear and nonlinear), Higher order linear differential equations with constant coefficients, Method of variation of parameters, Cauchy's and Euler's equations, Initial and boundary value problems, Partial Differential Equations and variable separable method.

Complex variables: Analytic functions, Cauchy's integral theorem and integral formula, Taylor's and Laurent' series, Residue theorem, solution integrals.

Probability and Statistics: Sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Discrete and continuous distributions, Poisson, Normal and Binomial distribution, Correlation and regression analysis.

Numerical Methods: Solutions of non-linear algebraic equations, single and multi-step

methods for differential equations.

Transform Theory: Fourier transform, Laplace transform, Z-transform.

ELECTRICAL ENGINEERING

Electrical Circuits and Fields: Network graph, KCL, KVL, node/ cut set, mesh/ tie set analysis, transient response of d.c. and a.c. networks; sinusoidal steady-state analysis; resonance in electrical circuits; concepts of ideal voltage and current sources, network theorems, driving point, immittance and transfer functions of two port networks, elementary concepts of filters; three phase circuits; Fourier series and its application; Gauss theorem, electric field intensity and potential due to point, line, plane and spherical charge distribution, dielectrics, capacitance calculations for simple configurations; Ampere's and Biot-Savart's law, inductance calculations for simple configurations.

Electrical Machines: Single phase transformer - equivalent circuit, phasor diagram, tests, regulation and efficiency; three phase transformers - connections, parallel operation; auto transformer and three-winding transformer; principles of energy conversion, windings of rotating machines: D. C. generators and motors - characteristics, starting and speed control, armature reaction and commutation; three phase induction motors-performance characteristics, starting and speed control; single-phase induction motors; synchronous generators-performance, regulation, parallel operation; synchronous motors - starting, characteristics, applications, synchronous condensers; fractional horse power motors; permanent magnet and stepper motors.

Power Systems: Electric power generation - thermal, hydro, nuclear; transmission line parameters; steady-state performance of overhead transmission lines and cables and surge propagation; distribution systems, insulators, bundle conductors, corona and radio interference effects; per-unit quantities; bus admittance and impedance matrices; load flow; voltage control and power factor correction; economic operation; symmetrical components, analysis of symmetrical and unsymmetrical faults; principles of over current, differential and distance protections; concept of solid state relays and digital protection; circuit breakers; concept of system stability-swing curves and equal area criterion; basic concepts of HVDC transmission.

Control Systems: Principles of feedback; transfer function; block diagrams: steady-state errors; stability-Routh and Nyquist criteria; Bode plots; compensation; root loci; elementary state variable formulation; state transition matrix and response for Linear Time Invariant systems.

Electrical and Electronic Measurements: Bridges and potentiometers, PMMC, moving iron, dynamometer and induction type instruments; measurement of voltage, current, power, energy and power factor; instrument transformers; digital voltmeters and multimeters; phase, time and frequency measurement; Q-meter, oscilloscopes, potentiometric recorders, error analysis.

Analog and Digital Electronics: Characteristics of diodes, BJT, FET, SCR; amplifiers-biasing, equivalent circuit and frequency response; oscillators and feedback amplifiers, operational amplifiers- characteristics and applications; simple active filters; VCOs and timers; combinational and sequential logic circuits, multiplexer, Schmitt trigger, multivibrators, sample and hold circuits, A/D and D/A converters; microprocessors and their applications.

Power Electronics and Electric Drives: Semiconductor power devices-diodes, transistors, thyristors, triacs, GTOs, MOSFETs and IGBTs - static characteristics and principles of operation; triggering circuits; phase control rectifiers; bridge converters-fully controlled and half controlled; principles of choppers and inverters, basic concepts of adjustable speed dc and ac drives.

GG - GEOLOGY AND GEOPHYSICS

PART - I

Earth and planetary system; size, shape, internal structure and composition of the earth; atmosphere and greenhouse effect; isostasy; elements of seismology; continents and continental processes; physical oceanography; palaeomagnetism, continental drift plate tectonics, geothermal energy.

Weathering; soil formation; action of river, wind and glacier; oceans and oceanic features; earthquakes, volcanoes, orogeny and mountain building; elements of structural geology; crystallography; classification, composition and properties of minerals and rocks; engineering properties of rocks and soils, role of geology in the construction of engineering structures.

Processes of ore formation, occurrence and distribution of ores on land and on ocean floor; coal and petroleum resources in India; ground water geology including well hydraulics, geological time scale and geochronology; stratigraphic principles and stratigraphy of India; basics concepts of gravity, magnetic and electrical prospecting for ores and ground water.

PART - IIA: GEOLOGY

Crystal symmetry, forms, twinning; crystal chemistry; optical mineralogy, classification of minerals, diagnostic properties of rock minerals.

Mineralogy, structure, texture and classification of igneous, sedimentary and metamorphic rock, their origin and evolution; application of thermodynamics; structure and petrology of sedimentary rocks; sedimentary processes and environments, sedimentary facies, basin studies; basement cover relationship;

Primary and secondary structures; geometry and genesis of folds, faults, joints, unconformities, cleavage, schistosity and lineation; methods of projection. Tectonites and their significance; shear zone; superposed folding.

Morphology, classification and geological significance of important invertebrates, vertebrates, microfossils and palaeoflora; stratigraphic principles and Indian stratigraphy; geomorphic processes and agents; development and evolution of landforms; slope and drainage; processes on deep oceanic and near-shore regions; quantitative and applied geomorphology; air photo interpretation and remote sensing; chemical and optical properties of ore minerals; formation and localization of ore deposits; prospecting and exploration of economic minerals; coal and petroleum geology; origin and distribution of mineral and fuel deposits in India; ore dressing and mineral economics.

Cosmic abundance; meteorites; geochemical evolution of the earth; geochemical cycles; distribution of major, minor and trace elements; isotope geochemistry; geochemistry of waters including solution equilibria and water rock interaction.

Engineering properties of rocks and soils; rocks as construction material; geology of dams, tunnels and excavation sites; natural hazards; the fly ash problem; ground water geology and exploration; water quality; impact of human activity; Remote sensing techniques for the interpretation of landforms and resource management.

PART - II B: GEOPHYSICS

The earth as a planet; different motions of the earth; gravity filed of the earth and its shape; geochronology; isostasy, seismology and interior of the earth; variation of density, velocity, pressure, temperature, electrical and magnetic properties inside the earth; earthquakes-causes and measurements; zonation and seismic hazards; geomagnetic field, palaeomagnetism; oceanic and continental lithosphere; plate tectonics; heat flow; upper and lower atmospheric phenomena.

Theories of scalar and vector potential fields; Laplace, Maxwell and Helmholtz equations for solution of different types of boundary value problems for Cartesian, cylindrical and spherical polar coordinates; Green's theorem; Image theory; integral equations and conformal transformations in potential theory; Eikonal equation and ray theory.

'G' and 'g' units of measurement, density of rocks, gravimeters, preparation, analysis and interpretation of gravity maps; derivative maps, analytical continuation; gravity anomaly type curves; calculation of mass.

Earth's magnetic field, units of measurement, magnetic susceptibility of rocks, magnetometers, corrections, preparation of magnetic maps, magnetic anomaly type curve, analytical continuation, interpretation and application; magnetic well logging.

Conduction of electricity through rocks, electrical conductivities of metals, metallic, non-metallic and rock forming minerals, D.C. resistivity units and methods of measurement, electrode configuration for sounding and profiling, application of filter theory, interpretation of resistivity field data, application; self potential origin, classification, field measurement, interpretation of induced polarization time frequency, phase domain; IP units and methods of measurement, interpretation and application; ground-water exploration.

Origin of electromagnetic field elliptic polarization, methods of measurement for different source-receiver configuration components in EM measurements, interpretation and applications; earth's natural electromagnetic field, tellurics, magneto-tellurics; geomagnetic depth sounding principles, methods of measurement, processing of data and interpretation.

Seismic methods of prospecting: Reflection, refraction and CDP surveys; land and marine seismic sources, generation and propagation of elastic waves, velocity increasing with depth, geophones, hydrophones, recording instruments (DFS), digital formats, field layouts, seismic noises and noise profile analysis, optimum geophone grouping, noise cancellation by shot and geophone arrays, 2D and 3D seismic data acquisition and processing, CDP stacking charts, binning, filtering, dip-moveout, static and dynamic corrections, deconvolution, migration, signal processing, Fourier and Hilbert transforms, attribute analysis, bright and dim spots, seismic stratigraphy, high resolution seismics, VSP.

Principles and techniques of geophysical well-logging, SP, resistivity, induction, micro gamma ray, neutron, density, sonic, temperature, dip meter, caliper, nuclear magnetic, cement bond logging. Quantitative evaluation of formations from well logs; well hydraulics and application of geophysical methods for groundwater study; application of bore hole geophysics in ground water, mineral and oil exploration. Remote sensing techniques and application of remote sensing methods in geophysics.

IN - INSTRUMENTATION ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix Algebra, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Mean value theorems, Theorems of integral calculus, Evaluation of definite and improper integrals, Partial Derivatives, Maxima and minima, Multiple integrals, Fourier series. Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equation (linear and nonlinear), Higher order linear differential equations with constant coefficients, Method of variation of parameters, Cauchy's and Euler's equations, Initial and boundary value problems, Partial Differential Equations and variable separable method.

Complex variables: Analytic functions, Cauchy's integral theorem and integral formula, Taylor's and Laurent' series, Residue theorem, solution integrals.

Probability and Statistics: Sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Discrete and continuous distributions, Poisson, Normal and Binomial distribution, Correlation and regression analysis.

Numerical Methods: Solutions of non-linear algebraic equations, single and multi-step methods for differential equations.

Transform Theory: Fourier transform, Laplace transform, Z-transform.

INSTRUMENTATION ENGINEERING

Measurement Basics and Metrology: Static and dynamic characteristics of measurement systems. Standards and calibration. Error and uncertainty analysis, statistical analysis of data, and curve fitting. Linear and angular measurements; Measurement of straightness, flatness, roundness and roughness.

Transducers, Mechanical Measurements and Industrial Instrumentation: Transducers - elastic, resistive, inductive, capacitive, thermo-electric, piezoelectric, photoelectric, electro-mechanical, electro-chemical, and ultrasonic. Measurement of displacement, velocity (linear and rotational), acceleration, shock, vibration, force, torque, power, strain, stress, pressure, flow, temperature, humidity, viscosity, and density. energy storing elements, suspension systems and dampers.

Analog Electronics: Characteristics of diodes, BJTs, JFETs and MOSFETs; Diode circuits; Amplifiers: single and multi-stage, feedback; Frequency response; Operational amplifiers - design, characteristic, linear and non-linear applications: difference amplifiers; instrumentation amplifiers; precision rectifiers, I-to-V converters, active filters, oscillators, comparators, signal generators, wave shaping circuits.

Digital Electronics: Combinational logic circuits, minimization of Boolean functions; IC families (TTL, MOS, CMOS), arithmetic circuits, multiplexer and decoders. Sequential circuits: flip-flops, counters, shift registers. Schmitt trigger, timers, and multivibrators. Analog switches, multiplexers, S/H circuits. Analog-to-digital and digital-to-analog converters. Basics of computer organization and architecture. 8-bit microprocessor (8085), applications, memory, I/O interfacing, and microcontrollers.

Signals and Systems: Vectors and matrices; Fourier series; Fourier transforms; Ordinary differential equations. Impulse and frequency responses of first and second order systems. Laplace transform and transfer function, convolution and correlation. Amplitude and frequency modulations and demodulations. Discrete time systems, difference equations, impulse and frequency responses; Z-transforms and transfer functions; IIR and FIR filters.

Electrical and Electronic Measurements: Measurement of R, L and C; bridges and potentiometers. Measurement of voltage, current, power, power factor, and energy; Instrument transformers; Q meter, waveform analyzers. Digital volt-meters and multi-meters. Time, phase and frequency measurements; Oscilloscope. Noise and interference in instrumentation.

Control Systems & Process Control: Principles of feedback; transfer function, signal flow graphs. Stability criteria, Bode plots, root-loci, Routh and Nyquist criteria. Compensation techniques; State space analysis. System components: mechanical, hydraulic, pneumatic, electrical and electronic; Servos and synchros; Stepper motors. On-off, cascade, P, PI, PID and feed-forward controls. Controller tuning and general frequency response.

Analytical, Optical and Biomedical Instrumentation: Principles of spectrometry, UV, visible, IR mass spectrometry, X-ray methods; nuclear radiation measurements, gas, solid and semi conductor lasers and their characteristics, interferometers, basics of fibre optics, transducers in biomedical applications, cardiovascular system measurements, instrumentation for clinical laboratory.

MA - MATHEMATICS

Linear Algebra: Finite dimensional vector spaces. Linear transformations and their matrix representations, rank; systems of linear equations, eigenvalues and eigenvectors, minimal polynomial, Cayley-Hamilton theorem, diagonalisation, Hermitian, Skew-Hermitian and unitary matrices. Finite dimensional inner product spaces, self-adjoint and Normal linear operators, spectral theorem, Quadratic forms.

Complex Analysis: Analytic functions, conformal mappings, bilinear transformations, complex integration: Cauchy's integral theorem and formula, Liouville's theorem, maximum modulus principle, Taylor and Laurent's series, residue theorem and applications for evaluating real integrals.

Real Analysis: Sequences and series of functions, uniform convergence, power series, Fourier series, functions of several variables, maxima, minima, multiple integrals, line, surface and volume integrals, theorems of Green, Stokes and Gauss; metric spaces, completeness, Weierstrass approximation theorem, compactness. Lebesgue measure, measurable functions; Lebesgue integral, Fatou's lemma, dominated convergence theorem.

Ordinary Differential Equations: First order ordinary differential equations, existence and uniqueness theorems, systems of linear first order ordinary differential equations, linear ordinary differential equations of higher order with constant coefficients; linear second order ordinary differential equations with variable coefficients, method of Laplace transforms for solving ordinary differential equations, series solutions; Legendre and Bessel functions and their orthogonality, Sturm Liouville system, Greeen's functions.

Algebra: Normal subgroups and homomorphisms theorems, automorphisms. Group actions, sylow's theorems and their applications groups of order less than or equal to 20, Finite p-groups. Euclidean domains, Principal ideal domains and unique factorizations domains. Prime ideals and maximal ideals in commutative rings.

Functional Analysis: Banach spaces, Hahn-Banach theorems, open mapping and closed graph theorems, principle of uniform boundedness; Hilbert spaces, orthonormal sets, Riesz representation theorem, self-adjoint, unitary and normal linear operators on Hilbert Spaces.

Numerical Analysis: Numerical solution of algebraic and transcendental equations; bisection, secant method, Newton-Raphson method, fixed point iteration, interpolation: existence and error of polynomial interpolation, Lagrange, Newton, Hermite(osculatory)interpolations; numerical differentiation and integration, Trapezoidal and Simpson rules; Gaussian quadrature; (Gauss-Legendre and Gauss-Chebyshev), method of undetermined parameters, least square and orthonormal polynomial approximation; numerical solution of systems of linear equations: direct and iterative methods, (Jacobi Gauss-Seidel and SOR) with convergence; matrix eigenvalue problems: Jacobi and Given's methods, numerical solution of ordinary differential equations: initial value problems, Taylor series method, Runge-Kutta methods, predictor-corrector methods; convergence and stability.

Partial Differential Equations: Linear and quasilinear first order partial differential equations, method of characteristics; second order linear equations in two variables and their classification; Cauchy, Dirichlet and Neumann problems, Green's functions; solutions of Laplace, wave and diffusion equations in two variables Fourier series and transform methods of solutions of the above equations and applications to physical problems.

Mechanics: Forces in three dimensions, Poinsot central axis, virtual work, Lagrange's equations for holonomic systems, theory of small oscillations, Hamiltonian equations;

Topology: Basic concepts of topology, product topology, connectedness, compactness, countability and separation axioms, Urysohn's Lemma, Tietze extension theorem, metrization theorems, Tychonoff theorem on compactness of product spaces.

Probability and Statistics: Probability space, conditional probability, Bayes' theorem, independence, Random variables, joint and conditional distributions, standard probability distributions and their properties, expectation, conditional expectation, moments. Weak and strong law of large numbers, central limit theorem. Sampling distributions, UMVU estimators, sufficiency and consistency, maximum likelihood estimators. Testing of hypotheses, Neyman-Pearson tests, monotone likelihood ratio, likelihood ratio tests, standard parametric tests based on normal, X2 ,t, F-distributions. Linear regression and test for linearity of regression. Interval estimation.

Linear Programming: Linear programming problem and its formulation, convex sets their properties, graphical method, basic feasible solution, simplex method, big-M and two phase methods, infeasible and unbounded LPP's, alternate optima. Dual problem and duality theorems, dual simplex method and its application in post optimality analysis, interpretation of dual variables. Balanced and unbalanced transportation problems, unimodular property and u-v method for solving transportation problems. Hungarian method for solving assignment problems.

Calculus of Variations and Integral Equations: Variational problems with fixed boundaries; sufficient conditions for extremum, Linear integral equations of Fredholm and Volterra type, their iterative solutions. Fredholm alternative.

ME - MECHANICAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

APPLIED MECHANICS AND DESIGN

Engineering Mechanics: Equivalent force systems, free-body concepts, equations of equilibrium, trusses and frames, virtual work and minimum potential energy. Kinematics and dynamics of particles and rigid bodies, impulse and momentum (linear and angular), energy methods, central force motion.

Strength of Materials: Stress and strain, stress-strain relationship and elastic constants, Mohr's circle for plane stress and plane strain, shear force and bending moment diagrams, bending and shear stresses, deflection of beams, torsion of circular shafts, thin and thick cylinders, Euler's theory of columns, strain energy methods, thermal stresses.

Theory of Machines: Displacement, velocity and acceleration, analysis of plane mechanisms, dynamic analysis of slider-crank mechanism, planar cams and followers, gear tooth profiles, kinematics of gears, governors and flywheels, balancing of reciprocating and rotating masses.

Vibrations: Free and forced vibration of single degree freedom systems, effect of damping, vibration isolation, resonance, critical speed of rotors.

Design of Machine Elements: Design for static and dynamic loading, failure theories, fatigue strength; design of bolted, riveted and welded joints; design of shafts and keys; design of spur gears, rolling and sliding contact bearings; brakes and clutches; belt, rope and chain drives.

FLUID MECHANICS AND THERMAL SCIENCES

Fluid Mechanics: Fluid properties, fluid statics, manometry, buoyancy; control-volume analysis of mass, momentum and energy; fluid acceleration; differential equations of continuity and momentum; Bernoulli's equation; viscous flow of incompressible fluids; boundary layer; elementary turbulent flow; flow through pipes, head losses in pipes, bends etc.

Heat-Transfer: Modes of heat transfer; one dimensional heat conduction, resistance concept, electrical analogy, unsteady heat conduction, fins; dimensionless parameters in free and forced convective heat transfer, various correlations for heat transfer in flow over flat plates and through pipes; thermal boundary layer; effect of turbulence; radiative heat transfer, black and grey surfaces, shape factors, network analysis; heat exchanger performance, LMTD and NTU methods.

Thermodynamics: Zeroth, First and Second laws of thermodynamics; thermodynamic system and processes; irreversibility and availability; behaviour of ideal and real gases, properties of pure substances, calculation of work and heat in ideal processes; analysis of thermodynamic cycles related to energy conversion; Carnot, Rankine, Otto, Diesel, Brayton and vapour compression cycles.

Power Plant Engineering: Steam generators; steam power cycles; steam turbines; impulse and reaction principles, velocity diagrams, pressure and velocity compounding; reheating and reheat factor; condensers and feed heaters.

I.C. Engines: Requirements and suitability of fuels in IC engines, fuel ratings, fuel-air mixture requirements; normal combustion in SI and CI engines; engine performance calculations.

Refrigeration and air-conditioning: Refrigerant compressors, expansion devices, condensers and evaporators; properties of moist air, psychrometric chart, basic psychometric processes.

Turbomachinery: Components of gas turbines; compression processes, centrifugal and axial flow compressors; axial flow turbines, elementary theory; hydraulic turbines; Euler-turbine equation; specific speed, Pelton-wheel, Francis and Kaplan turbines; centrifugal pumps.

MANUFACTURING AND INDUSTRIAL ENGINEERING

Engineering Materials: Structure and properties of engineering materials and their applications, heat treatment.

Metal Casting: Casting processes (expendable and non-expendable) -pattern, moulds and cores, heating and pouring, solidification and cooling, gating design, design considerations, defects.

Forming Processes: Stress-strain diagrams for ductile and brittle material, Plastic deformation and yield criteria, fundamentals of hot and cold working processes, Bulk metal forming processes (forging, rolling, extrusion, drawing), sheet metal working processes (punching, blanking, bending, deep drawing, coining, spinning, load estimation using homogeneous deformation methods, defects). processing of powder metals- atomization, compaction, sintering, secondary and finishing operations. forming and shaping of plastics- extrusion, injection moulding.

Joining Processes: Physics of welding, fusion and non-fusion welding processes, brazing and soldering, adhesive bonding, design considerations in welding, weld quality defects.

Machining and Machine Tool Operations: Mechanics of machining, single and multi-point cutting tools, tool geometry and materials, tool life and wear, cutting fluids, machinability, economics of machining, non-traditional machining processes.

Metrology and Inspection: Limits, fits and tolerances, linear and angular measurements, comparators, gauge design, interferometry, form and finish measurement, measurement of screw threads, alignment and testing methods.

Tool Engineering: Principles of work holding, design of jigs and fixtures.

Computer Integrated Manufacturing: Basic concepts of CAD, CAM and their integration tools.

Manufacturing Analysis: Part-print analysis, tolerance analysis in manufacturing and assembly, time and cost analysis.

Work-Study: Method study, work measurement, time study, work sampling, job evaluation, merit rating.

Production Planning and Control: Forecasting models, aggregate production planning, master scheduling, materials requirements planning.

Inventory Control: Deterministic and probabilistic models, safety stock inventory control systems.

Operations Research: Linear programming, simplex and duplex method, transportation, assignment, network flow models, simple queuing models, PERT and CPM

MN - MINING ENGINEERING

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of

trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

MINING ENGINEERING

Mechanics: Equivalent force systems, equations of equilibrium, two dimensional frames and trusses, free body diagrams, friction forces, particle kinematics and dynamics.

Mine Development, Geomechanics and Strata Control: Drivages for underground mine development, drilling methods and machines, explosives, blasting devices and practices, shaft sinking. Physico-mechanical properties of rocks, rock mass classification, ground control instrumentation and stress measurement techniques, theories of rock failure, ground vibrations, stress distribution around mine openings, subsidence, design of supports in roadways and workings, stability of open pits, slopes.

Mining Methods and Machinery: Surface mining - layout, development, loading, transportation and mechanization, continuous surface mining systems. Underground coal mining - bord and pillar system, longwall mining, thick seam mining methods. Underground metal mining: different stoping methods, stope mechanization, ore handling systems, mine filling. Generation and transmission of mechanical, hydraulic, and pneumatic power. Materials handling - haulages, conveyors, ropeways, face and development machinery, hoisting systems, and pumps.

Ventilation, Underground Hazards and Surface Environment: Underground atmosphere, heat load sources and thermal environment, air cooling, mechanics of air flow distribution, natural and mechanical ventilation, mine fans and their usage, auxiliary ventilation. Subsurface hazards from fires, explosions, gases, dust, and inundation, rescue apparatus and practices, safety in mines, accident analysis, noise, mine lighting. Air and water pollution: causes, dispersion, quality standards, and control.

Surveying, Mine Planning and Systems Engineering: Fundamentals of engineering surveying, Levels and levelling, Theodolite, tacheometry, triangulation, contouring, errors and adjustments, correlation, underground surveying, curves, photogrammetry, field astronomy, GPS fundamentals. Principles of planning - Sampling methods and practices, reserve estimation techniques, basics of geostatistics, optimization of facility location, cash flow concepts and mine valuation, open pit design. Work study, concepts of reliability, reliability of series and parallel systems. Linear programming, transportation and assignment problems, queueing, network analysis, inventory control.

MT - METALLURGICAL ENGINEERING

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of

trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

METALLURGICAL ENGINEERING

Thermodynamics and Rate Processes: Laws of thermodynamics, activity, equilibrium constant, applications to metallurgical systems, solutions, phase equilibria, basic kinetic laws, order of reactions, rate constants and rate limiting steps principles of electro chemistry, aqueous, corrosion and protection of metals, oxidation and high temperature corrosion - characterization and control; momentum transfer - concepts of viscosity, shell balances, Bernoulli's equation; heat transfer - conduction, convection and heat transfer coefficient relations, radiation, mass transfer - diffusion and Fick's laws.

Extractive Metallurgy: Flotation, gravity and other methods of mineral processing; agglomeration, pyro-hydro-and electro-metallurgical processes; material and energy balances; principles and processes for the extraction of non-ferrous metals - aluminium, copper, zinc, lead, magnesium, nickel, titanium and other rare metals; iron and steel making - principles, blast furnace, direct reduction processes, primary and secondary steel making, deoxidation and inclusion in steel; ingot and continuous casting; stainless steel making, design of furnaces; fuels and refractories.

Physical Metallurgy: Crystal structure and bonding characteristics of metals, alloys, ceramics and polymers; solid solutions; solidification; phase transformation and binary phase diagrams; principles of heat treatment of steels, aluminum alloys and cast irons; recovery, recrystallization and grain growth; industrially important ferrous and non-ferrous alloys; elements of X-ray and electron diffraction; principles of scanning and transmission electron microscopy; elements of ceramics, composites and electronic materials; electronic basis of thermal, optical, electrical and magnetic properties of materials.

Mechanical Metallurgy: Elements of elasticity and plasticity; defects in crystals; elements of dislocation theory - types of dislocations, slip and twinning, stress fields of dislocations, dislocation interactions and reactions, methods of seeing dislocations; strengthening mechanisms; tensile, fatigue and creep behaviour; superplasticity; fracture - Griffith theory, ductile to brittle transition, fracture toughness; failure analysis; mechanical testing - tension, compression, torsion, hardness, impact, creep, fatigue, fracture toughness and formability tests.

Manufacturing Processes: Metal casting - patterns, moulds, melting, gating, feeding and casting processes, defects and castings, hot and cold working of metals; Metal forming - fundamentals of metal forming, rolling wire drawing, extrusion, forming, sheet metal forming processes, defects in forming; Metal joining - soldering, brazing and welding, common welding processes, welding metallurgy, problems associated with welding of steels and aluminium alloys, defects in welding, powder metallurgy; NDT methods - ultrasonic, radiography, eddy current, acoustic emission and magnetic.

PH - PHYSICS

Mathematical Physics: Linear vector space, matrices; vector calculus; linear differential equations; elements of complex analysis; Laplace transforms, Fourier analysis, elementary ideas about tensors.

Classical Mechanics: Conservation laws; central forces; collisions and scattering in laboratory and centre of mass reference frames; mechanics of system of particles; rigid body dynamics; moment of inertia tensor; noninertial frames and pseudo forces; variational principle; Lagrange's and Hamilton's formalisms; equation of motion, cyclic coordinates, Poisson bracket; periodic motion, small oscillations, normal modes; wave equation and wave propagation; special theory of relativity - Lorentz transformations, relativistic kinematics, mass-energy equivalence.

Electromagnetic Theory: Laplace and Poisson equations; conductors and dielectrics; boundary value problems; Ampere's and Biot-Savart's laws; Faraday's law; Maxwell's equations; scalar and vector potentials; Coulomb and Lorentz gauges; boundary conditions at interfaces; electromagnetic waves; interference, diffraction and polarization; radiation from moving charges.

Quantum Mechanics: Physical basis of quantum mechanics; uncertainty principle; Schrodinger equation; one and three dimensional potential problems; Particle in a box, harmonic oscillator, hydrogen atom; linear vectors and operators in Hilbert space; angular momentum and spin; addition of angular momentum; time independent perturbation theory; elementary scattering theory.

Atomic and Molecular Physics: Spectra of one-and many-electron atoms; LS and jj coupling; hyperfine structure; Zeeman and Stark effects; electric dipole transitions and selection rules; X-ray spectra; rotational and vibrational spectra of diatomic molecules; electronic transition in diatomic molecules, Franck-Condon principle; Raman effect; NMR and ESR; lasers.

Thermodynamics and Statistical Physics: Laws of thermodynamics; macrostates, phase space; probability ensembles; partition function, free energy, calculation of thermodynamic quantities; classical and quantum statistics; degenerate Fermi gas; black body radiation and Planck's distribution law; Bose-Einstein condensation; first and second order phase transitions, critical point.

Solid State Physics: Elements of crystallography; diffraction methods for structure determination; bonding in solids; elastic properties of solids; defects in crystals; lattice vibrations and thermal properties of solids; free electron theory; band theory of solids; metals, semiconductors and insulators; transport properties; optical, dielectric and magnetic properties of solids; elements of superconductivity.

Nuclear and Particle Physics: Rutheford scattering; basic properties of nuclei; radioactive decay; nuclear forces; two nucleon problem; nuclear reactions; conservation laws; fission and fusion; nuclear models; particle accelerators, detectors; elementary particles; photons, baryons, mesons and leptons; Quark model.

Electronics: Network analysis; semiconductor devices; bipolar transistors; FETs; power supplies, amplifier, oscillators; operational amplifiers; elements of digital electronics; logic circuits.

PI - PRODUCTION AND INDUSTRIAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

GENERAL ENGINEERING:

Engineering Materials: Structure and properties of engineering materials and their applications; effect of strain, strain rate and temperature on mechanical properties of metals and alloys; heat treatment of metals and alloys.

Applied Mechanics: Engineering mechanics - equivalent force systems, free body concepts, equations of equilibrium, virtual work and minimum potential energy; strength of materials- stress, strain and their relationship, Mohr's circle, deflection of beams, bending and shear stress, Euler's theory of columns.

Theory of Machines and Design: Analysis of planar mechanisms, plane cams and followers; governers and fly wheels; design of elements-failure theories; design of bolted, riveted and welded joints; design of shafts, keys, belt drives, brakes and clutches.

Thermal Engineering: Fluid machines - fluid statics, Bernoulli's equation, flow through pipes, equations of continuity and momentum; Thermodynamics - zeroth, First and Second laws of thermodynamics, thermodynamic system and processes, calculation of work and heat for systems and control volumes; Heat transfer - fundamentals of conduction, convection and radiation.

PRODUCTION ENGINEERING

Metal Casting: Casting processes; patterns-materials; allowances; moulds and cores - materials, making and testing; melting and founding of cast iron, steels and nonferrous metals and alloys; solidification; design of casting, gating and risering; casting defects and inspection.

Metal working: Stress-strain in elastic and plastic deformation; deformation mechanisms; hot and cold working-forging, rolling, extrusion, wire and tube drawing; sheet metal working; analysis of rolling, forging, extrusion and wire /rod drawing; metal working defects, high energy rate forming processes-explosive, magnetic, electro and electrohydraulic.

Metal Joining Processes: Welding processes - gas shielded metal arc, TIG, MIG, submerged arc, electroslag, thermit, resistance, pressure and forge welding; thermal cutting; other joining processes - soldering, brazing, braze welding; welding codes, welding symbols, design of welded joints, defects and inspection; introduction to modern welding processes - friction, ultrasonic, explosive, electron beam, laser and plasma.

Machining and Machine Tool Operations: Machining processes-turning, drilling, boring, milling, shaping, planing, sawing, gear cutting, thread production, broaching, grinding, lapping, honing super finishing; mechanics of cutting- Merchant's analysis, geometry of cutting tools, cutting forces, power requirements; selection of process parameters; tool materials, tool wear and tool life, cutting fluids, machinability; nontraditional machining processes and hybrid processes- EDM, CHM, ECM, USM, LBM, EBM, AJM, PAM AND WJM; economics of machining.

Metrology and Inspection: Limits and fits, linear and angular measurements by mechanical and optical methods, comparators; design of limit gauges; interferometry; measurement of straightness, flatness, roundness, squareness and symmetry; surface finish measurement; inspection of screw threads and gears; alignment testing.

Powder Metallurgy and Processing of Plastics: Production of powders, compaction, sintering; Polymers and composites; injection, compression and blow molding, extrusion, calendaring and thermoforming; molding of composites.

Tool Engineering: Work-holding-location and clamping; principles and methods; design of jigs and fixtures; design of press working tools, forging dies.

Manufacturing Analysis: Sources of errors in manufacturing; process capability; part-print analysis; tolerance analysis in manufacturing and assembly; process planning; parameter selection and comparison of production alternatives; time and cost analysis; Issues in choosing manufacturing technologies and strategies.

Computer Integrated Manufacturing: Basic concepts of CAD, CAM, CAPP, group technology, NC, CNC, DNC, FMS, Robotics and CIM.

INDUSTRIAL ENGINEERING

Product Design and Development: Principles of good product design, component and tolerance design; efficiency, quality and cost considerations; product life cycle; standardization, simplification, diversification, value analysis, concurrent engineering.

Engineering Economy and Costing: Financial statements; elementary cost accounting, methods of depreciation; break-even analysis, techniques for evaluation of capital investments.

Work System Design: Taylor's scientific management, Gilbreths's contributions; productivity concepts and measurements; method study, micro-motion study, principles of motion economy; human factors engineering, ergonomics; work measurement - time study, PMTS, work sampling; job evaluation, merit rating, wage administration, incentive systems; business process reengineering.

Logistics and Facility Design: Facility location factors, evaluation of alternatives, types of plant layout, evaluation; computer aided layout; assembly line balancing; material handling systems; supply chain management.

Production Planning and Inventory Control: Inventory Function costs, classifications - deterministic and probabilistic models; quantity discount; safety stock; inventory control system; Forecasting techniques - causal and time series models, moving average, exponential smoothing; trend and seasonality; aggregate production planning; master scheduling; bill of materials and material requirement planning; order control and flow control, routing, scheduling and priority dispatching; JIT; Kanban PULL systems; bottleneck scheduling and theory of constraints.

Operation Research: Linear programming - problem formulation, simplex method, duality and sensitivity analysis; transportation; assignment; network flow models, constrained optimization and Lagrange multipliers; simple queuing models; dynamic programming; simulation; PERT and CPM, time-cost trade-off, resource leveling.

Quality Control: Taguchi method; design of experiments; quality costs, statistical quality assurance, process control charts, acceptance sampling, zero defects; quality circles, total quality management.

Reliability and Maintenance: Reliability, availability and maintainability; probabilistic failure and repair times; system reliability; preventive maintenance and replacement, TPM.

Management Information System: Value of information; information storage and retrieval system - database and data structures; interactive systems; knowledge based systems.

Intellectual Property System: Definition of intellectual property, importance of IPR; TRIPS, and its implications, WIPO and Global IP structure, and IPS in India; patent, copyright, industrial design and trademark; meanings, rules and procedures, terms, infringements and remedies.

PY - PHARMACEUTICAL SCIENCES

Natural Products: Pharmacognosy & Phytochemistry - Chemistry, tests, isolation, characterization and estimation of phytopharmaceuticals belonging to the group of Alkaloids, Glycosides, Terpenoids, Steroids, Bioflavanoids, Purines, Guggul lipids. Pharmacognosy of crude drugs which contain the above constituents. Standardisation of raw materials and herbal products. WHO guide lines. Quantitative microscopy including modern techniques used for evaluation. Biotechnological principles and techniques for plant development Tissue culture.

Pharmacology: General pharmacological principles including Toxicology. Drug interaction. Pharmacology of drugs acting on Central nervous system, Cardiovascular system, Autonomic nervous system, Gastro intestinal system and Respiratory system. Pharmacology of Autocoids, Hormones, Chemotherapeutic agents including anticancer drugs. Bioassays. Immuno Pharmacology.

Medicinal Chemistry: Structure, nomenclature, classification, synthesis, SAR and metabolism of the following category of drugs which are official in Indian Pharmacopoeia and British Pharmacopoeia Hypnotics and Sedatives, Analgesics, NSAIDS, Neuroleptics, Antidepressants, Anxiolytics, Anticonvulsants, Antihistaminics, Local anaesthetics, Cardio Vascular drugs - Antianginal agents Vasodilators, Adrenergic & cholinergic drugs, Cardiotonic agents, Diuretics, Antihypertensive drugs, Hypoglycemic agents, Antilipedmic agents, Coagulants, Anticoagulants, Antiplatelet agents. Chemotherapeutic agents - Antibiotics, Antibacterials, Sulphadrugs. Antiproliozoal drugs, Antiviral, Antitubercular, Antimalarial, Anticancer, Antiamoebic drugs. Diagnostic agents. Preparation and storage and uses of official Radiopharmaceuticals. Vitamins and Hormones.

Pharmaceutics: Development, manufacturing standards, labeling, packing as per the pharmacopoeal requirements, Storage of different dosage forms and new drug delivery systems. Biopharmaceutics and Pharmacokinetics and their importance in formulation. Formulation and preparation of cosmetics - lipstick, shampoo, creams, nail preparations and dentifrices. Pharmaceutical calculations.

Pharmaceutical Jurisprudence: Legal aspects of manufacture, storage, sale of drugs. D and C act and rules. Pharmacy act.

Pharmaceutical Analysis: Principles, instrumentation and applications of the following. Absorption spectroscopy (UV, visible & IR), Fluorimetry, Flame photometry, Potentiometry, Conductometry and Plarography. Pharmacopoeial assays. Principles of NMR, ESR, Mass spectroscopy, X-ray diffraction analysis and different chromatographic methods.

Biochemistry and Clinical Pharmacy: Biochemical role of hormones, Vitamins, Enzymes, Nucleic acids. Bioenergetics. General principles of immunology. Immunological techniques. Adverse drug interaction.

Microbiology: Principles and methods of microbiological assays of the Pharmacopoeia. Methods of preparation of official sera and vaccines. Serological and diagnostic tests. Applications of microorganisms in Bio Conversions and in Pharmaceutical industry.

TF - TEXTILE ENGINEERING AND FIBRE SCIENCE

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

TEXTILE ENGINEERING & FIBRE SCIENCE

Textile Fibres: Classification of textile fibres according to their nature and origin; general characteristics of textile fibres-their chemical and physical structures and their properties; essential characteristics of fibre forming polymers; uses of natural and man-made fibres; physical and chemical methods of fibre and blend identification and blend analysis.

Melt Spinning processes with special reference to polyamide and polyester fibres; wet and dry spinning of viscose and acrylic fibres; post spinning operations-drawing, heat setting, texturing- false twist and air-jet, tow-to-top conversion. Methods of investigating fibre structure e.g. X-ray diffraction, birefringence, optical and electron microscopy, I.R. absorption, thermal methods; structure and morphology and principal natural and man-made fibres, mechanical properties of fibres, moisture sorption in fibres; fibre structure and property correlation.

Textile Testing: Sampling techniques, sample size and sampling errors; measurement of fibre length, fineness, crimp, strength and reflectance; measurement of cotton fibre maturity ad trash content; HVI and AFIS for fibre testing. Measurement of yarn count, twist and hairiness; tensile testing of fibres, yarn and fabrics; evenness testing of slivers, rovings and yarns; testing equipment for measurement test methods of fabric properties like thickness, compressibility, air permeability, drape, crease recovery, tear strength bursting strength and abrasion resistance. Correlation analysis, significance tests and analysis of variance; frequency distributions and control charts.

Yarn Manufacture and Yarn Structure: Modern methods of opening, cleaning and blending of fibrous materials; the technology of carding with particular reference to modern developments; causes of irregularity introduced by drafting, the development of modern drafting systems; principles and techniques of preparing material for combing; recent development in combers; functions and synchronization of various mechanisms concerned with roving production; forces acting on yarn and traveller, ring and traveller designs; causes of end breakages; properties of doubles yarns; new methods of yarn production such as rotor spinning, air jet spinning and friction spinning.

Yarn diameter; specific volume, packing coefficient; twist-strength relationship; fibre orientation in yarn; fibre migration.

Fabric Manufacture and Fabric Structure: Principles of cheese and cone winding processes and machines; random and precision winding; package faults and their remedies; yarn clearers and tensioners; different systems of yarn splicing; features of modern cone winding machines; different types of warping creels; features of modern beam and sectional warping machines; different sizing systems, sizing of spun and filament yarns, modern sizing machines; principles of pirn winding processes and machines; primary and secondary motions of loom, effect of their settings and timings on fabric formation, fabric appearance and weaving performance; dobby and jacquard shedding; mechanics of weft insertion with shuttle; warp and weft stop motions, warp protection, weft replenishment; functional principles of weft insertion systems of shuttleless weaving machines, principles of multiphase and circular looms. Principles of weft and warp knitting; basic weft and warp knitted structures; classification, production and areas of application of nonwoven fabrics.

Basic woven fabric constructions and their derivatives; crepe, cord, terry, gauze, lino and double cloth constructions.

Peirce's equations for fabric geometry; thickness, cover and maximum sett of woven fabrics

Textile Chemical Processing: Preparatory processes for natural-and and their blends; mercerization of cotton; machines for yarn and fabric mercerization.

Dyeing and printing of natural- and synthetic- fibre fabrics and their blends with different dye classes; dyeing and printing machines; styles of printing; fastness properties of dyed and printed textile materials.

Finishing of textile materials, wash and wear, durable press, soil release, water repellent, flame retardant and antistatic finishes; shrink-resistance finish for wool; heat setting of synthetic-fibre fabrics, finishing machines; energy efficient processes; pollution control.

XE - ENGINERING SCIENCES

The syllabi of the sections of this paper are as follows:

SECTION A. ENGINEERING MATHEMATICS (Compulsory)

Linear Algebra : Determinates, algebra of matrices, rank, inverse, system of linear equations, symmetric, skew-symmetric and orthogonal matrices. Hermitian, skew-hermitian and unitary matrices. eigenvalues and eigenvectors, diagonalisation of matrices, Cayley-Hamiltonian, quadratic forms.

Calculus : Functions of single variables, limit, continuity and differentiability, Mean value theorems, Intermediate forms and L'Hospital rule, Maxima and minima, Taylor's series, Fundamental and mean value-theorems of integral calculus. Evaluation of definite and improper integrals, Beta and Gamma functions, Functions of two variables, limit, continuity, partial derivatives, Euler's theorem for homogeneous functions, total derivatives, maxima and minima, Lagrange method of multipliers, double and triple integrals and their applications, sequence and series, tests for convergence, power series, Fourier Series, Fourier integrals.

Complex variable: Analytic functions, Cauchy's integral theorem and integral formula without proof. Taylor's and Laurent' series, Residue theorem (without proof) with application to the evaluation of real integarls.

Vector Calculus: Gradient, divergence and curl, vector identities, directional derivatives, line, surface and volume integrals, Stokes, Gauss and Green's theorems (without proofs) with applications.

Ordinary Differential Equations: First order equation (linear and nonlinear), higher order linear differential equations with constant coefficients, method of variation of paramaters, Cauchy's and Euler's equations, initial and boundary value problems, power series solutions, Legendre polynomials and Bessel's functions of the first kind.

Partial Differential Equations: Variables separable method, solutions of one dimensional heat, wave and Laplace equations.

Probability and Statistics: Definitions of probability and simple theorems, conditional probability, mean, mode and standard deviation, random variables, discrete and continuous distributions, Poisson, normal and Binomial distribution, correlation and regression

Numerical Methods: L-U decomposition for systems of linear equations,Newton-Raphson method, numerical integration(trapezoidal and Simpson's rule), numerical methods for first order differential equation (Euler method)

SECTION B. COMPUTATIONAL SCIENCE

Numerical Methods: Truncation errors, round off errors and their propagation; Interpolation; Lagrange, Newton's forward, backward and divided difference formulas, least square curve fitting, solution of non-linear equations of one variables using bisection, false position, secant and Newton Raphson methods; Rate of convergence of these methods, general iterative methods. Simple and multiple roots of polynomials. Solutions of system of linear algebraic equations using Gauss elimination methods, Jacobi and Gauss-Seidel iterative methods and their rate of convergence; ill conditioned and well conditioned system. eigen values and eigen vectors using power methods. Numerical integration using trapezoidal, Simpson's rule and other quadrature formulas. Numerical Differentiation. Solution of boundary value problems. Solution of initial value problems of ordinary differential equations using Euler's method, predictor corrector and Runge Kutta method.

Programming : Elementary concepts and terminology of a computer system and system software, Fortran77 and C programming.

Fortran : Program organization, arithmetic statements, transfer of control, Do loops, subscripted variables, functions and subroutines.

C language : Basic data types and declarations, flow of control- iterative statement, conditional statement, unconditional branching, arrays, functions and procedures.

SECTION C. ELECTRICAL SCIENCES

Electric Circuits: Ideal voltage and current sources; RLC circuits, steady state and transient analysis of DC circuits, network theorems; alternating currents and voltages, single-phase AC circuits, resonance; three-phase circuits.

Magnetic circuits: Mmf and flux, and their relationship with voltage and current; transformer, equivalent circuit of a practical transformer, three-phase transformer connections.

Electrical machines: Principle of operation, characteristics, efficiency and regulation of DC and synchronous machines; equivalent circuit and performance of three-phase and single-phase induction motors.

Electronic Circuits: Characteristics of p-n junction diodes, zener diodes, bipolar junction transistors (BJT) and junction field effect transistors (JFET); MOSFET's structure, characteristics, and operations; rectifiers, filters, and regulated power supplies; biasing circuits, different configurations of transistor amplifiers, class A, B and C of power amplifiers; linear applications of operational amplifiers; oscillators; tuned and phase shift types.

Digital circuits: Number systems, Boolean algebra; logic gates, combinational circuits, flip-flops (RS, JK, D and T) counters.

Measuring instruments: Moving coil, moving iron, and dynamometer type instruments; shunts, instrument transformers, cathode ray oscilloscopes; D/A and A/D converters.

SECTION D. FLUID MECHANICS

Fluid Properties: Relation between stress and strain rate for Newtonian fluids

Hydrostatics, buoyancy, manometry

Concept of local and convective accelerations; control volume analysis for mass, momentum and energy conservation.

Differential equations of continuity and momentum (Euler's equation of motion); concept of fluid rotation, stream function, potential function; Bernoulli's equation and its applications.

Qualitative ideas of boundary layers and its separation; streamlined and bluff bodies; drag and lift forces.

Fully-developed pipe flow; laminar and turbulent flows; friction factor; Darcy Weisbach relation; Moody's friction chart; losses in pipe fittings; flow measurements using venturimeter and orifice plates.

Dimensional analysis; similitude and concept of dynamic similarity; importance of dimensionless numbers in model studies.

SECTION E. MATERIALS SCIENCE

Atomic structure and bonding in materials: metals, ceramics and polymers.

Structure of materials: Crystal systems, unit cells and space lattice; determination of structures of simple crystals by X-ray diffraction; Miller indices for planes and directions. Packing geometry in metallic, ionic and covalent solids.

Concept of amorphous, single and polycrystalline structures and their effects on properties of materials.

Imperfections in crystalline solids and their role in influencing various properties.

Fick´s laws of diffusion and applications of diffusion in sintering, doping of semiconductors and surface hardening of metals.

Alloys: solid solution and solubility limit. Binary phase diagram, intermediate phases and intermetallic compounds; iron-iron carbide phase diagram. Phase transformation in steels. Cold and hot working of metals, recovery, recrystallization and grain growth.

Properties and applications of ferrous and nonferrous alloys.

Structure, properties, processing and applications of traditional and advanced ceramics.

Polymers: classification, polymerization, structure and properties, additives for polymer products, processing and application.

Composites: properties and application of various composites.

Corrosion and environmental degradation of materials (metals, ceramics and polymers).

Mechanical properties of materials: Stress-strain diagrams of metallic, ceramic and polymeric materials, modulus of elasticity, yield strength, plastic deformation and toughness, tensile strength and elongation at break; viscoelasticity, hardness, impact strength. ductile and brittle fracture. creep and fatigue properties of materials.

Heat capacity, thermal conductivity, thermal expansion of materials.

Concept of energy band diagram for materials; conductors, semiconductors and insulators in terms of energy bands. Electrical conductivity, effect of temperature on conductivity in materials, intrinsic and extrinsic semiconductors, dielectric properties of materials.

Refraction, reflection, absorption and transmission of electromagnetic radiation in solids.

Origin of magnetism in metallic and ceramic materials, paramagnetism, diamagnetism, antiferromagnetism, ferromagnetism, ferrimagnetism in materials and magnetic hysteresis.

Advanced materials: Smart materials exhibiting ferroelectric, piezoelectric, optoelectronic, semiconducting behaviour; lasers and optical fibers; photoconductivity and superconductivity in materials.

SECTION F. SOLID MECHANICS

Equivalent force systems; free-body diagrams; equilibrium equations; analysis of determinate and indeterminate trusses and frames; friction.

Simple relative motion of particles; force as function of position, time and speed; force acting on a body in motion; laws of motion; law of conservation of energy; law of conservation of momentum

Stresses and strains; principal stresses and strains; Mohr's circle; generalized Hooke's Law; equilibrium equations; compatibility conditions; yield criteria.

Axial, shear and bending moment diagrams; axial, shear and bending stresses; deflection (for symmetric bending); torsion in circular shafts; thin cylinders; energy methods (Castigliano's Theorems); Euler buckling.

SECTION G. THERMODYNAMICS

Basic Concepts: Continuum, macroscopic approach, thermodynamic system (closed and open or control volume); thermodynamic properties and equilibrium; state of a system, state diagram, path and process; different modes of work; Zeroth law of thermodynamics; concept of temperature; heat.

First Law of Thermodynamics: Energy, enthalpy, specific heats, first law applied to systems and control volumes, steady and unsteady flow analysis.

Second Law of Thermodynamics: Kelvin-Planck and Clausius statements, reversible and irreversible processes, Carnot theorems, thermodynamic temperature scale, Clausius inequality and concept of entropy, principle of increase of entropy; availability and irreversibility.

Properties of Pure Substances: Thermodynamic properties of pure substances in solid, liquid and vapour phases, P-V-T behaviour of simple compressible substances, phase rule, thermodynamic property tables and charts, ideal and real gases, equations of state, compressibility chart.

Thermodynamic Relations: T-ds relations, Maxwell equations, Joule-Thomson coefficient, coefficient of volume expansion, adiabatic and isothermal compressibilities, Clapeyron equation.

Ideal Gas Mixtures: Dalton's and Amagat's laws, calculations of properties, air-water vapour mixtures.

XL - LIFE SCIENCES

The syllabi of the Sections of this paper are as follows:

SECTION H. CHEMISTRY (Compulsory)

Atomic structure and periodicity: Quantum chemistry; Planck's quantum theory, wave particle duality, uncertainty principle, quantum mechanical model of hydrogen atom; electronic configuration of atoms; periodic table and periodic properties; ionization energy, election affinity, electronegativity, atomic size.

Structure and bonding: Ionic and covalent bonding M.O. and V.B. approaches for diatomic molecules, VSEPR theory and shape of molecules, hybridisation, resonance, dipole moment, structure parameters such as bond length, bond angle and bond energy, hydrogen bonding, van der Waals interactions. Ionic solids; ionic radii, lattice energy (Born-Haber Cycle).

s.p. and d Block Elements: Oxides, halides and hydrides of alkali and alkaline earth metals, B, Al, S, N, P and S, silicones, general characteristics of 3d elements, coordination complexes: valence bond and crystal field theory, color, geometry and magnetic properties.

Chemical Equilibria: Colligative properties of solutions, ionic equilibria in solution, solubility product, common ion effect, hydrolysis of salts, pH, buffer and their applications in chemical analysis.

Electrochemistry: Conductance, Kohlrausch law, Half Cell potentials, emf, Nernst equation, galvanic cells, thermodynamic aspects and their applications.

Reaction Kinetics: Rate constant, order of reaction, molecularity, activation energy, zero, first and second order kinetics, equilibrium constants (Kc, Kp and Kx) for homogeneous reactions, catalysis and elementary enzyme reactions.

Thermodynamics: First law, reversible and irreversible processes, internal energy, enthalpy, Kirchoff's equation, heat of reaction, Hess law, heat of formation, Second law, entropy, free energy, and work function. Gibbs-Helmholtz equation, Clausius-Clapeyron equation, free energy change and equilibrium constant, Troutons rule, Third law of thermodynamics.

Mechanistic Basis of Organic Reactions: Elementary treatment of SN1, SN2, E1 and E2 reactions, Hoffmann and Saytzeff rules, Addition reactions, Markonikoff rule and Kharash effect, Diels-Alder reaction, aromatic electrophilic substitution, orientation effect as exemplified by various functional groups.

Structure-Reactivity Correlations: Acids and bases, electronic and steric effects, optical and geometrical isomerism, tautomerism, concept of aromaticity

SECTION I. BIOCHEMISTRY

Organization of life. Importance of water. Cell structure and organelles. Structure and function of biomolecules: Carbohydrates, Lipids, Proteins and Nucleic acids. Biochemical separation techniques. Spectroscopic methods; UV-visible and fluorescence. Protein structure, folding and function: Myoglobin, Hemoglobin, Lysozyme, ribonuclease A, Carboxypeptidase and Chymotrypsin. Enzyme kinetics and regulation, Coenzymes.

Metabolism and bioenergitics. Generation and utilization of ATP. Photosynthesis. Major metabolic pathways and their regulation. Biological membranes. Transport across membranes. Signal transduction; hormones and neurotransmitters.

DNA replication, transcription and translation. Biochemical regulation of gene expression. Recombinant DNA technology and applications. Genomics and Proteomics.

The immune system. Active and passive immunity. Complement system. Antobody structure, function and diversity. Cells of the immune system: T, B and macrophages. T and B cell activation. Major histocompatibilty complex. T cell receptor. Immunological techniques: Immunodiffusion, immunoelectrophoresis, RIA and ELISA.

SECTION J. BIOTECHNOLOGY

Recombinant DNA technology for the production of therapeutic proteins. Micro array technology. Heterologous protein expression systems in bacteria, yeast etc.

Architecture of plant genome; plant tissue culture techniques; methods of gene transfer into plant cells; manipulation of phenotypic traits in plants; plant cell fermentations and production of secondary metabolites using suspension/ immobilized cell culture; methods for plant micro propagation; crop improvement and development of transgenic plants. Expression of animal proteins in plants.

Animal cell metabolism and regulation; cell cycle; primary cell culture; nutritional requirements for animal cell culture; techniques for the mass culture of animal cell lines; production of vaccines; growth hormones and interferons using animal cell culture; cytokines-production and therapeutic uses; hybridoma technology; vectors for gene transfer and expression in animal cells. Transgenic animals and molecular pharming.

Microbial production of industrial enzymes; methods for immobilization of enzymes; kinetics of soluble and immobilized enzymes; application of soluble and immobilized enzymes; enzyme-based sensors.

Microbial growth kinetics; batch, fed batch and continuous culture of microbial cells; media for industrial fermentations; sterilization of air and media; design features and operation of stirred tank, air-lift and fluidized bed reactors; aeration and agitation in aerobic fermentations; recovery and purification of fermentation products- filtration, centrifugation, cell disintegration, solvent extraction and chromatographic separations; industrial fermentations for the production of ethanol, citric acid, lysine, penicillin and other biomolecules; simple calculations based on material and energy balance of fermentation processes; application of microbes in the management of domestic and industrial wastes.

SECTION K. BOTANY

Anatomy: Roots, stem and leaves of land plants, meristems, vascular system, their ontogeny, structure and functions. Plant cell structure, organisation, organelles, cytoskeleton, cell wall and membranes.

Development: Cell cycle, cell division, senescence, hormonal regulation of growth; life cycle of an angiosperm, pollination, fertilization, embryogenesis, seed formation, seed storage proteins, seed dormancy and germination. Concept of cellular totipotency, organogenesis and somatic embryogenesis, somaclonal variation, embryo culture, in vitro fertilization.

Physiology and Biochemistry: Plant water relations, transport of minerals and solutes, N2 metabolism, proteins and nucleic acid, respiration, photophysiology, photosynthesis, photorespiration; biosynthesis, mechanism of action and physiological effects of plant growth regulators.

Genetics: Principles of Mendelian inheritance, linkage, recombination and genetic mapping; extrachromosomal inheritance; eukaryotic genome organization (chromatin structure) and regulation of gene expression, gene mutation, chromosome aberrations (numerical and structural), transposons.

Plant Breeding: Principles, methods - selection, hybridization, heterosis; male sterility, self and inter-specific incompatibility; haploidy; somatic cell hybridization; molecular marker-assisted selection; gene transfer methods viz. direct and vector-mediated, transgenic plants and their applications in agriculture.

Economic Botany: Economically important plants - cereals, pulses, plants yielding fiber, timber, sugar, beverages, oils, rubber, dyes, gums, drugs and narcotics - a general account.

Systematics: Systems of classification (non-phylogenetic vs. phylogenetic - outline), plant groups, molecular systematics.

Plant Pathology: Nature and classification of plant diseases, diseases of important crops caused by fungi, bacteria and viruses, and their control measures, mechanism(s) of pathogenesis and resistance, molecular detection of pathogens; plant-microbe beneficial interactions.

Ecology and Plant Geography: Ecosystems - types, dynamics, degradation, ecological succession; food chains; vegetation types of the world; pollution and global warming; speciation and extinction, conservation strategies, cryopreservation.

SECTION L. MICROBIOLOGY

Historical perspective - Discovery of the microbial world; Controversy over spontaneous generation; Role of microorganisms in transformation of organic matter and in the causation of diseases.

Methods in microbiology - Pure culture techniques; Theory and practice of sterilization; Principles of microbial nutrition; Construction of culture media; Enrichment culture techniques for isolation of chemoautotrophs, chemoheterotrophs and photosynthetic microorganisms.

Microbial evolution, systematics and taxonomy - Evolution of earth and earliest life forms; Primitive organisms and their metabolic strategies; New approaches to bacterial taxonomic classification including ribotyping; Nomenclature.

Microbial diversity - Bacteria, archea and their broad classification; Eukaryotic microbes, yeast, fungi, slime mold and protozoa; Viruses and their classification.

Microbial growth -The definition of growth, mathematical expression of growth, growth curve, measurement of growth and growth yields; Synchronous growth; Continuous culture.

Nutrition and metabolism - Overview of metabolism; Microbial nutrition; Energy classes of microorganisms; Culture media; Energetics, modes of ATP generation; ATP generation by heterotrophs; Fermentation; Glycolysis; Respiration; The citric acid cycle; Electron transport systems; Alternate modes of energy generation; Pathways (anabolism) in the biosynthesis of amino acids, purines, pyrimidines and fatty acids.

Metabolic diversity among microorganisms - Photosynthesis in microorganisms; Role of chlorophylls, carotenoids and phycobilins; Calvin cycle; Chemolithotrophy; Hydrogen- iron- nitrite-oxidizing bacteria; Nitrate and sulfate reduction; Methanogenesis and acetogenesis.

Prokaryotic cells: structure-function - Cells walls of eubacteria (peptidoglycan) and related molecules; Outer-membrane of gram-negative bacteria; Cell wall and cell membrane synthesis; Flagella and motility; Cell inclusions like endospores, gas vesicles.

Microbial diseases and host parasite relationships - Normal microflora of skin; Oral cavity; Gastrointestinal tract; Entry of pathogens into the host; Infectious disease transmission; Respiratory infections caused by bacteria and viruses; Tuberculosis; Sexually transmitted diseases including AIDS; Diseases transmitted by animals (Rabies, plague), insects and ticks (rikettsias, Lyme disease, malaria); Food and water borne diseases; Public health and water quality; Pahtogenic fungi; Emerging and resurgent infectious diseases.

Chemotherapy/Antibiotics - Antimicrobial agents; Sulfa drugs; Antibiotics; Pencillins and cephalosporins; Broad-spectrum antibiotics; Antibiotics from prokaryotes; Antifungal antibiotics; Mode of action; Resistance to antibiotics.

Microbial genetics - Genes, mutation and mutagenesis - UV and chemical mutagnes; Types of mutations; Ames test for mutagenesis; Methods of genetic analysis. Bacterial genetic system - Transformation; Conjugation; Transduction; Recombination; Plasmids and Transposons; Bacterial genetic map with reference to E. coli. Viruses and their genetic system - Phage ? and its life cycle; RNA phages; RNA viruses; Retroviruses; Genetic systems of yeast and Neurospora; Extrachromosomal inheritance and mitochondrial genetics; Basic concept of genomics.

SECTION M. ZOOLOGY

Animal world: Animal diversity, distribution, systematic and classification of animals, the phylogenetic relationship.

Evolution: Origin of life, history of life on earth, evolutionary theories, natural selection, adaptation, speciation.

Genetics: Principles of inheritance, molecular basis of heredity, the genetic material, transmission of genetic material, mutations, cytoplasmic inheritance.

Biochemistry and Molecular Biology: Nucleic acids, proteins and other biological macromolecules. Replication, transcription and translation, regulation of gene expression, organization of genome, Kreb's cycle, glycolysis, enzyme catalysis, hormones and their action.

Cell Biology: Structure of cell, cellular organelles and their structure and function, cell cycle, cell division, cellular differentiation, chromosome and chromatin structure. Eukaryotic gene organisation and expression.

Animal Anatomy and Physiology: Comparative physiology, the respiratory system, circulatory system, digestive system, the nervous system, the excretory system, the endocrine system, the reproductive system, the skeletal system, osmoregulation.

Parasitology and Immunology: Nature of parasite, host-parasite relation, protozoan and helminthic parasites, the immune response, cellular and humoral immune response, evolution of the immune system.

Development Biology: Embryonic development, cellular differentiation, organogenesis, metamorphosis, genetic basis of development.

Ecology: The ecosystem, habitats the food chain, population dynamics, species diversity, zoogeography, biogeochemical cycles, conservation biology.

Animal Behaviour: Types of behaviours, courtship, mating and territoriality, instinct, learning and memory, social behaviour across the animal taxa, communication, pheromones, evolution of animal behaviour.

IT - INFORMATION TECHNOLOGY

ENGINEERING MATHEMATICS

Mathematical Logic: Propositional Logic; First Order Logic.

Probability: Conditional Probability; Mean, Median, Mode and Standard Deviation; Random Variables; Distributions; uniform, normal, exponential, Poisson, Binomial.

Set Theory & Algebra: Sets; Relations; Functions; Groups; Partial Orders; Lattice; Boolean Algebra.

Combinatorics: Permutations; Combinations; Counting; Summation; generating functions; recurrence relations; asymptotics.

Graph Theory: Connectivity; spanning trees; Cut vertices & edges; covering; matching; independent sets; Colouring; Planarity; Isomorphism.

Linear Algebra: Algebra of matrices, determinants, systems of linear equations, Eigen values and Eigen vectors.

Numerical Methods: LU decomposition for systems of linear equations; numerical solutions of non linear algebraic equations by Secant, Bisection and Newton-Raphson Methods; Numerical integration by trapezoidal and Simpson's rules.

Calculus: Limit, Continuity & differentiability, Mean value Theorems, Theorems of integral calculus, evaluation of definite & improper integrals, Partial derivatives, Total derivatives, maxima & minima.

FORMAL LANGUAGES AND AUTOMATA

Regular Languages: finite automata, regular expressions, regular grammar.

Context free languages: push down automata, context free grammars

COMPUTER HARDWARE

Digital Logic: Logic functions, minimization, design and synthesis of combinatorial and sequential circuits, number representation and computer arithmetic (fixed and floating point)

Computer organization: Machine instructions and addressing modes, ALU and data path, hardwired and microprogrammed control, memory interface, I/O interface (interrupt and DMA mode), serial communication interface, instruction pipelining, cache, main and secondary storage

SOFTWARE SYSTEMS

Data structures and Algorithms: the notion of abstract data types, stack, queue, list, set, string, tree, binary search tree, heap, graph, tree and graph traversals, connected components, spanning trees, shortest paths, hashing, sorting, searching, design techniques (greedy, dynamic, divide and conquer), asymptotic analysis (best, worst, average cases) of time and space, upper and lower bounds, intractability

Programming Methodology: C programming, program control (iteration, recursion, functions), scope, binding, parameter passing, elementary concepts of object oriented programming

Operating Systems (in the context of Unix): classical concepts (concurrency, synchronization, deadlock), processes, threads and interprocess communication, CPU scheduling, memory management, file systems, I/O systems, protection and security

Information Systems and Software Engineering: information gathering, requirement and feasibility analysis, data flow diagrams, process specifications, input/output design, process life cycle, planning and managing the project, design, coding, testing, implementation, maintenance.

Databases: relational model, database design, integrity constraints, normal forms, query languages (SQL), file structures (sequential, indexed), b-trees, transaction and concurrency control

Data Communication: data encoding and transmission, data link control, multiplexing, packet switching, LAN architecture, LAN systems (Ethernet, token ring), Network devices: switches, gateways, routers

Networks: ISO/OSI stack, sliding window protocols, routing protocols, TCP/UDP, application layer protocols & systems (http, smtp, dns, ftp), network security

Web technologies: three tier web based architecture; JSP, ASP, J2EE, .NET systems; html, XML

AG - AGRICULTURAL ENGINEERING

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

FARM MACHINERY AND POWER:

Sources of power on the farm-human, animal, mechanical, electrical, wind, solar and biomass; design and selection of machine elements - gears, pulleys, chains and sprockets and belts; overload safety devices used in farm machinery; measurement of force, torque, speed, displacement and acceleration on machine elements.

Soil tillage; forces acting on a tillage tool; hitch systems and hitching of tillage implements; functional requirements, principles of working, construction and operation of manual, animal and power operated equipment for tillage. sowing, planting, fertilizer application, inter-cultivation, spraying, mowing, chaff cutting, harvesting, threshing and transport; testing of agricultural machinery and equipment; calculation of performance parameters -field capacity, efficiency, application rate and losses; cost analysis of implements and tractors.

Thermodynamic principles of I.C. engines; I.C. engine cycles; engine components; fuels and combustion; lubricants and their properties; I.C. engine systems - fuel, cooling, lubrication, ignition, electrical, intake and exhaust; selection, operation, maintenance and repair of I.C. engines; power efficiencies and measurement; calculation of power, torque, fuel consumption, heat load and power losses.

Tractors and power tillers - type, selection, maintenance and repair; tractor clutches and brakes; power transmission systems - gear trains, differential, final drives and power take-off; mechanics of tractor chassis; traction theory; three point hitches- free link and restrained link operations; mechanical steering and hydraulic control systems used in tractors; human engineering and safety in tractor design; tractor tests and performance.

SOIL AND WATER CONSERVATION ENGINEERING:

Ideal and real fluids, properties of fluids; hydrostatic pressure and its measurement; hydrostatic forces on plane and curved surface; continuity equation; Bernoulli's theorem; laminar and turbulent flow in pipes, Darcy-Weisbach and Hazen-Williams equations, Moody's diagram; flow through orifices and notches; flow in open channels.

Engineering properties of soils, fundamental definitions and relationships; index properties of soils; permeability and seepage analysis; shear strength, Mohr's circle of stresses; active and passive earth pressures; stability of slopes.

Hydrological cycle; precipitation measurement, analysis of precipitation data; abstraction from precipitation; runoff; hydrograph analysis, unit hydrograph theory and application; stream flow measurement; flood routing, hydrological reservoir and channel routing.

Mechanics of soil erosion, factors affecting erosion; soil loss estimation; biological and engineering measures to control erosion, terraces and bunds; vegetative waterways; gully control structures, drop, drop inlet and chute spillways; farm ponds; earthen dams; principles of watershed management.

Water requirement of crops; consumptive use and evapo-transpiration; irrigation scheduling; irrigation efficiencies; design of prismatic and silt loaded channels; methods of irrigation water application; design and evaluation of irrigation methods; drainage coefficient; surface and subsurface drainage systems; leaching requirement and salinity control; irrigation and drainage water quality; classification of pumps; pump characteristics; pump selection; types of aquifer; evaluation of aquifer properties; well hydraulics; ground water recharge.

AGRICULTURAL PROCESSING AND FOOD ENGINEERING:

Steady state heat transfer in conduction, convection and radiation; transient heat transfer in simple geometry; condensation and boiling heat transfer; working principles of heat exchangers; diffusive and convective mass transfer; simultaneous heat and mass transfer in agricultural processing operations.

Material and energy balances in food processing systems; water activity, sorption and desorption isotherms; centrifugal separation of solids, liquids and gases; kinetics of microbial death - pasteurisation and sterilization of liquid foods; preservation of food by cooling and freezing; psychrometry - properties of air-vapour mixture; concentration and dehydration of liquid foods - evaporators, tray, drum and spray dryers.

Mechanics and energy requirement in size reduction of granular solids; particle size analysis for comminuted solids; size separation by screening; fluidisation of granular solids; cleaning and grading efficiency and effectiveness of grain cleaners; conditioning and hydrothermal treatments for grains; dehydration of food grains; processes and machines for processing of cereals, pulses and oilseeds; design considerations for grain silos.

AR - ARCHITECTURE AND PLANNING

City planning: Historical development of cities; principles of city planning; new towns; survey methods, site planning, planning regulations and building bye-laws.

Housing: Concept of shelter; housing policies and design; community planning; role of government agencies; finance and management.

Landscape Design: Principles of landscape design and site planning; history and landscape styles; landscape elements and materials; planting design.

Computer Aided Design: Application of computers in architecture and planning; understanding elements of hardware and software; computer graphics; programming languages - C and Visual Basic and usage of packages such as AutoCAD.

Environmental and Building Science: Elements of environmental science; ecological principles concerning environment; role of micro-climate in design; climatic control through design elements; thermal comfort; elements of solar architecture; principles of lighting and illumination; basic principles of architectural acoustics; air pollution, noise pollution and their control.

Visual and Urban Design: Principles of visual composition; proportion, scale, rhythm, symmetry, harmony, balance, form and colour; sense of place and space, division of space; focal point, vista, imageability, visual survey.

History of Architecture: Indian - Indus valley, Vedic, Buddhist, Indo-Aryan, Dravidian and Mughal periods; European - Egyptian, Greek, Roman, medieval and renaissance periods.

Development of Contemporary Architecture: Architectural developments and impacts on society since industrial revolution; influence of modern art on architecture; works of national and international architects; post modernism in architecture.

Building Services: Water supply, Sewerage and Drainage systems; Sanitary fittings and fixtures; principles of electrification of buildings; elevators, their standards and uses; air-conditioning systems; fire fighting systems.

Building Construction and Management: Building construction techniques, methods and details; building systems and prefabrication of building elements; principles of modular coordination; estimation, specification, valuation, professional practice; project management, PERT, CPM.

Materials and Structural Systems: Behavioural characteristics of all types of building materials e.g. mud, timber, bamboo, brick, concrete, steel, glass, FRP; principles of strength of materials; design of structural elements in wood, steel and RCC; elastic and limit state design; complex structural systems; principles of pre-stressing.

Planning Theory: Planning process; multilevel planning; comprehensive planning; central place theory; settlement pattern; land use and land utilization.

Techniques of Planning: Planning surveys; Preparation of urban and regional structure plans, development plans, action plans; site planning principles and design; statistical methods; application of remote sensing techniques in urban and regional planning.

Traffic and Transportation Planning: Principles of traffic engineering and transportation planning; methods of conducting surveys; design of roads, intersections and parking areas; hierarchy of roads and levels of services; traffic and transport management in urban areas; traffic safety and traffic laws; public transportation planning; modes of transportation.

Services and Amenities: Principles and design of water supply systems, sewerage systems, solid waste disposal systems, power supply and communication systems; Health, education, recreation and demography related standards at various levels of the settlements.

Development Administration and Management: Planning laws; development control and zoning regulations; laws relating to land acquisition; development enforcements, land ceiling; regional and urban plan preparations; planning and municipal administration; taxation, revenue resources and fiscal management; public participation and role of NGO.

CE - CIVIL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

STRUCTURAL ENGINEERING

Mechanics: Bending moments and shear forces in statically determinate beams; simple stress and strain: relationship; stress and strain in two dimensions, principal stresses, stress transformation, Mohr's circle; simple bending theory; flexural shear stress; thin-walled pressure vessels; uniform torsion.

Structural Analysis: Analysis of statically determinate trusses, arches and frames; displacements in statically determinate structures and analysis of statically indeterminate structures by force/energy methods; analysis by displacement methods (slope-deflection and moment-distribution methods); influence lines for determinate and indeterminate structures; basic concepts of matrix methods of structural analysis.

Concrete Structures: Basic working stress and limit states design concepts; analysis of ultimate load capacity and design of members subject to flexure, shear, compression and torsion (beams, columns and isolated footings); basic elements of prestressed concrete: analysis of beam sections at transfer and service loads.

Steel Structures: Analysis and design of tension and compression members, beams and beam-columns, column bases; connections - simple and eccentric, beam-column connections, plate girders and trusses; plastic analysis of beams and frames.

GEOTECHNICAL ENGINEERING

Soil Mechanics: Origin of soils; soil classification; three-phase system, fundamental definitions, relationship and inter-relationships; permeability and seepage; effective stress principle: consolidation, compaction; shear strength.

Foundation Engineering: Sub-surface investigation - scope, drilling bore holes, sampling, penetrometer tests, plate load test; earth pressure theories, effect of water table, layered soils; stability of slopes - infinite slopes, finite slopes; foundation types - foundation design requirements; shallow foundations; bearing capacity, effect of shape, water table and other factors, stress distribution, settlement analysis in sands and clays; deep foundations - pile types, dynamic and static formulae, load capacity of piles in sands and clays.

WATER RESOURCES ENGINEERING

Fluid Mechanics and Hydraulics: Hydrostatics, applications of Bernoulli equation, laminar and turbulent flow in pipes, pipe networks; concept of boundary layer and its growth; uniform flow, critical flow and gradually varied flow in channels, specific energy concept, hydraulic jump; forces on immersed bodies; flow measurement in channels; tanks and pipes; dimensional analysis and hydraulic modeling. Applications of momentum equation, potential flow, kinematics of flow; velocity triangles and specific speed of pumps and turbines.

Hydrology: Hydrologic cycle; rainfall; evaporation infiltration, unit hydrographs, flood estimation, reservoir design, reservoir and channel routing, well hydraulics.

Irrigation: Duty, delta, estimation of evapo-transpiration; crop water requirements; design of lined and unlined canals; waterways; head works, gravity dams and Ogee spillways. Designs of weirs on permeable foundation, irrigation methods.

ENVIRONMENTAL ENGINEERING

Water requirements; quality and standards, basic unit processes and operations for water treatment, distribution of water. Sewage and sewerage treatment: quantity and characteristic of waste water sewerage; primary and secondary treatment of waste water; sludge disposal; effluent discharge standards.

TRANSPORTATION ENGINEERING

Highway planning; geometric design of highways; testing and specifications of paving materials; design of flexible and rigid pavements.

CH - CHEMICAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

CHEMICAL ENGINEERING

Process Calculations and Thermodynamics: Laws of conservation of mass and energy; use of tie components; recycle, bypass and purge calculations; degree of freedom analysis.

First and Second laws of thermodynamics and their applications; equations of state and thermodynamic properties of real systems; phase equilibria; fugacity, excess properties and correlations of activity coefficients; chemical reaction equilibria.

Fluid Mechanics and Mechanical Operations: Fluid statics, Newtonian and non-Newtonian fluids, Bernoulli equation, Macroscopic friction factors, energy balance, dimensional analysis, shell balances, flow through pipeline systems, flow meters, pumps and compressors, packed and fluidized beds, elementary boundary layer theory, size reduction and size separation; free and hindered settling; centrifuge and cyclones; thickening and classification, filtration, mixing and agitation; conveying of solids.

Heat Transfer: Conduction, convection and radiation, heat transfer coefficients, steady and unsteady heat conduction, boiling, condensation and evaporation; types of heat exchangers and evaporators and their design.

Mass Transfer: Fick's law, molecular diffusion in fluids, mass transfer coefficients, film, penetration and surface renewal theories; momentum, heat and mass transfer analogies; stagewise and continuous contacting and stage efficiencies; HTU & NTU concepts design and operation of equipment for distillation, absorption, leaching, liquid-liquid extraction, crystallization, drying, humidification, dehumidification and adsorption.

Chemical Reaction Engineering: Theories of reaction rates; kinetics of homogeneous reactions, interpretation of kinetic data, single and multiple reactions in ideal reactors, non-ideal reactors; residence time; non-isothermal reactors; kinetics of heterogeneous catalytic reactions; diffusion effects in catalysis.

Instrumentation and Process Control: Measurement of process variables; sensors, transducers and their dynamics, dynamics of simple systems, dynamics such as CSTRs, transfer functions and responses of simple systems, process reaction curve, controller modes (P, PI, and PID); control valves; analysis of closed loop systems including stability, frequency response (including Bode plots) and controller tuning, cascade, feed forward control.

Plant Design and Economics: Design and sizing of chemical engineering equipment such as compressors, heat exchangers, multistage contactors; principles of process economics and cost estimation including total annualized cost, cost indexes, rate of return, payback period, discounted cash flow, optimization in Design.

Chemical Technology: Inorganic chemical industries; sulfuric acid, NaOH, fertilizers (Ammonia, Urea, SSP and TSP); natural products industries (Pulp and Paper, Sugar, Oil, and Fats); petroleum refining and petrochemicals; polymerization industries; polyethylene, polypropylene, PVC and polyester synthetic fibers.

CS - COMPUTER SCIENCE AND ENGINEERING

ENGINEERING MATHEMATICS

Mathematical Logic: Propositional Logic; First Order Logic.

Probability: Conditional Probability; Mean, Median, Mode and Standard Deviation; Random Variables; Distributions; uniform, normal, exponential, Poisson, Binomial.

Set Theory & Algebra: Sets; Relations; Functions; Groups; Partial Orders; Lattice; Boolean Algebra.

Combinatorics: Permutations; Combinations; Counting; Summation; generating functions; recurrence relations; asymptotics.

Graph Theory: Connectivity; spanning trees; Cut vertices & edges; covering; matching; independent sets; Colouring; Planarity; Isomorphism.

Linear Algebra: Algebra of matrices, determinants, systems of linear equations, Eigen values and Eigen vectors.

Numerical Methods: LU decomposition for systems of linear equations; numerical solutions of non linear algebraic equations by Secant, Bisection and Newton-Raphson Methods; Numerical integration by trapezoidal and Simpson's rules.

Calculus: Limit, Continuity & differentiability, Mean value Theorems, Theorems of integral calculus, evaluation of definite & improper integrals, Partial derivatives, Total derivatives, maxima & minima.

THEORY OF COMPUTATION

Formal Languages and Automata Theory: Regular languages and finite automata, Context free languages and Push-down automata, Recursively enumerable sets and Turing machines, Un-decidability;

Analysis of Algorithms and Computational Complexity: Asymptotic analysis (best, worst, average case) of time and space, Upper and lower bounds on the complexity of specific problems, NP-completeness.

COMPUTER HARDWARE

Digital Logic: Logic functions, Minimization, Design and synthesis of Combinational and Sequential circuits; Number representation and Computer Arithmetic (fixed and floating point);

Computer Organization: Machine instructions and addressing modes, ALU and Data-path, hardwired and micro-programmed control, Memory interface, I/O interface (Interrupt and DMA mode), Serial communication interface, Instruction pipelining, Cache, main and secondary storage.

SOFTWARE SYSTEMS

Data structures: Notion of abstract data types, Stack, Queue, List, Set, String, Tree, Binary search tree, Heap, Graph;

Programming Methodology: C programming, Program control (iteration, recursion, Functions), Scope, Binding, Parameter passing, Elementary concepts of Object oriented, Functional and Logic Programming;

Algorithms for problem solving: Tree and graph traversals, Connected components, Spanning trees, Shortest paths; Hashing, Sorting, Searching; Design techniques (Greedy, Dynamic Programming, Divide-and-conquer);

Compiler Design: Lexical analysis, Parsing, Syntax directed translation, Runtime environment, Code generation, Linking (static and dynamic); Operating Systems: Classical concepts (concurrency, synchronization, deadlock), Processes, threads and Inter-process communication, CPU scheduling, Memory management, File systems, I/O systems, Protection and security.

Databases: Relational model (ER-model, relational algebra, tuple calculus), Database design (integrity constraints, normal forms), Query languages (SQL), File structures (sequential files, indexing, B+ trees), Transactions and concurrency control;

Computer Networks: ISO/OSI stack, sliding window protocol, LAN Technologies (Ethernet, Token ring), TCP/UDP, IP, Basic concepts of switches, gateways, and routers.

CH - CHEMISTRY

PHYSICAL CHEMISTRY

Structure: Quantum theory - principles and techniques; applications to particle in a box, harmonic oscillator, rigid rotor and hydrogen atom; valence bond and molecular orbital theories and Huckel approximation, approximate techniques: variation and perturbation; symmetry, point groups; rotational, vibrational, electronic, NMR and ESR spectroscopy.

Equilibrium: First law of thermodynamics, heat, energy and work; second law of thermodynamics and entropy; third law and absolute entropy; free energy; partial molar quantities; ideal and non-ideal solutions; phase transformation: phase rule and phase diagrams- one, two, and three component systems; activity, activity coefficient, fugacity and fugacity coefficient ; chemical equilibrium, response of chemical equilibrium to temperature and pressure; colligative properties; kinetic theory of gases; thermodynamics of electrochemical cells; standard electrode potentials: applications - corrosion and energy conversion; molecular partition function (translational, rotational, vibrational and electronic).

Kinetics: Rates of chemical reactions, theories of reaction rates, collision and transition state theory; temperature dependence of chemical reactions; elementary reactions, consecutive elementary reactions; steady state approximation, kinetics of photochemical reactions and free radical polymerization, homogenous and heterogeneous catalysis.

INORGANIC CHEMISTRY

Non-Transition Elements: General characteristics, structure and reactions of simple and industrially important compounds, boranes, carboranes, silicates, silicones, diamond and graphite; hydrides, oxides and oxoacids of N, P, S and halogens; boron nitride, borazines and phosphazenes; xenon compounds. Shapes of molecules, hard-soft acid base concept.

Transition Elements: General characteristics of d and f block elements; coordination chemistry: structure and isomerism, stability, theories of metal-ligand bonding (CFT and LFT), electronic spectra and magnetic properties of transition metal complexes and lanthanides; metal carbonyls, metal-metal bonds and metal atom clusters, metallocenes; transition metal complexes with bonds to hydrogen, alkyls, alkenes, and arenes; metal carbenes; use of organometallic compounds as catalysts in organic synthesis; mechanisms of substitution and electron transfer reactions of coordination complexes. Role of metals with special reference to Na, K, Mg, Ca, Fe, Co, Zn, and Mo in biological systems.

Solids: Crystal systems and lattices, Miller planes, crystal packing, crystal defects; Bragg's Law; ionic crystals, band theory, metals and semiconductors. Spinels.

Instrumental methods of analysis: atomic absorption, UV-visible spectrometry, chromatographic and electro-analytical methods.

ORGANIC CHEMISTRY

Synthesis, reactions and mechanisms involving the following: Alkenes, alkynes, arenes, alcohols, phenols, aldehydes, ketones, carboxylic acids and their derivatives; halides, nitro compounds and amines; stereochemical and conformational effects on reactivity and specificity; reactions with diborane and peracids. Michael reaction, Robinson annulation, reactivity umpolung, acyl anion equivalents; molecular rearrangements involving electron deficient atoms.

Photochemistry: Basic principles, photochemistry of olefins, carbonyl compounds, arenes, photo oxidation and reduction.

Pericyclic reactions: Cycloadditions, electrocyclic reactions, sigmatropic reactions; Woodward-Hoffmann rules.

Heterocycles: Structural properties and reactions of furan, pyrrole, thiophene, pyridine, indole.

Biomolecules: Structure, properties and reactions of mono- and di-saccharides, physico-chemical properties of amino acids, structural features of proteins and nucleic acids.

Spectroscopy: Principles and applications of IR, UV-visible, NMR and mass spectrometry in the determination of structures of organic compounds.

EC - ELECTRONICS AND COMMUNICATION ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix Algebra, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Mean value theorems, Theorems of integral calculus, Evaluation of definite and improper integrals, Partial Derivatives, Maxima and minima, Multiple integrals, Fourier series. Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equation (linear and nonlinear), Higher order linear differential equations with constant coefficients, Method of variation of parameters, Cauchy's and Euler's equations, Initial and boundary value problems, Partial Differential Equations and variable separable method.

Complex variables: Analytic functions, Cauchy's integral theorem and integral formula, Taylor's and Laurent' series, Residue theorem, solution integrals.

Probability and Statistics: Sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Discrete and continuous distributions, Poisson, Normal and Binomial distribution, Correlation and regression analysis.

Numerical Methods: Solutions of non-linear algebraic equations, single and multi-step methods for differential equations.

Transform Theory: Fourier transform, Laplace transform, Z-transform.

ELECTRONICS & COMMUNICATION ENGINEERING

Networks: Network graphs: matrices associated with graphs; incidence, fundamental cut set and fundamental circuit matrices. Solution methods: nodal and mesh analysis. Network theorems: superposition, Thevenin and Norton's maximum power transfer, Wye-Delta transformation. Steady state sinusoidal analysis using phasors. Linear constant coefficient differential equations; time domain analysis of simple RLC circuits, Solution of network equations using Laplace transform: frequency domain analysis of RLC circuits. 2-port network parameters: driving point and transfer functions. State equations for networks.

Electronic Devices: Energy bands in silicon, intrinsic and extrinsic silicon. Carrier transport in silicon: diffusion current, drift current, mobility, resistivity. Generation and recombination of carriers. p-n junction diode, Zener diode, tunnel diode, BJT, JFET, MOS capacitor, MOSFET, LED, p-I-n and avalanche photo diode, LASERs. Device technology: integrated circuits fabrication process, oxidation, diffusion, ion implantation, photolithography, n-tub, p-tub and twin-tub CMOS process.

Analog Circuits: Equivalent circuits (large and small-signal) of diodes, BJTs, JFETs, and MOSFETs. Simple diode circuits, clipping, clamping, rectifier. Biasing and bias stability of transistor and FET amplifiers. Amplifiers: single-and multi-stage, differential, operational, feedback and power. Analysis of amplifiers; frequency response of amplifiers. Simple op-amp circuits. Filters. Sinusoidal oscillators; criterion for oscillation; single-transistor and op-amp configurations. Function generators and wave-shaping circuits. Power supplies.

Digital circuits: Boolean algebra, minimization of Boolean functions; logic gates digital IC families (DTL, TTL, ECL, MOS, CMOS). Combinational circuits: arithmetic circuits, code converters, multiplexers and decoders. Sequential circuits: latches and flip-flops, counters and shift-registers. Sample and hold circuits, ADCs, DACs. Semiconductor memories. Microprocessor(8085): architecture, programming, memory and I/O interfacing.

Signals and Systems: Definitions and properties of Laplace transform, continuous-time and discrete-time Fourier series, continuous-time and discrete-time Fourier Transform, z-transform. Sampling theorems. Linear Time-Invariant (LTI) Systems: definitions and properties; casuality, stability, impulse response, convolution, poles and zeros frequency response, group delay, phase delay. Signal transmission through LTI systems. Random signals and noise: probability, random variables, probability density function, autocorrelation, power spectral density.

Controls Systems: Basic control system components; block diagrammatic description, reduction of block diagrams. Open loop and closed loop (feedback) systems and stability analysis of these systems. Signal flow graphs and their use in determining transfer functions of systems; transient and steady state analysis of LTI control systems and frequency response. Tools and techniques for LTI control system analysis: root loci, Routh-Hurwitz criterion, Bode and Nyquist plots. Control system compensators: elements of lead and lag compensation, elements of Proportional-Integral-Derivative(PID) control. State variable representation and solution of state equation of LTI control systems.

Communications: Analog communication systems: amplitude and angle modulation and demodulation systems, spectral analysis of these operations, superheterodyne receivers; elements of hardware, realizations of analog communication systems; signal-to-noise ratio (SNR) calculations for amplitude modulation (AM) and frequency modulation (FM) for low noise conditions. Digital communication systems: pulse code modulation (PCM), differential pulse code modulation (DPCM), delta modulation (DM); digital modulation schemes-amplitude, phase and frequency shift keying schemes (ASK, PSK, FSK), matched filter receivers, bandwith consideration and probability of error calculations for these schemes.

Electromagnetics: Elements of vector calculus: divergence and curl; Gauss' and Stokes' theorems, Maxwell's equations: differential and integral forms. Wave equation, Poynting vector. Plane waves: propagation through various media; reflection and refraction; phase and group velocity; skin depth. Transmission lines: characteristic impedance; impedance transformation; Smith chart; impedance matching; pulse excitation. Waveguides: modes in rectangular waveguides; boundary conditions; cut-off frequencies; dispersion relations. Antennas: Dipole antennas; antenna arrays; radiation pattern; reciprocity theorem, antenna gain.

EE - ELECTRICAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix Algebra, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Mean value theorems, Theorems of integral calculus, Evaluation of definite and improper integrals, Partial Derivatives, Maxima and minima, Multiple integrals, Fourier series. Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equation (linear and nonlinear), Higher order linear differential equations with constant coefficients, Method of variation of parameters, Cauchy's and Euler's equations, Initial and boundary value problems, Partial Differential Equations and variable separable method.

Complex variables: Analytic functions, Cauchy's integral theorem and integral formula, Taylor's and Laurent' series, Residue theorem, solution integrals.

Probability and Statistics: Sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Discrete and continuous distributions, Poisson, Normal and Binomial distribution, Correlation and regression analysis.

Numerical Methods: Solutions of non-linear algebraic equations, single and multi-step methods for differential equations.

Transform Theory: Fourier transform, Laplace transform, Z-transform.

ELECTRICAL ENGINEERING

Electrical Circuits and Fields: Network graph, KCL, KVL, node/ cut set, mesh/ tie set analysis, transient response of d.c. and a.c. networks; sinusoidal steady-state analysis; resonance in electrical circuits; concepts of ideal voltage and current sources, network theorems, driving point, immittance and transfer functions of two port networks, elementary concepts of filters; three phase circuits; Fourier series and its application; Gauss theorem, electric field intensity and potential due to point, line, plane and spherical charge distribution, dielectrics, capacitance calculations for simple configurations; Ampere's and Biot-Savart's law, inductance calculations for simple configurations.

Electrical Machines: Single phase transformer - equivalent circuit, phasor diagram, tests, regulation and efficiency; three phase transformers - connections, parallel operation; auto transformer and three-winding transformer; principles of energy conversion, windings of rotating machines: D. C. generators and motors - characteristics, starting and speed control, armature reaction and commutation; three phase induction motors-performance characteristics, starting and speed control; single-phase induction motors; synchronous generators-performance, regulation, parallel operation; synchronous motors - starting, characteristics, applications, synchronous condensers; fractional horse power motors; permanent magnet and stepper motors.

Power Systems: Electric power generation - thermal, hydro, nuclear; transmission line parameters; steady-state performance of overhead transmission lines and cables and surge propagation; distribution systems, insulators, bundle conductors, corona and radio interference effects; per-unit quantities; bus admittance and impedance matrices; load flow; voltage control and power factor correction; economic operation; symmetrical components, analysis of symmetrical and unsymmetrical faults; principles of over current, differential and distance protections; concept of solid state relays and digital protection; circuit breakers; concept of system stability-swing curves and equal area criterion; basic concepts of HVDC transmission.

Control Systems: Principles of feedback; transfer function; block diagrams: steady-state errors; stability-Routh and Nyquist criteria; Bode plots; compensation; root loci; elementary state variable formulation; state transition matrix and response for Linear Time Invariant systems.

Electrical and Electronic Measurements: Bridges and potentiometers, PMMC, moving iron, dynamometer and induction type instruments; measurement of voltage, current, power, energy and power factor; instrument transformers; digital voltmeters and multimeters; phase, time and frequency measurement; Q-meter, oscilloscopes, potentiometric recorders, error analysis.

Analog and Digital Electronics: Characteristics of diodes, BJT, FET, SCR; amplifiers-biasing, equivalent circuit and frequency response; oscillators and feedback amplifiers, operational amplifiers- characteristics and applications; simple active filters; VCOs and timers; combinational and sequential logic circuits, multiplexer, Schmitt trigger, multivibrators, sample and hold circuits, A/D and D/A converters; microprocessors and their applications.

Power Electronics and Electric Drives: Semiconductor power devices-diodes, transistors, thyristors, triacs, GTOs, MOSFETs and IGBTs - static characteristics and principles of operation; triggering circuits; phase control rectifiers; bridge converters-fully controlled and half controlled; principles of choppers and inverters, basic concepts of adjustable speed dc and ac drives.

GG - GEOLOGY AND GEOPHYSICS

PART - I

Earth and planetary system; size, shape, internal structure and composition of the earth; atmosphere and greenhouse effect; isostasy; elements of seismology; continents and continental processes; physical oceanography; palaeomagnetism, continental drift plate tectonics, geothermal energy.

Weathering; soil formation; action of river, wind and glacier; oceans and oceanic features; earthquakes, volcanoes, orogeny and mountain building; elements of structural geology; crystallography; classification, composition and properties of minerals and rocks; engineering properties of rocks and soils, role of geology in the construction of engineering structures.

Processes of ore formation, occurrence and distribution of ores on land and on ocean floor; coal and petroleum resources in India; ground water geology including well hydraulics, geological time scale and geochronology; stratigraphic principles and stratigraphy of India; basics concepts of gravity, magnetic and electrical prospecting for ores and ground water.

PART - IIA: GEOLOGY

Crystal symmetry, forms, twinning; crystal chemistry; optical mineralogy, classification of minerals, diagnostic properties of rock minerals.

Mineralogy, structure, texture and classification of igneous, sedimentary and metamorphic rock, their origin and evolution; application of thermodynamics; structure and petrology of sedimentary rocks; sedimentary processes and environments, sedimentary facies, basin studies; basement cover relationship;

Primary and secondary structures; geometry and genesis of folds, faults, joints, unconformities, cleavage, schistosity and lineation; methods of projection. Tectonites and their significance; shear zone; superposed folding.

Morphology, classification and geological significance of important invertebrates, vertebrates, microfossils and palaeoflora; stratigraphic principles and Indian stratigraphy; geomorphic processes and agents; development and evolution of landforms; slope and drainage; processes on deep oceanic and near-shore regions; quantitative and applied geomorphology; air photo interpretation and remote sensing; chemical and optical properties of ore minerals; formation and localization of ore deposits; prospecting and exploration of economic minerals; coal and petroleum geology; origin and distribution of mineral and fuel deposits in India; ore dressing and mineral economics.

Cosmic abundance; meteorites; geochemical evolution of the earth; geochemical cycles; distribution of major, minor and trace elements; isotope geochemistry; geochemistry of waters including solution equilibria and water rock interaction.

Engineering properties of rocks and soils; rocks as construction material; geology of dams, tunnels and excavation sites; natural hazards; the fly ash problem; ground water geology and exploration; water quality; impact of human activity; Remote sensing techniques for the interpretation of landforms and resource management.

PART - II B: GEOPHYSICS

The earth as a planet; different motions of the earth; gravity filed of the earth and its shape; geochronology; isostasy, seismology and interior of the earth; variation of density, velocity, pressure, temperature, electrical and magnetic properties inside the earth; earthquakes-causes and measurements; zonation and seismic hazards; geomagnetic field, palaeomagnetism; oceanic and continental lithosphere; plate tectonics; heat flow; upper and lower atmospheric phenomena.

Theories of scalar and vector potential fields; Laplace, Maxwell and Helmholtz equations for solution of different types of boundary value problems for Cartesian, cylindrical and spherical polar coordinates; Green's theorem; Image theory; integral equations and conformal transformations in potential theory; Eikonal equation and ray theory.

'G' and 'g' units of measurement, density of rocks, gravimeters, preparation, analysis and interpretation of gravity maps; derivative maps, analytical continuation; gravity anomaly type curves; calculation of mass.

Earth's magnetic field, units of measurement, magnetic susceptibility of rocks, magnetometers, corrections, preparation of magnetic maps, magnetic anomaly type curve, analytical continuation, interpretation and application; magnetic well logging.

Conduction of electricity through rocks, electrical conductivities of metals, metallic, non-metallic and rock forming minerals, D.C. resistivity units and methods of measurement, electrode configuration for sounding and profiling, application of filter theory, interpretation of resistivity field data, application; self potential origin, classification, field measurement, interpretation of induced polarization time frequency, phase domain; IP units and methods of measurement, interpretation and application; ground-water exploration.

Origin of electromagnetic field elliptic polarization, methods of measurement for different source-receiver configuration components in EM measurements, interpretation and applications; earth's natural electromagnetic field, tellurics, magneto-tellurics; geomagnetic depth sounding principles, methods of measurement, processing of data and interpretation.

Seismic methods of prospecting: Reflection, refraction and CDP surveys; land and marine seismic sources, generation and propagation of elastic waves, velocity increasing with depth, geophones, hydrophones, recording instruments (DFS), digital formats, field layouts, seismic noises and noise profile analysis, optimum geophone grouping, noise cancellation by shot and geophone arrays, 2D and 3D seismic data acquisition and processing, CDP stacking charts, binning, filtering, dip-moveout, static and dynamic corrections, deconvolution, migration, signal processing, Fourier and Hilbert transforms, attribute analysis, bright and dim spots, seismic stratigraphy, high resolution seismics, VSP.

Principles and techniques of geophysical well-logging, SP, resistivity, induction, micro gamma ray, neutron, density, sonic, temperature, dip meter, caliper, nuclear magnetic, cement bond logging. Quantitative evaluation of formations from well logs; well hydraulics and application of geophysical methods for groundwater study; application of bore hole geophysics in ground water, mineral and oil exploration. Remote sensing techniques and application of remote sensing methods in geophysics.

IN - INSTRUMENTATION ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix Algebra, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Mean value theorems, Theorems of integral calculus, Evaluation of definite and improper integrals, Partial Derivatives, Maxima and minima, Multiple integrals, Fourier series. Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equation (linear and nonlinear), Higher order linear differential equations with constant coefficients, Method of variation of parameters, Cauchy's and Euler's equations, Initial and boundary value problems, Partial Differential Equations and variable separable method.

Complex variables: Analytic functions, Cauchy's integral theorem and integral formula, Taylor's and Laurent' series, Residue theorem, solution integrals.

Probability and Statistics: Sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Discrete and continuous distributions, Poisson, Normal and Binomial distribution, Correlation and regression analysis.

Numerical Methods: Solutions of non-linear algebraic equations, single and multi-step methods for differential equations.

Transform Theory: Fourier transform, Laplace transform, Z-transform.

INSTRUMENTATION ENGINEERING

Measurement Basics and Metrology: Static and dynamic characteristics of measurement systems. Standards and calibration. Error and uncertainty analysis, statistical analysis of data, and curve fitting. Linear and angular measurements; Measurement of straightness, flatness, roundness and roughness.

Transducers, Mechanical Measurements and Industrial Instrumentation: Transducers - elastic, resistive, inductive, capacitive, thermo-electric, piezoelectric, photoelectric, electro-mechanical, electro-chemical, and ultrasonic. Measurement of displacement, velocity (linear and rotational), acceleration, shock, vibration, force, torque, power, strain, stress, pressure, flow, temperature, humidity, viscosity, and density. energy storing elements, suspension systems and dampers.

Analog Electronics: Characteristics of diodes, BJTs, JFETs and MOSFETs; Diode circuits; Amplifiers: single and multi-stage, feedback; Frequency response; Operational amplifiers - design, characteristic, linear and non-linear applications: difference amplifiers; instrumentation amplifiers; precision rectifiers, I-to-V converters, active filters, oscillators, comparators, signal generators, wave shaping circuits.

Digital Electronics: Combinational logic circuits, minimization of Boolean functions; IC families (TTL, MOS, CMOS), arithmetic circuits, multiplexer and decoders. Sequential circuits: flip-flops, counters, shift registers. Schmitt trigger, timers, and multivibrators. Analog switches, multiplexers, S/H circuits. Analog-to-digital and digital-to-analog converters. Basics of computer organization and architecture. 8-bit microprocessor (8085), applications, memory, I/O interfacing, and microcontrollers.

Signals and Systems: Vectors and matrices; Fourier series; Fourier transforms; Ordinary differential equations. Impulse and frequency responses of first and second order systems. Laplace transform and transfer function, convolution and correlation. Amplitude and frequency modulations and demodulations. Discrete time systems, difference equations, impulse and frequency responses; Z-transforms and transfer functions; IIR and FIR filters.

Electrical and Electronic Measurements: Measurement of R, L and C; bridges and potentiometers. Measurement of voltage, current, power, power factor, and energy; Instrument transformers; Q meter, waveform analyzers. Digital volt-meters and multi-meters. Time, phase and frequency measurements; Oscilloscope. Noise and interference in instrumentation.

Control Systems & Process Control: Principles of feedback; transfer function, signal flow graphs. Stability criteria, Bode plots, root-loci, Routh and Nyquist criteria. Compensation techniques; State space analysis. System components: mechanical, hydraulic, pneumatic, electrical and electronic; Servos and synchros; Stepper motors. On-off, cascade, P, PI, PID and feed-forward controls. Controller tuning and general frequency response.

Analytical, Optical and Biomedical Instrumentation: Principles of spectrometry, UV, visible, IR mass spectrometry, X-ray methods; nuclear radiation measurements, gas, solid and semi conductor lasers and their characteristics, interferometers, basics of fibre optics, transducers in biomedical applications, cardiovascular system measurements, instrumentation for clinical laboratory.

MA - MATHEMATICS

Linear Algebra: Finite dimensional vector spaces. Linear transformations and their matrix representations, rank; systems of linear equations, eigenvalues and eigenvectors, minimal polynomial, Cayley-Hamilton theorem, diagonalisation, Hermitian, Skew-Hermitian and unitary matrices. Finite dimensional inner product spaces, self-adjoint and Normal linear operators, spectral theorem, Quadratic forms.

Complex Analysis: Analytic functions, conformal mappings, bilinear transformations, complex integration: Cauchy's integral theorem and formula, Liouville's theorem, maximum modulus principle, Taylor and Laurent's series, residue theorem and applications for evaluating real integrals.

Real Analysis: Sequences and series of functions, uniform convergence, power series, Fourier series, functions of several variables, maxima, minima, multiple integrals, line, surface and volume integrals, theorems of Green, Stokes and Gauss; metric spaces, completeness, Weierstrass approximation theorem, compactness. Lebesgue measure, measurable functions; Lebesgue integral, Fatou's lemma, dominated convergence theorem.

Ordinary Differential Equations: First order ordinary differential equations, existence and uniqueness theorems, systems of linear first order ordinary differential equations, linear ordinary differential equations of higher order with constant coefficients; linear second order ordinary differential equations with variable coefficients, method of Laplace transforms for solving ordinary differential equations, series solutions; Legendre and Bessel functions and their orthogonality, Sturm Liouville system, Greeen's functions.

Algebra: Normal subgroups and homomorphisms theorems, automorphisms. Group actions, sylow's theorems and their applications groups of order less than or equal to 20, Finite p-groups. Euclidean domains, Principal ideal domains and unique factorizations domains. Prime ideals and maximal ideals in commutative rings.

Functional Analysis: Banach spaces, Hahn-Banach theorems, open mapping and closed graph theorems, principle of uniform boundedness; Hilbert spaces, orthonormal sets, Riesz representation theorem, self-adjoint, unitary and normal linear operators on Hilbert Spaces.

Numerical Analysis: Numerical solution of algebraic and transcendental equations; bisection, secant method, Newton-Raphson method, fixed point iteration, interpolation: existence and error of polynomial interpolation, Lagrange, Newton, Hermite(osculatory)interpolations; numerical differentiation and integration, Trapezoidal and Simpson rules; Gaussian quadrature; (Gauss-Legendre and Gauss-Chebyshev), method of undetermined parameters, least square and orthonormal polynomial approximation; numerical solution of systems of linear equations: direct and iterative methods, (Jacobi Gauss-Seidel and SOR) with convergence; matrix eigenvalue problems: Jacobi and Given's methods, numerical solution of ordinary differential equations: initial value problems, Taylor series method, Runge-Kutta methods, predictor-corrector methods; convergence and stability.

Partial Differential Equations: Linear and quasilinear first order partial differential equations, method of characteristics; second order linear equations in two variables and their classification; Cauchy, Dirichlet and Neumann problems, Green's functions; solutions of Laplace, wave and diffusion equations in two variables Fourier series and transform methods of solutions of the above equations and applications to physical problems.

Mechanics: Forces in three dimensions, Poinsot central axis, virtual work, Lagrange's equations for holonomic systems, theory of small oscillations, Hamiltonian equations;

Topology: Basic concepts of topology, product topology, connectedness, compactness, countability and separation axioms, Urysohn's Lemma, Tietze extension theorem, metrization theorems, Tychonoff theorem on compactness of product spaces.

Probability and Statistics: Probability space, conditional probability, Bayes' theorem, independence, Random variables, joint and conditional distributions, standard probability distributions and their properties, expectation, conditional expectation, moments. Weak and strong law of large numbers, central limit theorem. Sampling distributions, UMVU estimators, sufficiency and consistency, maximum likelihood estimators. Testing of hypotheses, Neyman-

Pearson tests, monotone likelihood ratio, likelihood ratio tests, standard parametric tests based on normal, X2 ,t, F-distributions. Linear regression and test for linearity of regression. Interval estimation.

Linear Programming: Linear programming problem and its formulation, convex sets their properties, graphical method, basic feasible solution, simplex method, big-M and two phase methods, infeasible and unbounded LPP's, alternate optima. Dual problem and duality theorems, dual simplex method and its application in post optimality analysis, interpretation of dual variables. Balanced and unbalanced transportation problems, unimodular property and u-v method for solving transportation problems. Hungarian method for solving assignment problems.

Calculus of Variations and Integral Equations: Variational problems with fixed boundaries; sufficient conditions for extremum, Linear integral equations of Fredholm and Volterra type, their iterative solutions. Fredholm alternative.

ME - MECHANICAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

APPLIED MECHANICS AND DESIGN

Engineering Mechanics: Equivalent force systems, free-body concepts, equations of equilibrium, trusses and frames, virtual work and minimum potential energy. Kinematics and dynamics of particles and rigid bodies, impulse and momentum (linear and angular), energy methods, central force motion.

Strength of Materials: Stress and strain, stress-strain relationship and elastic constants, Mohr's circle for plane stress and plane strain, shear force and bending moment diagrams, bending and shear stresses, deflection of beams, torsion of circular shafts, thin and thick cylinders, Euler's theory of columns, strain energy methods, thermal stresses.

Theory of Machines: Displacement, velocity and acceleration, analysis of plane mechanisms, dynamic analysis of slider-crank mechanism, planar cams and followers, gear tooth profiles, kinematics of gears, governors and flywheels, balancing of reciprocating and rotating masses.

Vibrations: Free and forced vibration of single degree freedom systems, effect of damping, vibration isolation, resonance, critical speed of rotors.

Design of Machine Elements: Design for static and dynamic loading, failure theories, fatigue strength; design of bolted, riveted and welded joints; design of shafts and keys; design of spur gears, rolling and sliding contact bearings; brakes and clutches; belt, rope and chain drives.

FLUID MECHANICS AND THERMAL SCIENCES

Fluid Mechanics: Fluid properties, fluid statics, manometry, buoyancy; control-volume analysis of mass, momentum and energy; fluid acceleration; differential equations of continuity and momentum; Bernoulli's equation; viscous flow of incompressible fluids; boundary layer; elementary turbulent flow; flow through pipes, head losses in pipes, bends etc.

Heat-Transfer: Modes of heat transfer; one dimensional heat conduction, resistance concept, electrical analogy, unsteady heat conduction, fins; dimensionless parameters in free and forced convective heat transfer, various correlations for heat transfer in flow over flat plates and through pipes; thermal boundary layer; effect of turbulence; radiative heat transfer, black and grey surfaces, shape factors, network analysis; heat exchanger performance, LMTD and NTU methods.

Thermodynamics: Zeroth, First and Second laws of thermodynamics; thermodynamic system and processes; irreversibility and availability; behaviour of ideal and real gases, properties of pure substances, calculation of work and heat in ideal processes; analysis of thermodynamic cycles related to energy conversion; Carnot, Rankine, Otto, Diesel, Brayton and vapour compression cycles.

Power Plant Engineering: Steam generators; steam power cycles; steam turbines; impulse and reaction principles, velocity diagrams, pressure and velocity compounding; reheating and reheat factor; condensers and feed heaters.

I.C. Engines: Requirements and suitability of fuels in IC engines, fuel ratings, fuel-air mixture requirements; normal combustion in SI and CI engines; engine performance calculations.

Refrigeration and air-conditioning: Refrigerant compressors, expansion devices, condensers and evaporators; properties of moist air, psychrometric chart, basic psychometric processes.

Turbomachinery: Components of gas turbines; compression processes, centrifugal and axial flow compressors; axial flow turbines, elementary theory; hydraulic turbines; Euler-turbine equation; specific speed, Pelton-wheel, Francis and Kaplan turbines; centrifugal pumps.

MANUFACTURING AND INDUSTRIAL ENGINEERING

Engineering Materials: Structure and properties of engineering materials and their applications, heat treatment.

Metal Casting: Casting processes (expendable and non-expendable) -pattern, moulds and cores, heating and pouring, solidification and cooling, gating design, design considerations, defects.

Forming Processes: Stress-strain diagrams for ductile and brittle material, Plastic deformation and yield criteria, fundamentals of hot and cold working processes, Bulk metal forming processes (forging, rolling, extrusion, drawing), sheet metal working processes (punching, blanking, bending, deep drawing, coining, spinning, load estimation using homogeneous deformation methods, defects). processing of powder metals- atomization, compaction, sintering, secondary and finishing operations. forming and shaping of plastics- extrusion, injection moulding.

Joining Processes: Physics of welding, fusion and non-fusion welding processes, brazing and soldering, adhesive bonding, design considerations in welding, weld quality defects.

Machining and Machine Tool Operations: Mechanics of machining, single and multi-point cutting tools, tool geometry and materials, tool life and wear, cutting fluids, machinability, economics of machining, non-traditional machining processes.

Metrology and Inspection: Limits, fits and tolerances, linear and angular measurements, comparators, gauge design, interferometry, form and finish measurement, measurement of screw threads, alignment and testing methods.

Tool Engineering: Principles of work holding, design of jigs and fixtures.

Computer Integrated Manufacturing: Basic concepts of CAD, CAM and their integration tools.

Manufacturing Analysis: Part-print analysis, tolerance analysis in manufacturing and assembly, time and cost analysis.

Work-Study: Method study, work measurement, time study, work sampling, job evaluation, merit rating.

Production Planning and Control: Forecasting models, aggregate production planning, master scheduling, materials requirements planning.

Inventory Control: Deterministic and probabilistic models, safety stock inventory control systems.

Operations Research: Linear programming, simplex and duplex method, transportation, assignment, network flow models, simple queuing models, PERT and CPM

MN - MINING ENGINEERING

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

MINING ENGINEERING

Mechanics: Equivalent force systems, equations of equilibrium, two dimensional frames and trusses, free body diagrams, friction forces, particle kinematics and dynamics.

Mine Development, Geomechanics and Strata Control: Drivages for underground mine development, drilling methods and machines, explosives, blasting devices and practices, shaft sinking. Physico-mechanical properties of rocks, rock mass classification, ground control instrumentation and stress measurement techniques, theories of rock failure, ground vibrations, stress distribution around mine openings, subsidence, design of supports in roadways and workings, stability of open pits, slopes.

Mining Methods and Machinery: Surface mining - layout, development, loading, transportation and mechanization, continuous surface mining systems. Underground coal mining - bord and pillar system, longwall mining, thick seam mining methods. Underground metal mining: different stoping methods, stope mechanization, ore handling systems, mine filling. Generation and transmission of mechanical, hydraulic, and pneumatic power. Materials handling - haulages, conveyors, ropeways, face and development machinery, hoisting systems, and pumps.

Ventilation, Underground Hazards and Surface Environment: Underground atmosphere, heat load sources and thermal environment, air cooling, mechanics of air flow distribution, natural and mechanical ventilation, mine fans and their usage, auxiliary ventilation. Subsurface hazards from fires, explosions, gases, dust, and inundation, rescue apparatus and practices, safety in mines, accident analysis, noise, mine lighting. Air and water pollution: causes, dispersion, quality standards, and control.

Surveying, Mine Planning and Systems Engineering: Fundamentals of engineering surveying, Levels and levelling, Theodolite, tacheometry, triangulation, contouring, errors and adjustments, correlation, underground surveying, curves, photogrammetry, field astronomy, GPS fundamentals. Principles of planning - Sampling methods and practices, reserve estimation techniques, basics of geostatistics, optimization of facility location, cash flow concepts and mine valuation, open pit design. Work study, concepts of reliability, reliability of series and parallel systems. Linear programming, transportation and assignment problems, queueing, network analysis, inventory control.

MT - METALLURGICAL ENGINEERING

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

METALLURGICAL ENGINEERING

Thermodynamics and Rate Processes: Laws of thermodynamics, activity, equilibrium constant, applications to metallurgical systems, solutions, phase equilibria, basic kinetic laws, order of reactions, rate constants and rate limiting steps principles of electro chemistry, aqueous, corrosion and protection of metals, oxidation and high temperature corrosion - characterization and control; momentum transfer - concepts of viscosity, shell balances, Bernoulli's equation; heat transfer - conduction, convection and heat transfer coefficient relations, radiation, mass transfer - diffusion and Fick's laws.

Extractive Metallurgy: Flotation, gravity and other methods of mineral processing; agglomeration, pyro-hydro-and electro-metallurgical processes; material and energy balances; principles and processes for the extraction of non-ferrous metals - aluminium, copper, zinc, lead, magnesium, nickel, titanium and other rare metals; iron and steel making - principles, blast furnace, direct reduction processes, primary and secondary steel making, deoxidation and inclusion in steel; ingot and continuous casting; stainless steel making, design of furnaces; fuels and refractories.

Physical Metallurgy: Crystal structure and bonding characteristics of metals, alloys, ceramics and polymers; solid solutions; solidification; phase transformation and binary phase diagrams; principles of heat treatment of steels, aluminum alloys and cast irons; recovery, recrystallization and grain growth; industrially important ferrous and non-ferrous alloys; elements of X-ray and electron diffraction; principles of scanning and transmission electron microscopy; elements of ceramics, composites and electronic materials; electronic basis of thermal, optical, electrical and magnetic properties of materials.

Mechanical Metallurgy: Elements of elasticity and plasticity; defects in crystals; elements of dislocation theory - types of dislocations, slip and twinning, stress fields of dislocations, dislocation interactions and reactions, methods of seeing dislocations; strengthening mechanisms; tensile, fatigue and creep behaviour; superplasticity; fracture - Griffith theory, ductile to brittle transition, fracture toughness; failure analysis; mechanical testing - tension, compression, torsion, hardness, impact, creep, fatigue, fracture toughness and formability tests.

Manufacturing Processes: Metal casting - patterns, moulds, melting, gating, feeding and casting processes, defects and castings, hot and cold working of metals; Metal forming - fundamentals of metal forming, rolling wire drawing, extrusion, forming, sheet metal forming processes, defects in forming; Metal joining - soldering, brazing and welding, common welding processes, welding metallurgy, problems associated with welding of steels and aluminium alloys, defects in welding, powder metallurgy; NDT methods - ultrasonic, radiography, eddy current, acoustic emission and magnetic.

PH - PHYSICS

Mathematical Physics: Linear vector space, matrices; vector calculus; linear differential equations; elements of complex analysis; Laplace transforms, Fourier analysis, elementary ideas about tensors.

Classical Mechanics: Conservation laws; central forces; collisions and scattering in laboratory and centre of mass reference frames; mechanics of system of particles; rigid body dynamics; moment of inertia tensor; noninertial frames and pseudo forces; variational principle; Lagrange's and Hamilton's formalisms; equation of motion, cyclic coordinates, Poisson bracket; periodic motion, small oscillations, normal modes; wave equation and wave propagation; special theory of relativity - Lorentz transformations, relativistic kinematics, mass-energy equivalence.

Electromagnetic Theory: Laplace and Poisson equations; conductors and dielectrics; boundary value problems; Ampere's and Biot-Savart's laws; Faraday's law; Maxwell's equations; scalar and vector potentials; Coulomb and Lorentz gauges; boundary conditions at interfaces; electromagnetic waves; interference, diffraction and polarization; radiation from moving charges.

Quantum Mechanics: Physical basis of quantum mechanics; uncertainty principle; Schrodinger equation; one and three dimensional potential problems; Particle in a box, harmonic oscillator, hydrogen atom; linear vectors and operators in Hilbert space; angular momentum and spin; addition of angular momentum; time independent perturbation theory; elementary scattering theory.

Atomic and Molecular Physics: Spectra of one-and many-electron atoms; LS and jj coupling; hyperfine structure; Zeeman and Stark effects; electric dipole transitions and selection rules; X-ray spectra; rotational and vibrational spectra of diatomic molecules; electronic transition in diatomic molecules, Franck-Condon principle; Raman effect; NMR and ESR; lasers.

Thermodynamics and Statistical Physics: Laws of thermodynamics; macrostates, phase space; probability ensembles; partition function, free energy, calculation of thermodynamic quantities; classical and quantum statistics; degenerate Fermi gas; black body radiation and Planck's distribution law; Bose-Einstein condensation; first and second order phase transitions, critical point.

Solid State Physics: Elements of crystallography; diffraction methods for structure determination; bonding in solids; elastic properties of solids; defects in crystals; lattice vibrations and thermal properties of solids; free electron theory; band theory of solids; metals, semiconductors and insulators; transport properties; optical, dielectric and magnetic properties of solids; elements of superconductivity.

Nuclear and Particle Physics: Rutheford scattering; basic properties of nuclei; radioactive decay; nuclear forces; two nucleon problem; nuclear reactions; conservation laws; fission and fusion; nuclear models; particle accelerators, detectors; elementary particles; photons, baryons, mesons and leptons; Quark model.

Electronics: Network analysis; semiconductor devices; bipolar transistors; FETs; power supplies, amplifier, oscillators; operational amplifiers; elements of digital electronics; logic circuits.

PI - PRODUCTION AND INDUSTRIAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

GENERAL ENGINEERING:

Engineering Materials: Structure and properties of engineering materials and their applications; effect of strain, strain rate and temperature on mechanical properties of metals and alloys; heat treatment of metals and alloys.

Applied Mechanics: Engineering mechanics - equivalent force systems, free body concepts, equations of equilibrium, virtual work and minimum potential energy; strength of materials-stress, strain and their relationship, Mohr's circle, deflection of beams, bending and shear stress, Euler's theory of columns.

Theory of Machines and Design: Analysis of planar mechanisms, plane cams and followers; governers and fly wheels; design of elements-failure theories; design of bolted, riveted and welded joints; design of shafts, keys, belt drives, brakes and clutches.

Thermal Engineering: Fluid machines - fluid statics, Bernoulli's equation, flow through pipes, equations of continuity and momentum; Thermodynamics - zeroth, First and Second laws of thermodynamics, thermodynamic system and processes, calculation of work and heat for systems and control volumes; Heat transfer - fundamentals of conduction, convection and radiation.

PRODUCTION ENGINEERING

Metal Casting: Casting processes; patterns-materials; allowances; moulds and cores - materials, making and testing; melting and founding of cast iron, steels and nonferrous metals and alloys; solidification; design of casting, gating and risering; casting defects and inspection.

Metal working: Stress-strain in elastic and plastic deformation; deformation mechanisms; hot and cold working-forging, rolling, extrusion, wire and tube drawing; sheet metal working; analysis of rolling, forging, extrusion and wire /rod drawing; metal working defects, high energy rate forming processes-explosive, magnetic, electro and electrohydraulic.

Metal Joining Processes: Welding processes - gas shielded metal arc, TIG, MIG, submerged arc, electroslag, thermit, resistance, pressure and forge welding; thermal cutting; other joining processes - soldering, brazing, braze welding; welding codes, welding symbols, design of welded joints, defects and inspection; introduction to modern welding processes - friction, ultrasonic, explosive, electron beam, laser and plasma.

Machining and Machine Tool Operations: Machining processes-turning, drilling, boring, milling, shaping, planing, sawing, gear cutting, thread production, broaching, grinding, lapping, honing super finishing; mechanics of cutting- Merchant's analysis, geometry of cutting tools, cutting forces, power requirements; selection of process parameters; tool materials, tool wear and tool life, cutting fluids, machinability; nontraditional machining processes and hybrid processes- EDM, CHM, ECM, USM, LBM, EBM, AJM, PAM AND WJM; economics of machining.

Metrology and Inspection: Limits and fits, linear and angular measurements by mechanical and optical methods, comparators; design of limit gauges; interferometry; measurement of straightness, flatness, roundness, squareness and symmetry; surface finish measurement; inspection of screw threads and gears; alignment testing.

Powder Metallurgy and Processing of Plastics: Production of powders, compaction, sintering; Polymers and composites; injection, compression and blow molding, extrusion, calendaring and thermoforming; molding of composites.

Tool Engineering: Work-holding-location and clamping; principles and methods; design of jigs and fixtures; design of press working tools, forging dies.

Manufacturing Analysis: Sources of errors in manufacturing; process capability; part-print analysis; tolerance analysis in manufacturing and assembly; process planning; parameter selection and comparison of production alternatives; time and cost analysis; Issues in choosing manufacturing technologies and strategies.

Computer Integrated Manufacturing: Basic concepts of CAD, CAM, CAPP, group technology, NC, CNC, DNC, FMS, Robotics and CIM.

INDUSTRIAL ENGINEERING

Product Design and Development: Principles of good product design, component and tolerance design; efficiency, quality and cost considerations; product life cycle; standardization, simplification, diversification, value analysis, concurrent engineering.

Engineering Economy and Costing: Financial statements; elementary cost accounting, methods of depreciation; break-even analysis, techniques for evaluation of capital investments.

Work System Design: Taylor's scientific management, Gilbreths's contributions; productivity concepts and measurements; method study, micro-motion study, principles of motion economy; human factors engineering, ergonomics; work measurement - time study, PMTS, work sampling; job evaluation, merit rating, wage administration, incentive systems; business process reengineering.

Logistics and Facility Design: Facility location factors, evaluation of alternatives, types of plant layout, evaluation; computer aided layout; assembly line balancing; material handling systems; supply chain management.

Production Planning and Inventory Control: Inventory Function costs, classifications - deterministic and probabilistic models; quantity discount; safety stock; inventory control system; Forecasting techniques - causal and time series models, moving average, exponential smoothing; trend and seasonality; aggregate production planning; master scheduling; bill of materials and material requirement planning; order control and flow control, routing, scheduling and priority dispatching; JIT; Kanban PULL systems; bottleneck scheduling and theory of constraints.

Operation Research: Linear programming - problem formulation, simplex method, duality and sensitivity analysis; transportation; assignment; network flow models, constrained optimization and Lagrange multipliers; simple queuing models; dynamic programming; simulation; PERT and CPM, time-cost trade-off, resource leveling.

Quality Control: Taguchi method; design of experiments; quality costs, statistical quality assurance, process control charts, acceptance sampling, zero defects; quality circles, total quality management.

Reliability and Maintenance: Reliability, availability and maintainability; probabilistic failure and repair times; system reliability; preventive maintenance and replacement, TPM.

Management Information System: Value of information; information storage and retrieval system - database and data structures; interactive systems; knowledge based systems.

Intellectual Property System: Definition of intellectual property, importance of IPR; TRIPS, and its implications, WIPO and Global IP structure, and IPS in India; patent, copyright, industrial design and trademark; meanings, rules and procedures, terms, infringements and remedies.

PY - PHARMACEUTICAL SCIENCES

Natural Products: Pharmacognosy & Phytochemistry - Chemistry, tests, isolation, characterization and estimation of phytopharmaceuticals belonging to the group of Alkaloids, Glycosides, Terpenoids, Steroids, Bioflavanoids, Purines, Guggul lipids. Pharmacognosy of crude drugs which contain the above constituents. Standardisation of raw materials and herbal products. WHO guide lines. Quantitative microscopy including modern techniques used for evaluation. Biotechnological principles and techniques for plant development Tissue culture.

Pharmacology: General pharmacological principles including Toxicology. Drug interaction. Pharmacology of drugs acting on Central nervous system, Cardiovascular system, Autonomic nervous system, Gastro intestinal system and Respiratory system. Pharmacology of Autocoids, Hormones, Chemotherapeutic agents including anticancer drugs. Bioassays. Immuno Pharmacology.

Medicinal Chemistry: Structure, nomenclature, classification, synthesis, SAR and metabolism of the following category of drugs which are official in Indian Pharmacopoeia and British Pharmacopoeia Hypnotics and Sedatives, Analgesics, NSAIDS, Neuroleptics, Antidepressants, Anxiolytics, Anticonvulsants, Antihistaminics, Local anaesthetics, Cardio Vascular drugs - Antianginal agents Vasodilators, Adrenergic & cholinergic drugs, Cardiotonic agents, Diuretics, Antihypertensive drugs, Hypoglycemic agents, Antilipedmic agents, Coagulants, Anticoagulants, Antiplatelet agents. Chemotherapeutic agents - Antibiotics, Antibacterials, Sulphadrugs. Antiproliozoal drugs, Antiviral, Antitubercular, Antimalarial, Anticancer, Antiamoebic drugs. Diagnostic agents. Preparation and storage and uses of official Radiopharmaceuticals. Vitamins and Hormones.

Pharmaceutics: Development, manufacturing standards, labeling, packing as per the pharmacopoeal requirements, Storage of different dosage forms and new drug delivery systems. Biopharmaceutics and Pharmacokinetics and their importance in formulation. Formulation and preparation of cosmetics - lipstick, shampoo, creams, nail preparations and dentifrices. Pharmaceutical calculations.

Pharmaceutical Jurisprudence: Legal aspects of manufacture, storage, sale of drugs. D and C act and rules. Pharmacy act.

Pharmaceutical Analysis: Principles, instrumentation and applications of the following. Absorption spectroscopy (UV, visible & IR), Fluorimetry, Flame photometry, Potentiometry, Conductometry and Plarography. Pharmacopoeial assays. Principles of NMR, ESR, Mass spectroscopy, X-ray diffraction analysis and different chromatographic methods.

Biochemistry and Clinical Pharmacy: Biochemical role of hormones, Vitamins, Enzymes, Nucleic acids. Bioenergetics. General principles of immunology. Immunological techniques. Adverse drug interaction.

Microbiology: Principles and methods of microbiological assays of the Pharmacopoeia. Methods of preparation of official sera and vaccines. Serological and diagnostic tests. Applications of microorganisms in Bio Conversions and in Pharmaceutical industry.

TF - TEXTILE ENGINEERING AND FIBRE SCIENCE

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

TEXTILE ENGINEERING & FIBRE SCIENCE

Textile Fibres: Classification of textile fibres according to their nature and origin; general characteristics of textile fibres-their chemical and physical structures and their properties; essential characteristics of fibre forming polymers; uses of natural and man-made fibres; physical and chemical methods of fibre and blend identification and blend analysis.

Melt Spinning processes with special reference to polyamide and polyester fibres; wet and dry spinning of viscose and acrylic fibres; post spinning operations-drawing, heat setting, texturing- false twist and air-jet, tow-to-top conversion. Methods of investigating fibre structure e.g. X-ray diffraction, birefringence, optical and electron microscopy, I.R. absorption, thermal methods; structure and morphology and principal natural and man-made fibres, mechanical properties of fibres, moisture sorption in fibres; fibre structure and property correlation.

Textile Testing: Sampling techniques, sample size and sampling errors; measurement of fibre length, fineness, crimp, strength and reflectance; measurement of cotton fibre maturity ad trash content; HVI and AFIS for fibre testing. Measurement of yarn count, twist and hairiness; tensile testing of fibres, yarn and fabrics; evenness testing of slivers, rovings and yarns; testing equipment for measurement test methods of fabric properties like thickness, compressibility, air permeability, drape, crease recovery, tear strength bursting strength and abrasion resistance. Correlation analysis, significance tests and analysis of variance; frequency distributions and control charts.

Yarn Manufacture and Yarn Structure: Modern methods of opening, cleaning and blending of fibrous materials; the technology of carding with particular reference to modern developments; causes of irregularity introduced by drafting, the development of modern drafting systems; principles and techniques of preparing material for combing; recent development in combers; functions and synchronization of various mechanisms concerned with roving production; forces acting on yarn and traveller, ring and traveller designs; causes of end breakages; properties of doubles yarns; new methods of yarn production such as rotor spinning, air jet spinning and friction spinning.

Yarn diameter; specific volume, packing coefficient; twist-strength relationship; fibre orientation in yarn; fibre migration.

Fabric Manufacture and Fabric Structure: Principles of cheese and cone winding processes and machines; random and precision winding; package faults and their remedies; yarn clearers and tensioners; different systems of yarn splicing; features of modern cone winding machines; different types of warping creels; features of modern beam and sectional warping machines; different sizing systems, sizing of spun and filament yarns, modern sizing machines; principles of pirn winding processes and machines; primary and secondary motions of loom, effect of their settings and timings on fabric formation, fabric appearance and weaving performance; dobby and jacquard shedding; mechanics of weft insertion with shuttle; warp and weft stop motions, warp protection, weft replenishment; functional principles of weft insertion systems of shuttleless weaving machines, principles of multiphase and circular looms. Principles of weft and warp knitting; basic weft and warp knitted structures; classification, production and areas of application of nonwoven fabrics.

Basic woven fabric constructions and their derivatives; crepe, cord, terry, gauze, lino and double cloth constructions.

Peirce's equations for fabric geometry; thickness, cover and maximum sett of woven fabrics

Textile Chemical Processing: Preparatory processes for natural-and and their blends; mercerization of cotton; machines for yarn and fabric mercerization.

Dyeing and printing of natural- and synthetic- fibre fabrics and their blends with different dye classes; dyeing and printing machines; styles of printing; fastness properties of dyed and printed textile materials.

Finishing of textile materials, wash and wear, durable press, soil release, water repellent, flame retardant and antistatic finishes; shrink-resistance finish for wool; heat setting of synthetic-fibre fabrics, finishing machines; energy efficient processes; pollution control.

XE - ENGINERING SCIENCES

The syllabi of the sections of this paper are as follows:

SECTION A. ENGINEERING MATHEMATICS (Compulsory)

Linear Algebra : Determinates, algebra of matrices, rank, inverse, system of linear equations, symmetric, skew-symmetric and orthogonal matrices. Hermitian, skew-hermitian and unitary matrices. eigenvalues and eigenvectors, diagonalisation of matrices, Cayley-Hamiltonian, quadratic forms.

Calculus : Functions of single variables, limit, continuity and differentiability, Mean value theorems, Intermediate forms and L'Hospital rule, Maxima and minima, Taylor's series, Fundamental and mean value-theorems of integral calculus. Evaluation of definite and improper integrals, Beta and Gamma functions, Functions of two variables, limit, continuity, partial derivatives, Euler's theorem for homogeneous functions, total derivatives, maxima and minima, Lagrange method of multipliers, double and triple integrals and their applications, sequence and series, tests for convergence, power series, Fourier Series, Fourier integrals.

Complex variable: Analytic functions, Cauchy's integral theorem and integral formula without proof. Taylor's and Laurent' series, Residue theorem (without proof) with application to the evaluation of real integarls.

Vector Calculus: Gradient, divergence and curl, vector identities, directional derivatives, line, surface and volume integrals, Stokes, Gauss and Green's theorems (without proofs) with applications.

Ordinary Differential Equations: First order equation (linear and nonlinear), higher order linear differential equations with constant coefficients, method of variation of paramaters, Cauchy's and Euler's equations, initial and boundary value problems, power series solutions, Legendre polynomials and Bessel's functions of the first kind.

Partial Differential Equations: Variables separable method, solutions of one dimensional heat, wave and Laplace equations.

Probability and Statistics: Definitions of probability and simple theorems, conditional probability, mean, mode and standard deviation, random variables, discrete and continuous distributions, Poisson, normal and Binomial distribution, correlation and regression

Numerical Methods: L-U decomposition for systems of linear equations,Newton-Raphson method, numerical integration(trapezoidal and Simpson's rule), numerical methods for first order differential equation (Euler method)

SECTION B. COMPUTATIONAL SCIENCE

Numerical Methods: Truncation errors, round off errors and their propagation; Interpolation; Lagrange, Newton's forward, backward and divided difference formulas, least square curve fitting, solution of non-linear equations of one variables using bisection, false position, secant and Newton Raphson methods; Rate of convergence of these methods, general iterative methods. Simple and multiple roots of polynomials. Solutions of system of linear algebraic equations using Gauss elimination methods, Jacobi and Gauss-Seidel iterative methods and their rate of convergence; ill conditioned and well conditioned system. eigen values and eigen vectors using power methods. Numerical integration using trapezoidal, Simpson's rule and other quadrature formulas. Numerical Differentiation. Solution of boundary value problems. Solution of initial value problems of ordinary differential equations using Euler's method, predictor corrector and Runge Kutta method.

Programming : Elementary concepts and terminology of a computer system and system software, Fortran77 and C programming.

Fortran : Program organization, arithmetic statements, transfer of control, Do loops, subscripted variables, functions and subroutines.

C language : Basic data types and declarations, flow of control- iterative statement, conditional statement, unconditional branching, arrays, functions and procedures.

SECTION C. ELECTRICAL SCIENCES

Electric Circuits: Ideal voltage and current sources; RLC circuits, steady state and transient analysis of DC circuits, network theorems; alternating currents and voltages, single-phase AC circuits, resonance; three-phase circuits.

Magnetic circuits: Mmf and flux, and their relationship with voltage and current; transformer, equivalent circuit of a practical transformer, three-phase transformer connections.

Electrical machines: Principle of operation, characteristics, efficiency and regulation of DC and synchronous machines; equivalent circuit and performance of three-phase and single-phase induction motors.

Electronic Circuits: Characteristics of p-n junction diodes, zener diodes, bipolar junction transistors (BJT) and junction field effect transistors (JFET); MOSFET's structure, characteristics, and operations; rectifiers, filters, and regulated power supplies; biasing circuits, different configurations of transistor amplifiers, class A, B and C of power amplifiers; linear applications of operational amplifiers; oscillators; tuned and phase shift types.

Digital circuits: Number systems, Boolean algebra; logic gates, combinational circuits, flip-flops (RS, JK, D and T) counters.

Measuring instruments: Moving coil, moving iron, and dynamometer type instruments; shunts, instrument transformers, cathode ray oscilloscopes; D/A and A/D converters.

SECTION D. FLUID MECHANICS

Fluid Properties: Relation between stress and strain rate for Newtonian fluids

Hydrostatics, buoyancy, manometry

Concept of local and convective accelerations; control volume analysis for mass, momentum and energy conservation.

Differential equations of continuity and momentum (Euler's equation of motion); concept of fluid rotation, stream function, potential function; Bernoulli's equation and its applications.

Qualitative ideas of boundary layers and its separation; streamlined and bluff bodies; drag and lift forces.

Fully-developed pipe flow; laminar and turbulent flows; friction factor; Darcy Weisbach relation; Moody's friction chart; losses in pipe fittings; flow measurements using venturimeter and orifice plates.

Dimensional analysis; similitude and concept of dynamic similarity; importance of dimensionless numbers in model studies.

SECTION E. MATERIALS SCIENCE

Atomic structure and bonding in materials: metals, ceramics and polymers.

Structure of materials: Crystal systems, unit cells and space lattice; determination of structures of simple crystals by X-ray diffraction; Miller indices for planes and directions. Packing geometry in metallic, ionic and covalent solids.

Concept of amorphous, single and polycrystalline structures and their effects on properties of materials.

Imperfections in crystalline solids and their role in influencing various properties.

Fick´s laws of diffusion and applications of diffusion in sintering, doping of semiconductors and surface hardening of metals.

Alloys: solid solution and solubility limit. Binary phase diagram, intermediate phases and intermetallic compounds; iron-iron carbide phase diagram. Phase transformation in steels. Cold and hot working of metals, recovery, recrystallization and grain growth.

Properties and applications of ferrous and nonferrous alloys.

Structure, properties, processing and applications of traditional and advanced ceramics.

Polymers: classification, polymerization, structure and properties, additives for polymer products, processing and application.

Composites: properties and application of various composites.

Corrosion and environmental degradation of materials (metals, ceramics and polymers).

Mechanical properties of materials: Stress-strain diagrams of metallic, ceramic and polymeric materials, modulus of elasticity, yield strength, plastic deformation and toughness, tensile strength and elongation at break; viscoelasticity, hardness, impact strength. ductile and brittle fracture. creep and fatigue properties of materials.

Heat capacity, thermal conductivity, thermal expansion of materials.

Concept of energy band diagram for materials; conductors, semiconductors and insulators in terms of energy bands. Electrical conductivity, effect of temperature on conductivity in materials, intrinsic and extrinsic semiconductors, dielectric properties of materials.

Refraction, reflection, absorption and transmission of electromagnetic radiation in solids.

Origin of magnetism in metallic and ceramic materials, paramagnetism, diamagnetism, antiferromagnetism, ferromagnetism, ferrimagnetism in materials and magnetic hysteresis.

Advanced materials: Smart materials exhibiting ferroelectric, piezoelectric, optoelectronic, semiconducting behaviour; lasers and optical fibers; photoconductivity and superconductivity in materials.

SECTION F. SOLID MECHANICS

Equivalent force systems; free-body diagrams; equilibrium equations; analysis of determinate and indeterminate trusses and frames; friction.

Simple relative motion of particles; force as function of position, time and speed; force acting on a body in motion; laws of motion; law of conservation of energy; law of conservation of momentum

Stresses and strains; principal stresses and strains; Mohr's circle; generalized Hooke's Law; equilibrium equations; compatibility conditions; yield criteria.

Axial, shear and bending moment diagrams; axial, shear and bending stresses; deflection (for symmetric bending); torsion in circular shafts; thin cylinders; energy methods (Castigliano's Theorems); Euler buckling.

SECTION G. THERMODYNAMICS

Basic Concepts: Continuum, macroscopic approach, thermodynamic system (closed and open or control volume); thermodynamic properties and equilibrium; state of a system, state diagram, path and process; different modes of work; Zeroth law of thermodynamics; concept of temperature; heat.

First Law of Thermodynamics: Energy, enthalpy, specific heats, first law applied to systems and control volumes, steady and unsteady flow analysis.

Second Law of Thermodynamics: Kelvin-Planck and Clausius statements, reversible and irreversible processes, Carnot theorems, thermodynamic temperature scale, Clausius inequality and concept of entropy, principle of increase of entropy; availability and irreversibility.

Properties of Pure Substances: Thermodynamic properties of pure substances in solid, liquid and vapour phases, P-V-T behaviour of simple compressible substances, phase rule, thermodynamic property tables and charts, ideal and real gases, equations of state, compressibility chart.

Thermodynamic Relations: T-ds relations, Maxwell equations, Joule-Thomson coefficient, coefficient of volume expansion, adiabatic and isothermal compressibilities, Clapeyron equation.

Ideal Gas Mixtures: Dalton's and Amagat's laws, calculations of properties, air-water vapour mixtures.

XL - LIFE SCIENCES

The syllabi of the Sections of this paper are as follows:

SECTION H. CHEMISTRY (Compulsory)

Atomic structure and periodicity: Quantum chemistry; Planck's quantum theory, wave particle duality, uncertainty principle, quantum mechanical model of hydrogen atom; electronic configuration of atoms; periodic table and periodic properties; ionization energy, election affinity, electronegativity, atomic size.

Structure and bonding: Ionic and covalent bonding M.O. and V.B. approaches for diatomic molecules, VSEPR theory and shape of molecules, hybridisation, resonance, dipole moment, structure parameters such as bond length, bond angle and bond energy, hydrogen bonding, van der Waals interactions. Ionic solids; ionic radii, lattice energy (Born-Haber Cycle).

s.p. and d Block Elements: Oxides, halides and hydrides of alkali and alkaline earth metals, B, Al, S, N, P and S, silicones, general characteristics of 3d elements, coordination complexes: valence bond and crystal field theory, color, geometry and magnetic properties.

Chemical Equilibria: Colligative properties of solutions, ionic equilibria in solution, solubility product, common ion effect, hydrolysis of salts, pH, buffer and their applications in chemical analysis.

Electrochemistry: Conductance, Kohlrausch law, Half Cell potentials, emf, Nernst equation, galvanic cells, thermodynamic aspects and their applications.

Reaction Kinetics: Rate constant, order of reaction, molecularity, activation energy, zero, first and second order kinetics, equilibrium constants (Kc, Kp and Kx) for homogeneous reactions, catalysis and elementary enzyme reactions.

Thermodynamics: First law, reversible and irreversible processes, internal energy, enthalpy, Kirchoff's equation, heat of reaction, Hess law, heat of formation, Second law, entropy, free energy, and work function. Gibbs-Helmholtz equation, Clausius-Clapeyron equation, free energy change and equilibrium constant, Troutons rule, Third law of thermodynamics.

Mechanistic Basis of Organic Reactions: Elementary treatment of SN1, SN2, E1 and E2 reactions, Hoffmann and Saytzeff rules, Addition reactions, Markonikoff rule and Kharash effect, Diels-Alder reaction, aromatic electrophilic substitution, orientation effect as exemplified by various functional groups.

Structure-Reactivity Correlations: Acids and bases, electronic and steric effects, optical and geometrical isomerism, tautomerism, concept of aromaticity

SECTION I. BIOCHEMISTRY

Organization of life. Importance of water. Cell structure and organelles. Structure and function of biomolecules: Carbohydrates, Lipids, Proteins and Nucleic acids. Biochemical separation techniques. Spectroscopic methods; UV-visible and fluorescence. Protein structure, folding and function: Myoglobin, Hemoglobin, Lysozyme, ribonuclease A, Carboxypeptidase and Chymotrypsin. Enzyme kinetics and regulation, Coenzymes.

Metabolism and bioenergitics. Generation and utilization of ATP. Photosynthesis. Major metabolic pathways and their regulation. Biological membranes. Transport across membranes. Signal transduction; hormones and neurotransmitters.

DNA replication, transcription and translation. Biochemical regulation of gene expression. Recombinant DNA technology and applications. Genomics and Proteomics.

The immune system. Active and passive immunity. Complement system. Antobody structure, function and diversity. Cells of the immune system: T, B and macrophages. T and B cell activation. Major histocompatibilty complex. T cell receptor. Immunological techniques: Immunodiffusion, immunoelectrophoresis, RIA and ELISA.

SECTION J. BIOTECHNOLOGY

Recombinant DNA technology for the production of therapeutic proteins. Micro array technology. Heterologous protein expression systems in bacteria, yeast etc.

Architecture of plant genome; plant tissue culture techniques; methods of gene transfer into plant cells; manipulation of phenotypic traits in plants; plant cell fermentations and production of secondary metabolites using suspension/ immobilized cell culture; methods for plant micro propagation; crop improvement and development of transgenic plants. Expression of animal proteins in plants.

Animal cell metabolism and regulation; cell cycle; primary cell culture; nutritional requirements for animal cell culture; techniques for the mass culture of animal cell lines; production of vaccines; growth hormones and interferons using animal cell culture; cytokines-production and therapeutic uses; hybridoma technology; vectors for gene transfer and expression in animal cells. Transgenic animals and molecular pharming.

Microbial production of industrial enzymes; methods for immobilization of enzymes; kinetics of soluble and immobilized enzymes; application of soluble and immobilized enzymes; enzyme-based sensors.

Microbial growth kinetics; batch, fed batch and continuous culture of microbial cells; media for industrial fermentations; sterilization of air and media; design features and operation of stirred tank, air-lift and fluidized bed reactors; aeration and agitation in aerobic fermentations; recovery and purification of fermentation products- filtration, centrifugation, cell disintegration, solvent extraction and chromatographic separations; industrial fermentations for the production of ethanol, citric acid, lysine, penicillin and other biomolecules; simple calculations based on material and energy balance of fermentation processes; application of microbes in the management of domestic and industrial wastes.

SECTION K. BOTANY

Anatomy: Roots, stem and leaves of land plants, meristems, vascular system, their ontogeny, structure and functions. Plant cell structure, organisation, organelles, cytoskeleton, cell wall and membranes.

Development: Cell cycle, cell division, senescence, hormonal regulation of growth; life cycle of an angiosperm, pollination, fertilization, embryogenesis, seed formation, seed storage proteins, seed dormancy and germination. Concept of cellular totipotency, organogenesis and somatic embryogenesis, somaclonal variation, embryo culture, in vitro fertilization.

Physiology and Biochemistry: Plant water relations, transport of minerals and solutes, N2 metabolism, proteins and nucleic acid, respiration, photophysiology, photosynthesis, photorespiration; biosynthesis, mechanism of action and physiological effects of plant growth regulators.

Genetics: Principles of Mendelian inheritance, linkage, recombination and genetic mapping; extrachromosomal inheritance; eukaryotic genome organization (chromatin structure) and regulation of gene expression, gene mutation, chromosome aberrations (numerical and structural), transposons.

Plant Breeding: Principles, methods - selection, hybridization, heterosis; male sterility, self and inter-specific incompatibility; haploidy; somatic cell hybridization; molecular marker-assisted selection; gene transfer methods viz. direct and vector-mediated, transgenic plants and their applications in agriculture.

Economic Botany: Economically important plants - cereals, pulses, plants yielding fiber, timber, sugar, beverages, oils, rubber, dyes, gums, drugs and narcotics - a general account.

Systematics: Systems of classification (non-phylogenetic vs. phylogenetic - outline), plant groups, molecular systematics.

Plant Pathology: Nature and classification of plant diseases, diseases of important crops caused by fungi, bacteria and viruses, and their control measures, mechanism(s) of pathogenesis and resistance, molecular detection of pathogens; plant-microbe beneficial interactions.

Ecology and Plant Geography: Ecosystems - types, dynamics, degradation, ecological succession; food chains; vegetation types of the world; pollution and global warming; speciation and extinction, conservation strategies, cryopreservation.

SECTION L. MICROBIOLOGY

Historical perspective - Discovery of the microbial world; Controversy over spontaneous generation; Role of microorganisms in transformation of organic matter and in the causation of diseases.

Methods in microbiology - Pure culture techniques; Theory and practice of sterilization; Principles of microbial nutrition; Construction of culture media; Enrichment culture techniques for isolation of chemoautotrophs, chemoheterotrophs and photosynthetic microorganisms.

Microbial evolution, systematics and taxonomy - Evolution of earth and earliest life forms; Primitive organisms and their metabolic strategies; New approaches to bacterial taxonomic classification including ribotyping; Nomenclature.

Microbial diversity - Bacteria, archea and their broad classification; Eukaryotic microbes, yeast, fungi, slime mold and protozoa; Viruses and their classification.

Microbial growth -The definition of growth, mathematical expression of growth, growth curve, measurement of growth and growth yields; Synchronous growth; Continuous culture.

Nutrition and metabolism - Overview of metabolism; Microbial nutrition; Energy classes of microorganisms; Culture media; Energetics, modes of ATP generation; ATP generation by heterotrophs; Fermentation; Glycolysis; Respiration; The citric acid cycle; Electron transport systems; Alternate modes of energy generation; Pathways (anabolism) in the biosynthesis of amino acids, purines, pyrimidines and fatty acids.

Metabolic diversity among microorganisms - Photosynthesis in microorganisms; Role of chlorophylls, carotenoids and phycobilins; Calvin cycle; Chemolithotrophy; Hydrogen- iron-nitrite-oxidizing bacteria; Nitrate and sulfate reduction; Methanogenesis and acetogenesis.

Prokaryotic cells: structure-function - Cells walls of eubacteria (peptidoglycan) and related molecules; Outer-membrane of gram-negative bacteria; Cell wall and cell membrane synthesis; Flagella and motility; Cell inclusions like endospores, gas vesicles.

Microbial diseases and host parasite relationships - Normal microflora of skin; Oral cavity; Gastrointestinal tract; Entry of pathogens into the host; Infectious disease transmission; Respiratory infections caused by bacteria and viruses; Tuberculosis; Sexually transmitted diseases including AIDS; Diseases transmitted by animals (Rabies, plague), insects and ticks (rikettsias, Lyme disease, malaria); Food and water borne diseases; Public health and water quality; Pahtogenic fungi; Emerging and resurgent infectious diseases.

Chemotherapy/Antibiotics - Antimicrobial agents; Sulfa drugs; Antibiotics; Pencillins and cephalosporins; Broad-spectrum antibiotics; Antibiotics from prokaryotes; Antifungal antibiotics; Mode of action; Resistance to antibiotics.

Microbial genetics - Genes, mutation and mutagenesis - UV and chemical mutagnes; Types of mutations; Ames test for mutagenesis; Methods of genetic analysis. Bacterial genetic system - Transformation; Conjugation; Transduction; Recombination; Plasmids and Transposons; Bacterial genetic map with reference to E. coli. Viruses and their genetic system - Phage ? and its life cycle; RNA phages; RNA viruses; Retroviruses; Genetic systems of yeast and Neurospora; Extrachromosomal inheritance and mitochondrial genetics; Basic concept of genomics.

SECTION M. ZOOLOGY

Animal world: Animal diversity, distribution, systematic and classification of animals, the phylogenetic relationship.

Evolution: Origin of life, history of life on earth, evolutionary theories, natural selection, adaptation, speciation.

Genetics: Principles of inheritance, molecular basis of heredity, the genetic material, transmission of genetic material, mutations, cytoplasmic inheritance.

Biochemistry and Molecular Biology: Nucleic acids, proteins and other biological macromolecules. Replication, transcription and translation, regulation of gene expression, organization of genome, Kreb's cycle, glycolysis, enzyme catalysis, hormones and their action.

Cell Biology: Structure of cell, cellular organelles and their structure and function, cell cycle, cell division, cellular differentiation, chromosome and chromatin structure. Eukaryotic gene organisation and expression.

Animal Anatomy and Physiology: Comparative physiology, the respiratory system, circulatory system, digestive system, the nervous system, the excretory system, the endocrine system, the reproductive system, the skeletal system, osmoregulation.

Parasitology and Immunology: Nature of parasite, host-parasite relation, protozoan and helminthic parasites, the immune response, cellular and humoral immune response, evolution of the immune system.

Development Biology: Embryonic development, cellular differentiation, organogenesis, metamorphosis, genetic basis of development.

Ecology: The ecosystem, habitats the food chain, population dynamics, species diversity, zoogeography, biogeochemical cycles, conservation biology.

Animal Behaviour: Types of behaviours, courtship, mating and territoriality, instinct, learning and memory, social behaviour across the animal taxa, communication, pheromones, evolution of animal behaviour.

IT - INFORMATION TECHNOLOGY

ENGINEERING MATHEMATICS

Mathematical Logic: Propositional Logic; First Order Logic.

Probability: Conditional Probability; Mean, Median, Mode and Standard Deviation; Random Variables; Distributions; uniform, normal, exponential, Poisson, Binomial.

Set Theory & Algebra: Sets; Relations; Functions; Groups; Partial Orders; Lattice; Boolean Algebra.

Combinatorics: Permutations; Combinations; Counting; Summation; generating functions; recurrence relations; asymptotics.

Graph Theory: Connectivity; spanning trees; Cut vertices & edges; covering; matching; independent sets; Colouring; Planarity; Isomorphism.

Linear Algebra: Algebra of matrices, determinants, systems of linear equations, Eigen values and Eigen vectors.

Numerical Methods: LU decomposition for systems of linear equations; numerical solutions of non linear algebraic equations by Secant, Bisection and Newton-Raphson Methods; Numerical integration by trapezoidal and Simpson's rules.

Calculus: Limit, Continuity & differentiability, Mean value Theorems, Theorems of integral calculus, evaluation of definite & improper integrals, Partial derivatives, Total derivatives, maxima & minima.

FORMAL LANGUAGES AND AUTOMATA

Regular Languages: finite automata, regular expressions, regular grammar.

Context free languages: push down automata, context free grammars

COMPUTER HARDWARE

Digital Logic: Logic functions, minimization, design and synthesis of combinatorial and sequential circuits, number representation and computer arithmetic (fixed and floating point)

Computer organization: Machine instructions and addressing modes, ALU and data path, hardwired and microprogrammed control, memory interface, I/O interface (interrupt and DMA mode), serial communication interface, instruction pipelining, cache, main and secondary storage

SOFTWARE SYSTEMS

Data structures and Algorithms: the notion of abstract data types, stack, queue, list, set, string, tree, binary search tree, heap, graph, tree and graph traversals, connected components, spanning trees, shortest paths, hashing, sorting, searching, design techniques (greedy, dynamic, divide and conquer), asymptotic analysis (best, worst, average cases) of time and space, upper and lower bounds, intractability

Programming Methodology: C programming, program control (iteration, recursion, functions), scope, binding, parameter passing, elementary concepts of object oriented programming

Operating Systems (in the context of Unix): classical concepts (concurrency, synchronization, deadlock), processes, threads and interprocess communication, CPU scheduling, memory management, file systems, I/O systems, protection and security

Information Systems and Software Engineering: information gathering, requirement and feasibility analysis, data flow diagrams, process specifications, input/output design, process life cycle, planning and managing the project, design, coding, testing, implementation, maintenance.

Databases: relational model, database design, integrity constraints, normal forms, query languages (SQL), file structures (sequential, indexed), b-trees, transaction and concurrency control

Data Communication: data encoding and transmission, data link control, multiplexing, packet switching, LAN architecture, LAN systems (Ethernet, token ring), Network devices: switches, gateways, routers

Networks: ISO/OSI stack, sliding window protocols, routing protocols, TCP/UDP, application layer protocols & systems (http, smtp, dns, ftp), network security

Web technologies: three tier web based architecture; JSP, ASP, J2EE, .NET systems; html, XML

AG - AGRICULTURAL ENGINEERING

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

FARM MACHINERY AND POWER:

Sources of power on the farm-human, animal, mechanical, electrical, wind, solar and biomass; design and selection of machine elements - gears, pulleys, chains and sprockets and belts; overload safety devices used in farm machinery; measurement of force, torque, speed, displacement and acceleration on machine elements.

Soil tillage; forces acting on a tillage tool; hitch systems and hitching of tillage implements; functional requirements, principles of working, construction and operation of manual, animal and power operated equipment for tillage. sowing, planting, fertilizer application, inter-cultivation, spraying, mowing, chaff cutting, harvesting, threshing and transport; testing of agricultural machinery and equipment; calculation of performance parameters -field capacity, efficiency, application rate and losses; cost analysis of implements and tractors.

Thermodynamic principles of I.C. engines; I.C. engine cycles; engine components; fuels and combustion; lubricants and their properties; I.C. engine systems - fuel, cooling, lubrication, ignition, electrical, intake and exhaust; selection, operation, maintenance and repair of I.C. engines; power efficiencies and measurement; calculation of power, torque, fuel consumption, heat load and power losses.

Tractors and power tillers - type, selection, maintenance and repair; tractor clutches and brakes; power transmission systems - gear trains, differential, final drives and power take-off; mechanics of tractor chassis; traction theory; three point hitches- free link and restrained link operations; mechanical steering and hydraulic control systems used in tractors; human engineering and safety in tractor design; tractor tests and performance.

SOIL AND WATER CONSERVATION ENGINEERING:

Ideal and real fluids, properties of fluids; hydrostatic pressure and its measurement; hydrostatic forces on plane and curved surface; continuity equation; Bernoulli's theorem; laminar and turbulent flow in pipes, Darcy-Weisbach and Hazen-Williams equations, Moody's diagram; flow through orifices and notches; flow in open channels.

Engineering properties of soils, fundamental definitions and relationships; index properties of soils; permeability and seepage analysis; shear strength, Mohr's circle of stresses; active and passive earth pressures; stability of slopes.

Hydrological cycle; precipitation measurement, analysis of precipitation data; abstraction from precipitation; runoff; hydrograph analysis, unit hydrograph theory and application; stream flow measurement; flood routing, hydrological reservoir and channel routing.

Mechanics of soil erosion, factors affecting erosion; soil loss estimation; biological and engineering measures to control erosion, terraces and bunds; vegetative waterways; gully control structures, drop, drop inlet and chute spillways; farm ponds; earthen dams; principles of watershed management.

Water requirement of crops; consumptive use and evapo-transpiration; irrigation scheduling; irrigation efficiencies; design of prismatic and silt loaded channels; methods of irrigation water application; design and evaluation of irrigation methods; drainage coefficient; surface and subsurface drainage systems; leaching requirement and salinity control; irrigation and drainage water quality; classification of pumps; pump characteristics; pump selection; types of aquifer; evaluation of aquifer properties; well hydraulics; ground water recharge.

AGRICULTURAL PROCESSING AND FOOD ENGINEERING:

Steady state heat transfer in conduction, convection and radiation; transient heat transfer in simple geometry; condensation and boiling heat transfer; working principles of heat exchangers; diffusive and convective mass transfer; simultaneous heat and mass transfer in agricultural processing operations.

Material and energy balances in food processing systems; water activity, sorption and desorption isotherms; centrifugal separation of solids, liquids and gases; kinetics of microbial death - pasteurisation and sterilization of liquid foods; preservation of food by cooling and freezing; psychrometry - properties of air-vapour mixture; concentration and dehydration of liquid foods - evaporators, tray, drum and spray dryers.

Mechanics and energy requirement in size reduction of granular solids; particle size analysis for comminuted solids; size separation by screening; fluidisation of granular solids; cleaning and grading efficiency and effectiveness of grain cleaners; conditioning and hydrothermal treatments for grains; dehydration of food grains; processes and machines for processing of cereals, pulses and oilseeds; design considerations for grain silos.

AR - ARCHITECTURE AND PLANNING

City planning: Historical development of cities; principles of city planning; new towns; survey methods, site planning, planning regulations and building bye-laws.

Housing: Concept of shelter; housing policies and design; community planning; role of government agencies; finance and management.

Landscape Design: Principles of landscape design and site planning; history and landscape styles; landscape elements and materials; planting design.

Computer Aided Design: Application of computers in architecture and planning; understanding elements of hardware and software; computer graphics; programming languages - C and Visual Basic and usage of packages such as AutoCAD.

Environmental and Building Science: Elements of environmental science; ecological principles concerning environment; role of micro-climate in design; climatic control through design elements; thermal comfort; elements of solar architecture; principles of lighting and illumination; basic principles of architectural acoustics; air pollution, noise pollution and their control.

Visual and Urban Design: Principles of visual composition; proportion, scale, rhythm, symmetry, harmony, balance, form and colour; sense of place and space, division of space; focal point, vista, imageability, visual survey.

History of Architecture: Indian - Indus valley, Vedic, Buddhist, Indo-Aryan, Dravidian and Mughal periods; European - Egyptian, Greek, Roman, medieval and renaissance periods.

Development of Contemporary Architecture: Architectural developments and impacts on society since industrial revolution; influence of modern art on architecture; works of national and international architects; post modernism in architecture.

Building Services: Water supply, Sewerage and Drainage systems; Sanitary fittings and fixtures; principles of electrification of buildings; elevators, their standards and uses; air-conditioning systems; fire fighting systems.

Building Construction and Management: Building construction techniques, methods and details; building systems and prefabrication of building elements; principles of modular coordination; estimation, specification, valuation, professional practice; project management, PERT, CPM.

Materials and Structural Systems: Behavioural characteristics of all types of building materials e.g. mud, timber, bamboo, brick, concrete, steel, glass, FRP; principles of strength of materials; design of structural elements in wood, steel and RCC; elastic and limit state design; complex structural systems; principles of pre-stressing.

Planning Theory: Planning process; multilevel planning; comprehensive planning; central place theory; settlement pattern; land use and land utilization.

Techniques of Planning: Planning surveys; Preparation of urban and regional structure plans, development plans, action plans; site planning principles and design; statistical methods; application of remote sensing techniques in urban and regional planning.

Traffic and Transportation Planning: Principles of traffic engineering and transportation planning; methods of conducting surveys; design of roads, intersections and parking areas; hierarchy of roads and levels of services; traffic and transport management in urban areas; traffic safety and traffic laws; public transportation planning; modes of transportation.

Services and Amenities: Principles and design of water supply systems, sewerage systems, solid waste disposal systems, power supply and communication systems; Health, education, recreation and demography related standards at various levels of the settlements.

Development Administration and Management: Planning laws; development control and zoning regulations; laws relating to land acquisition; development enforcements, land ceiling; regional and urban plan preparations; planning and municipal administration; taxation, revenue resources and fiscal management; public participation and role of NGO.

CE - CIVIL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

STRUCTURAL ENGINEERING

Mechanics: Bending moments and shear forces in statically determinate beams; simple stress and strain: relationship; stress and strain in two dimensions, principal stresses, stress transformation, Mohr's circle; simple bending theory; flexural shear stress; thin-walled pressure vessels; uniform torsion.

Structural Analysis: Analysis of statically determinate trusses, arches and frames; displacements in statically determinate structures and analysis of statically indeterminate structures by force/energy methods; analysis by displacement methods (slope-deflection and moment-distribution methods); influence lines for determinate and indeterminate structures; basic concepts of matrix methods of structural analysis.

Concrete Structures: Basic working stress and limit states design concepts; analysis of ultimate load capacity and design of members subject to flexure, shear, compression and torsion (beams, columns and isolated footings); basic elements of prestressed concrete: analysis of beam sections at transfer and service loads.

Steel Structures: Analysis and design of tension and compression members, beams and beam-columns, column bases; connections - simple and eccentric, beam-column connections, plate girders and trusses; plastic analysis of beams and frames.

GEOTECHNICAL ENGINEERING

Soil Mechanics: Origin of soils; soil classification; three-phase system, fundamental definitions, relationship and inter-relationships; permeability and seepage; effective stress principle: consolidation, compaction; shear strength.

Foundation Engineering: Sub-surface investigation - scope, drilling bore holes, sampling, penetrometer tests, plate load test; earth pressure theories, effect of water table, layered soils; stability of slopes - infinite slopes, finite slopes; foundation types - foundation design requirements; shallow foundations; bearing capacity, effect of shape, water table and other factors, stress distribution, settlement analysis in sands and clays; deep foundations - pile types, dynamic and static formulae, load capacity of piles in sands and clays.

WATER RESOURCES ENGINEERING

Fluid Mechanics and Hydraulics: Hydrostatics, applications of Bernoulli equation, laminar and turbulent flow in pipes, pipe networks; concept of boundary layer and its growth; uniform flow, critical flow and gradually varied flow in channels, specific energy concept, hydraulic jump; forces on immersed bodies; flow measurement in channels; tanks and pipes; dimensional analysis and hydraulic modeling. Applications of momentum equation, potential flow, kinematics of flow; velocity triangles and specific speed of pumps and turbines.

Hydrology: Hydrologic cycle; rainfall; evaporation infiltration, unit hydrographs, flood estimation, reservoir design, reservoir and channel routing, well hydraulics.

Irrigation: Duty, delta, estimation of evapo-transpiration; crop water requirements; design of lined and unlined canals; waterways; head works, gravity dams and Ogee spillways. Designs of weirs on permeable foundation, irrigation methods.

ENVIRONMENTAL ENGINEERING

Water requirements; quality and standards, basic unit processes and operations for water treatment, distribution of water. Sewage and sewerage treatment: quantity and characteristic of waste water sewerage; primary and secondary treatment of waste water; sludge disposal; effluent discharge standards.

TRANSPORTATION ENGINEERING

Highway planning; geometric design of highways; testing and specifications of paving materials; design of flexible and rigid pavements.

CH - CHEMICAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

CHEMICAL ENGINEERING

Process Calculations and Thermodynamics: Laws of conservation of mass and energy; use of tie components; recycle, bypass and purge calculations; degree of freedom analysis.

First and Second laws of thermodynamics and their applications; equations of state and thermodynamic properties of real systems; phase equilibria; fugacity, excess properties and correlations of activity coefficients; chemical reaction equilibria.

Fluid Mechanics and Mechanical Operations: Fluid statics, Newtonian and non-Newtonian fluids, Bernoulli equation, Macroscopic friction factors, energy balance, dimensional analysis, shell balances, flow through pipeline systems, flow meters, pumps and compressors, packed and fluidized beds, elementary boundary layer theory, size reduction and size separation; free and hindered settling; centrifuge and cyclones; thickening and classification, filtration, mixing and agitation; conveying of solids.

Heat Transfer: Conduction, convection and radiation, heat transfer coefficients, steady and unsteady heat conduction, boiling, condensation and evaporation; types of heat exchangers and evaporators and their design.

Mass Transfer: Fick's law, molecular diffusion in fluids, mass transfer coefficients, film, penetration and surface renewal theories; momentum, heat and mass transfer analogies; stagewise and continuous contacting and stage efficiencies; HTU & NTU concepts design and operation of equipment for distillation, absorption, leaching, liquid-liquid extraction, crystallization, drying, humidification, dehumidification and adsorption.

Chemical Reaction Engineering: Theories of reaction rates; kinetics of homogeneous reactions, interpretation of kinetic data, single and multiple reactions in ideal reactors, non-ideal reactors; residence time; non-isothermal reactors; kinetics of heterogeneous catalytic reactions; diffusion effects in catalysis.

Instrumentation and Process Control: Measurement of process variables; sensors, transducers and their dynamics, dynamics of simple systems, dynamics such as CSTRs, transfer functions and responses of simple systems, process reaction curve, controller modes (P, PI, and PID); control valves; analysis of closed loop systems including stability, frequency response (including Bode plots) and controller tuning, cascade, feed forward control.

Plant Design and Economics: Design and sizing of chemical engineering equipment such as compressors, heat exchangers, multistage contactors; principles of process economics and cost estimation including total annualized cost, cost indexes, rate of return, payback period, discounted cash flow, optimization in Design.

Chemical Technology: Inorganic chemical industries; sulfuric acid, NaOH, fertilizers (Ammonia, Urea, SSP and TSP); natural products industries (Pulp and Paper, Sugar, Oil, and Fats); petroleum refining and petrochemicals; polymerization industries; polyethylene, polypropylene, PVC and polyester synthetic fibers.

CS - COMPUTER SCIENCE AND ENGINEERING

ENGINEERING MATHEMATICS

Mathematical Logic: Propositional Logic; First Order Logic.

Probability: Conditional Probability; Mean, Median, Mode and Standard Deviation; Random Variables; Distributions; uniform, normal, exponential, Poisson, Binomial.

Set Theory & Algebra: Sets; Relations; Functions; Groups; Partial Orders; Lattice; Boolean Algebra.

Combinatorics: Permutations; Combinations; Counting; Summation; generating functions; recurrence relations; asymptotics.

Graph Theory: Connectivity; spanning trees; Cut vertices & edges; covering; matching; independent sets; Colouring; Planarity; Isomorphism.

Linear Algebra: Algebra of matrices, determinants, systems of linear equations, Eigen values and Eigen vectors.

Numerical Methods: LU decomposition for systems of linear equations; numerical solutions of non linear algebraic equations by Secant, Bisection and Newton-Raphson Methods; Numerical integration by trapezoidal and Simpson's rules.

Calculus: Limit, Continuity & differentiability, Mean value Theorems, Theorems of integral calculus, evaluation of definite & improper integrals, Partial derivatives, Total derivatives, maxima & minima.

THEORY OF COMPUTATION

Formal Languages and Automata Theory: Regular languages and finite automata, Context free languages and Push-down automata, Recursively enumerable sets and Turing machines, Un-decidability;

Analysis of Algorithms and Computational Complexity: Asymptotic analysis (best, worst, average case) of time and space, Upper and lower bounds on the complexity of specific problems, NP-completeness.

COMPUTER HARDWARE

Digital Logic: Logic functions, Minimization, Design and synthesis of Combinational and Sequential circuits; Number representation and Computer Arithmetic (fixed and floating point);

Computer Organization: Machine instructions and addressing modes, ALU and Data-path, hardwired and micro-programmed control, Memory interface, I/O interface (Interrupt and DMA mode), Serial communication interface, Instruction pipelining, Cache, main and secondary storage.

SOFTWARE SYSTEMS

Data structures: Notion of abstract data types, Stack, Queue, List, Set, String, Tree, Binary search tree, Heap, Graph;

Programming Methodology: C programming, Program control (iteration, recursion, Functions), Scope, Binding, Parameter passing, Elementary concepts of Object oriented, Functional and Logic Programming;

Algorithms for problem solving: Tree and graph traversals, Connected components, Spanning trees, Shortest paths; Hashing, Sorting, Searching; Design techniques (Greedy, Dynamic Programming, Divide-and-conquer);

Compiler Design: Lexical analysis, Parsing, Syntax directed translation, Runtime environment, Code generation, Linking (static and dynamic); Operating Systems: Classical concepts (concurrency, synchronization, deadlock), Processes, threads and Inter-process communication, CPU scheduling, Memory management, File systems, I/O systems, Protection and security.

Databases: Relational model (ER-model, relational algebra, tuple calculus), Database design (integrity constraints, normal forms), Query languages (SQL), File structures (sequential files, indexing, B+ trees), Transactions and concurrency control;

Computer Networks: ISO/OSI stack, sliding window protocol, LAN Technologies (Ethernet, Token ring), TCP/UDP, IP, Basic concepts of switches, gateways, and routers.

CH - CHEMISTRY

PHYSICAL CHEMISTRY

Structure: Quantum theory - principles and techniques; applications to particle in a box, harmonic oscillator, rigid rotor and hydrogen atom; valence bond and molecular orbital theories and Huckel approximation, approximate techniques: variation and perturbation; symmetry, point groups; rotational, vibrational, electronic, NMR and ESR spectroscopy.

Equilibrium: First law of thermodynamics, heat, energy and work; second law of thermodynamics and entropy; third law and absolute entropy; free energy; partial molar quantities; ideal and non-ideal solutions; phase transformation: phase rule and phase diagrams- one, two, and three component systems; activity, activity coefficient, fugacity and fugacity coefficient ; chemical equilibrium, response of chemical equilibrium to temperature and pressure; colligative properties; kinetic theory of gases; thermodynamics of electrochemical cells; standard electrode potentials: applications - corrosion and energy conversion; molecular partition function (translational, rotational, vibrational and electronic).

Kinetics: Rates of chemical reactions, theories of reaction rates, collision and transition state theory; temperature dependence of chemical reactions; elementary reactions, consecutive elementary reactions; steady state approximation, kinetics of photochemical reactions and free radical polymerization, homogenous and heterogeneous catalysis.

INORGANIC CHEMISTRY

Non-Transition Elements: General characteristics, structure and reactions of simple and industrially important compounds, boranes, carboranes, silicates, silicones, diamond and graphite; hydrides, oxides and oxoacids of N, P, S and halogens; boron nitride, borazines and phosphazenes; xenon compounds. Shapes of molecules, hard-soft acid base concept.

Transition Elements: General characteristics of d and f block elements; coordination chemistry: structure and isomerism, stability, theories of metal-ligand bonding (CFT and LFT), electronic spectra and magnetic properties of transition metal complexes and lanthanides; metal carbonyls, metal-metal bonds and metal atom clusters, metallocenes; transition metal complexes with bonds to hydrogen, alkyls, alkenes, and arenes; metal carbenes; use of organometallic compounds as catalysts in organic synthesis; mechanisms of substitution and electron transfer reactions of coordination complexes. Role of metals with special reference to Na, K, Mg, Ca, Fe, Co, Zn, and Mo in biological systems.

Solids: Crystal systems and lattices, Miller planes, crystal packing, crystal defects; Bragg's Law; ionic crystals, band theory, metals and semiconductors. Spinels.

Instrumental methods of analysis: atomic absorption, UV-visible spectrometry, chromatographic and electro-analytical methods.

ORGANIC CHEMISTRY

Synthesis, reactions and mechanisms involving the following: Alkenes, alkynes, arenes, alcohols, phenols, aldehydes, ketones, carboxylic acids and their derivatives; halides, nitro compounds and amines; stereochemical and conformational effects on reactivity and specificity; reactions with diborane and peracids. Michael reaction, Robinson annulation, reactivity umpolung, acyl anion equivalents; molecular rearrangements involving electron deficient atoms.

Photochemistry: Basic principles, photochemistry of olefins, carbonyl compounds, arenes, photo oxidation and reduction.

Pericyclic reactions: Cycloadditions, electrocyclic reactions, sigmatropic reactions; Woodward-Hoffmann rules.

Heterocycles: Structural properties and reactions of furan, pyrrole, thiophene, pyridine, indole.

Biomolecules: Structure, properties and reactions of mono- and di-saccharides, physico-chemical properties of amino acids, structural features of proteins and nucleic acids.

Spectroscopy: Principles and applications of IR, UV-visible, NMR and mass spectrometry in the determination of structures of organic compounds.

EC - ELECTRONICS AND COMMUNICATION ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix Algebra, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Mean value theorems, Theorems of integral calculus, Evaluation of definite and improper integrals, Partial Derivatives, Maxima and minima, Multiple integrals, Fourier series. Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equation (linear and nonlinear), Higher order linear differential equations with constant coefficients, Method of variation of parameters, Cauchy's and Euler's equations, Initial and boundary value problems, Partial Differential Equations and variable separable method.

Complex variables: Analytic functions, Cauchy's integral theorem and integral formula, Taylor's and Laurent' series, Residue theorem, solution integrals.

Probability and Statistics: Sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Discrete and continuous distributions, Poisson, Normal and Binomial distribution, Correlation and regression analysis.

Numerical Methods: Solutions of non-linear algebraic equations, single and multi-step methods for differential equations.

Transform Theory: Fourier transform, Laplace transform, Z-transform.

ELECTRONICS & COMMUNICATION ENGINEERING

Networks: Network graphs: matrices associated with graphs; incidence, fundamental cut set and fundamental circuit matrices. Solution methods: nodal and mesh analysis. Network theorems: superposition, Thevenin and Norton's maximum power transfer, Wye-Delta transformation. Steady state sinusoidal analysis using phasors. Linear constant coefficient differential equations; time domain analysis of simple RLC circuits, Solution of network equations using Laplace transform: frequency domain analysis of RLC circuits. 2-port network parameters: driving point and transfer functions. State equations for networks.

Electronic Devices: Energy bands in silicon, intrinsic and extrinsic silicon. Carrier transport in silicon: diffusion current, drift current, mobility, resistivity. Generation and recombination of carriers. p-n junction diode, Zener diode, tunnel diode, BJT, JFET, MOS capacitor, MOSFET, LED, p-I-n and avalanche photo diode, LASERs. Device technology: integrated circuits fabrication process, oxidation, diffusion, ion implantation, photolithography, n-tub, p-tub and twin-tub CMOS process.

Analog Circuits: Equivalent circuits (large and small-signal) of diodes, BJTs, JFETs, and MOSFETs. Simple diode circuits, clipping, clamping, rectifier. Biasing and bias stability of transistor and FET amplifiers. Amplifiers: single-and multi-stage, differential, operational, feedback and power. Analysis of amplifiers; frequency response of amplifiers. Simple op-amp circuits. Filters. Sinusoidal oscillators; criterion for oscillation; single-transistor and op-amp configurations. Function generators and wave-shaping circuits. Power supplies.

Digital circuits: Boolean algebra, minimization of Boolean functions; logic gates digital IC families (DTL, TTL, ECL, MOS, CMOS). Combinational circuits: arithmetic circuits, code converters, multiplexers and decoders. Sequential circuits: latches and flip-flops, counters and shift-registers. Sample and hold circuits, ADCs, DACs. Semiconductor memories. Microprocessor(8085): architecture, programming, memory and I/O interfacing.

Signals and Systems: Definitions and properties of Laplace transform, continuous-time and discrete-time Fourier series, continuous-time and discrete-time Fourier Transform, z-transform. Sampling theorems. Linear Time-Invariant (LTI) Systems: definitions and properties; casuality, stability, impulse response, convolution, poles and zeros frequency response, group delay, phase delay. Signal transmission through LTI systems. Random signals and noise: probability, random variables, probability density function, autocorrelation, power spectral density.

Controls Systems: Basic control system components; block diagrammatic description, reduction of block diagrams. Open loop and closed loop (feedback) systems and stability analysis of these systems. Signal flow graphs and their use in determining transfer functions of systems; transient and steady state analysis of LTI control systems and frequency response. Tools and techniques for LTI control system analysis: root loci, Routh-Hurwitz criterion, Bode and Nyquist plots. Control system compensators: elements of lead and lag compensation, elements of Proportional-Integral-Derivative(PID) control. State variable representation and solution of state equation of LTI control systems.

Communications: Analog communication systems: amplitude and angle modulation and demodulation systems, spectral analysis of these operations, superheterodyne receivers; elements of hardware, realizations of analog communication systems; signal-to-noise ratio (SNR) calculations for amplitude modulation (AM) and frequency modulation (FM) for low noise conditions. Digital communication systems: pulse code modulation (PCM), differential pulse code modulation (DPCM), delta modulation (DM); digital modulation schemes-amplitude, phase and frequency shift keying schemes (ASK, PSK, FSK), matched filter receivers, bandwith consideration and probability of error calculations for these schemes.

Electromagnetics: Elements of vector calculus: divergence and curl; Gauss' and Stokes' theorems, Maxwell's equations: differential and integral forms. Wave equation, Poynting vector. Plane waves: propagation through various media; reflection and refraction; phase and group velocity; skin depth. Transmission lines: characteristic impedance; impedance transformation; Smith chart; impedance matching; pulse excitation. Waveguides: modes in rectangular waveguides; boundary conditions; cut-off frequencies; dispersion relations. Antennas: Dipole antennas; antenna arrays; radiation pattern; reciprocity theorem, antenna gain.

EE - ELECTRICAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix Algebra, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Mean value theorems, Theorems of integral calculus, Evaluation of definite and improper integrals, Partial Derivatives, Maxima and minima, Multiple integrals, Fourier series. Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equation (linear and nonlinear), Higher order linear differential equations with constant coefficients, Method of variation of parameters, Cauchy's and Euler's equations, Initial and boundary value problems, Partial Differential Equations and variable separable method.

Complex variables: Analytic functions, Cauchy's integral theorem and integral formula, Taylor's and Laurent' series, Residue theorem, solution integrals.

Probability and Statistics: Sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Discrete and continuous distributions, Poisson, Normal and Binomial distribution, Correlation and regression analysis.

Numerical Methods: Solutions of non-linear algebraic equations, single and multi-step methods for differential equations.

Transform Theory: Fourier transform, Laplace transform, Z-transform.

ELECTRICAL ENGINEERING

Electrical Circuits and Fields: Network graph, KCL, KVL, node/ cut set, mesh/ tie set analysis, transient response of d.c. and a.c. networks; sinusoidal steady-state analysis; resonance in electrical circuits; concepts of ideal voltage and current sources, network theorems, driving point, immittance and transfer functions of two port networks, elementary concepts of filters; three phase circuits; Fourier series and its application; Gauss theorem, electric field intensity and potential due to point, line, plane and spherical charge distribution, dielectrics, capacitance calculations for simple configurations; Ampere's and Biot-Savart's law, inductance calculations for simple configurations.

Electrical Machines: Single phase transformer - equivalent circuit, phasor diagram, tests, regulation and efficiency; three phase transformers - connections, parallel operation; auto transformer and three-winding transformer; principles of energy conversion, windings of rotating machines: D. C. generators and motors - characteristics, starting and speed control, armature reaction and commutation; three phase induction motors-performance characteristics, starting and speed control; single-phase induction motors; synchronous generators-performance, regulation, parallel operation; synchronous motors - starting, characteristics, applications, synchronous condensers; fractional horse power motors; permanent magnet and stepper motors.

Power Systems: Electric power generation - thermal, hydro, nuclear; transmission line parameters; steady-state performance of overhead transmission lines and cables and surge propagation; distribution systems, insulators, bundle conductors, corona and radio interference effects; per-unit quantities; bus admittance and impedance matrices; load flow; voltage control and power factor correction; economic operation; symmetrical components, analysis of symmetrical and unsymmetrical faults; principles of over current, differential and distance protections; concept of solid state relays and digital protection; circuit breakers; concept of system stability-swing curves and equal area criterion; basic concepts of HVDC transmission.

Control Systems: Principles of feedback; transfer function; block diagrams: steady-state errors; stability-Routh and Nyquist criteria; Bode plots; compensation; root loci; elementary state variable formulation; state transition matrix and response for Linear Time Invariant systems.

Electrical and Electronic Measurements: Bridges and potentiometers, PMMC, moving iron, dynamometer and induction type instruments; measurement of voltage, current, power, energy and power factor; instrument transformers; digital voltmeters and multimeters; phase, time and frequency measurement; Q-meter, oscilloscopes, potentiometric recorders, error analysis.

Analog and Digital Electronics: Characteristics of diodes, BJT, FET, SCR; amplifiers-biasing, equivalent circuit and frequency response; oscillators and feedback amplifiers, operational amplifiers- characteristics and applications; simple active filters; VCOs and timers; combinational and sequential logic circuits, multiplexer, Schmitt trigger, multivibrators, sample and hold circuits, A/D and D/A converters; microprocessors and their applications.

Power Electronics and Electric Drives: Semiconductor power devices-diodes, transistors, thyristors, triacs, GTOs, MOSFETs and IGBTs - static characteristics and principles of operation; triggering circuits; phase control rectifiers; bridge converters-fully controlled and half controlled; principles of choppers and inverters, basic concepts of adjustable speed dc and ac drives.

GG - GEOLOGY AND GEOPHYSICS

PART - I

Earth and planetary system; size, shape, internal structure and composition of the earth; atmosphere and greenhouse effect; isostasy; elements of seismology; continents and continental processes; physical oceanography; palaeomagnetism, continental drift plate tectonics, geothermal energy.

Weathering; soil formation; action of river, wind and glacier; oceans and oceanic features; earthquakes, volcanoes, orogeny and mountain building; elements of structural geology; crystallography; classification, composition and properties of minerals and rocks; engineering properties of rocks and soils, role of geology in the construction of engineering structures.

Processes of ore formation, occurrence and distribution of ores on land and on ocean floor;

coal and petroleum resources in India; ground water geology including well hydraulics, geological time scale and geochronology; stratigraphic principles and stratigraphy of India; basics concepts of gravity, magnetic and electrical prospecting for ores and ground water.

PART - IIA: GEOLOGY

Crystal symmetry, forms, twinning; crystal chemistry; optical mineralogy, classification of minerals, diagnostic properties of rock minerals.

Mineralogy, structure, texture and classification of igneous, sedimentary and metamorphic rock, their origin and evolution; application of thermodynamics; structure and petrology of sedimentary rocks; sedimentary processes and environments, sedimentary facies, basin studies; basement cover relationship;

Primary and secondary structures; geometry and genesis of folds, faults, joints, unconformities, cleavage, schistosity and lineation; methods of projection. Tectonites and their significance; shear zone; superposed folding.

Morphology, classification and geological significance of important invertebrates, vertebrates, microfossils and palaeoflora; stratigraphic principles and Indian stratigraphy; geomorphic processes and agents; development and evolution of landforms; slope and drainage; processes on deep oceanic and near-shore regions; quantitative and applied geomorphology; air photo interpretation and remote sensing; chemical and optical properties of ore minerals; formation and localization of ore deposits; prospecting and exploration of economic minerals; coal and petroleum geology; origin and distribution of mineral and fuel deposits in India; ore dressing and mineral economics.

Cosmic abundance; meteorites; geochemical evolution of the earth; geochemical cycles; distribution of major, minor and trace elements; isotope geochemistry; geochemistry of waters including solution equilibria and water rock interaction.

Engineering properties of rocks and soils; rocks as construction material; geology of dams, tunnels and excavation sites; natural hazards; the fly ash problem; ground water geology and exploration; water quality; impact of human activity; Remote sensing techniques for the interpretation of landforms and resource management.

PART - II B: GEOPHYSICS

The earth as a planet; different motions of the earth; gravity filed of the earth and its shape; geochronology; isostasy, seismology and interior of the earth; variation of density, velocity, pressure, temperature, electrical and magnetic properties inside the earth; earthquakes-causes and measurements; zonation and seismic hazards; geomagnetic field, palaeomagnetism; oceanic and continental lithosphere; plate tectonics; heat flow; upper and lower atmospheric phenomena.

Theories of scalar and vector potential fields; Laplace, Maxwell and Helmholtz equations for solution of different types of boundary value problems for Cartesian, cylindrical and spherical polar coordinates; Green's theorem; Image theory; integral equations and conformal transformations in potential theory; Eikonal equation and ray theory.

'G' and 'g' units of measurement, density of rocks, gravimeters, preparation, analysis and interpretation of gravity maps; derivative maps, analytical continuation; gravity anomaly type curves; calculation of mass.

Earth's magnetic field, units of measurement, magnetic susceptibility of rocks, magnetometers, corrections, preparation of magnetic maps, magnetic anomaly type curve, analytical continuation, interpretation and application; magnetic well logging.

Conduction of electricity through rocks, electrical conductivities of metals, metallic, non-metallic and rock forming minerals, D.C. resistivity units and methods of measurement, electrode configuration for sounding and profiling, application of filter theory, interpretation of resistivity field data, application; self potential origin, classification, field measurement, interpretation of induced polarization time frequency, phase domain; IP units and methods of measurement, interpretation and application; ground-water exploration.

Origin of electromagnetic field elliptic polarization, methods of measurement for different source-receiver configuration components in EM measurements, interpretation and applications; earth's natural electromagnetic field, tellurics, magneto-tellurics; geomagnetic depth sounding principles, methods of measurement, processing of data and interpretation.

Seismic methods of prospecting: Reflection, refraction and CDP surveys; land and marine seismic sources, generation and propagation of elastic waves, velocity increasing with depth, geophones, hydrophones, recording instruments (DFS), digital formats, field layouts, seismic noises and noise profile analysis, optimum geophone grouping, noise cancellation by shot and geophone arrays, 2D and 3D seismic data acquisition and processing, CDP stacking charts, binning, filtering, dip-moveout, static and dynamic corrections, deconvolution, migration, signal processing, Fourier and Hilbert transforms, attribute analysis, bright and dim spots, seismic stratigraphy, high resolution seismics, VSP.

Principles and techniques of geophysical well-logging, SP, resistivity, induction, micro gamma ray, neutron, density, sonic, temperature, dip meter, caliper, nuclear magnetic, cement bond logging. Quantitative evaluation of formations from well logs; well hydraulics and application of geophysical methods for groundwater study; application of bore hole geophysics in ground water, mineral and oil exploration. Remote sensing techniques and application of remote sensing methods in geophysics.

IN - INSTRUMENTATION ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix Algebra, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Mean value theorems, Theorems of integral calculus, Evaluation of definite and improper integrals, Partial Derivatives, Maxima and minima, Multiple integrals, Fourier series. Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equation (linear and nonlinear), Higher order linear differential equations with constant coefficients, Method of variation of parameters, Cauchy's and Euler's equations, Initial and boundary value problems, Partial Differential Equations and variable separable method.

Complex variables: Analytic functions, Cauchy's integral theorem and integral formula, Taylor's and Laurent' series, Residue theorem, solution integrals.

Probability and Statistics: Sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Discrete and continuous distributions, Poisson, Normal and Binomial distribution, Correlation and regression analysis.

Numerical Methods: Solutions of non-linear algebraic equations, single and multi-step methods for differential equations.

Transform Theory: Fourier transform, Laplace transform, Z-transform.

INSTRUMENTATION ENGINEERING

Measurement Basics and Metrology: Static and dynamic characteristics of measurement systems. Standards and calibration. Error and uncertainty analysis, statistical analysis of data, and curve fitting. Linear and angular measurements; Measurement of straightness, flatness, roundness and roughness.

Transducers, Mechanical Measurements and Industrial Instrumentation: Transducers - elastic, resistive, inductive, capacitive, thermo-electric, piezoelectric, photoelectric, electro-mechanical, electro-chemical, and ultrasonic. Measurement of displacement, velocity (linear and rotational), acceleration, shock, vibration, force, torque, power, strain, stress, pressure, flow, temperature, humidity, viscosity, and density. energy storing elements, suspension systems and dampers.

Analog Electronics: Characteristics of diodes, BJTs, JFETs and MOSFETs; Diode circuits; Amplifiers: single and multi-stage, feedback; Frequency response; Operational amplifiers - design, characteristic, linear and non-linear applications: difference amplifiers; instrumentation amplifiers; precision rectifiers, I-to-V converters, active filters, oscillators, comparators, signal generators, wave shaping circuits.

Digital Electronics: Combinational logic circuits, minimization of Boolean functions; IC families (TTL, MOS, CMOS), arithmetic circuits, multiplexer and decoders. Sequential circuits: flip-flops, counters, shift registers. Schmitt trigger, timers, and multivibrators. Analog switches, multiplexers, S/H circuits. Analog-to-digital and digital-to-analog converters. Basics of computer organization and architecture. 8-bit microprocessor (8085), applications, memory, I/O interfacing, and microcontrollers.

Signals and Systems: Vectors and matrices; Fourier series; Fourier transforms; Ordinary differential equations. Impulse and frequency responses of first and second order systems. Laplace transform and transfer function, convolution and correlation. Amplitude and frequency modulations and demodulations. Discrete time systems, difference equations, impulse and frequency responses; Z-transforms and transfer functions; IIR and FIR filters.

Electrical and Electronic Measurements: Measurement of R, L and C; bridges and potentiometers. Measurement of voltage, current, power, power factor, and energy; Instrument transformers; Q meter, waveform analyzers. Digital volt-meters and multi-meters. Time, phase and frequency measurements; Oscilloscope. Noise and interference in instrumentation.

Control Systems & Process Control: Principles of feedback; transfer function, signal flow graphs. Stability criteria, Bode plots, root-loci, Routh and Nyquist criteria. Compensation techniques; State space analysis. System components: mechanical, hydraulic, pneumatic, electrical and electronic; Servos and synchros; Stepper motors. On-off, cascade, P, PI, PID and feed-forward controls. Controller tuning and general frequency response.

Analytical, Optical and Biomedical Instrumentation: Principles of spectrometry, UV, visible, IR mass spectrometry, X-ray methods; nuclear radiation measurements, gas, solid and semi conductor lasers and their characteristics, interferometers, basics of fibre optics, transducers in biomedical applications, cardiovascular system measurements, instrumentation for clinical laboratory.

MA - MATHEMATICS

Linear Algebra: Finite dimensional vector spaces. Linear transformations and their matrix representations, rank; systems of linear equations, eigenvalues and eigenvectors, minimal polynomial, Cayley-Hamilton theorem, diagonalisation, Hermitian, Skew-Hermitian and unitary matrices. Finite dimensional inner product spaces, self-adjoint and Normal linear operators, spectral theorem, Quadratic forms.

Complex Analysis: Analytic functions, conformal mappings, bilinear transformations, complex integration: Cauchy's integral theorem and formula, Liouville's theorem, maximum modulus principle, Taylor and Laurent's series, residue theorem and applications for evaluating real integrals.

Real Analysis: Sequences and series of functions, uniform convergence, power series, Fourier series, functions of several variables, maxima, minima, multiple integrals, line, surface and volume integrals, theorems of Green, Stokes and Gauss; metric spaces, completeness, Weierstrass approximation theorem, compactness. Lebesgue measure, measurable functions; Lebesgue integral, Fatou's lemma, dominated convergence theorem.

Ordinary Differential Equations: First order ordinary differential equations, existence and uniqueness theorems, systems of linear first order ordinary differential equations, linear ordinary differential equations of higher order with constant coefficients; linear second order ordinary differential equations with variable coefficients, method of Laplace transforms for solving ordinary differential equations, series solutions; Legendre and Bessel functions and their orthogonality, Sturm Liouville system, Greeen's functions.

Algebra: Normal subgroups and homomorphisms theorems, automorphisms. Group actions, sylow's theorems and their applications groups of order less than or equal to 20, Finite p-groups. Euclidean domains, Principal ideal domains and unique factorizations domains. Prime ideals and maximal ideals in commutative rings.

Functional Analysis: Banach spaces, Hahn-Banach theorems, open mapping and closed graph theorems, principle of uniform boundedness; Hilbert spaces, orthonormal sets, Riesz representation theorem, self-adjoint, unitary and normal linear operators on Hilbert Spaces.

Numerical Analysis: Numerical solution of algebraic and transcendental equations; bisection, secant method, Newton-Raphson method, fixed point iteration, interpolation: existence and error of polynomial interpolation, Lagrange, Newton, Hermite(osculatory)interpolations; numerical differentiation and integration, Trapezoidal and Simpson rules; Gaussian quadrature; (Gauss-Legendre and Gauss-Chebyshev), method of undetermined parameters, least square and orthonormal polynomial approximation; numerical solution of systems of linear equations: direct and iterative methods, (Jacobi Gauss-Seidel and SOR) with convergence; matrix eigenvalue problems: Jacobi and Given's methods, numerical solution of ordinary differential equations: initial value problems, Taylor series method, Runge-Kutta methods, predictor-corrector methods; convergence and stability.

Partial Differential Equations: Linear and quasilinear first order partial differential equations, method of characteristics; second order linear equations in two variables and their classification; Cauchy, Dirichlet and Neumann problems, Green's functions; solutions of Laplace, wave and diffusion equations in two variables Fourier series and transform methods of solutions of the above equations and applications to physical problems.

Mechanics: Forces in three dimensions, Poinsot central axis, virtual work, Lagrange's equations for holonomic systems, theory of small oscillations, Hamiltonian equations;

Topology: Basic concepts of topology, product topology, connectedness, compactness, countability and separation axioms, Urysohn's Lemma, Tietze extension theorem, metrization theorems, Tychonoff theorem on compactness of product spaces.

Probability and Statistics: Probability space, conditional probability, Bayes' theorem, independence, Random variables, joint and conditional distributions, standard probability distributions and their properties, expectation, conditional expectation, moments. Weak and strong law of large numbers, central limit theorem. Sampling distributions, UMVU estimators, sufficiency and consistency, maximum likelihood estimators. Testing of hypotheses, Neyman-Pearson tests, monotone likelihood ratio, likelihood ratio tests, standard parametric tests based on normal, X2 ,t, F-distributions. Linear regression and test for linearity of regression. Interval estimation.

Linear Programming: Linear programming problem and its formulation, convex sets their properties, graphical method, basic feasible solution, simplex method, big-M and two phase methods, infeasible and unbounded LPP's, alternate optima. Dual problem and duality theorems, dual simplex method and its application in post optimality analysis, interpretation of dual variables. Balanced and unbalanced transportation problems, unimodular property and u-v method for solving transportation problems. Hungarian method for solving assignment problems.

Calculus of Variations and Integral Equations: Variational problems with fixed boundaries; sufficient conditions for extremum, Linear integral equations of Fredholm and Volterra type, their iterative solutions. Fredholm alternative.

ME - MECHANICAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

APPLIED MECHANICS AND DESIGN

Engineering Mechanics: Equivalent force systems, free-body concepts, equations of equilibrium, trusses and frames, virtual work and minimum potential energy. Kinematics and dynamics of particles and rigid bodies, impulse and momentum (linear and angular), energy methods, central force motion.

Strength of Materials: Stress and strain, stress-strain relationship and elastic constants, Mohr's circle for plane stress and plane strain, shear force and bending moment diagrams, bending and shear stresses, deflection of beams, torsion of circular shafts, thin and thick cylinders, Euler's theory of columns, strain energy methods, thermal stresses.

Theory of Machines: Displacement, velocity and acceleration, analysis of plane mechanisms, dynamic analysis of slider-crank mechanism, planar cams and followers, gear tooth profiles, kinematics of gears, governors and flywheels, balancing of reciprocating and rotating masses.

Vibrations: Free and forced vibration of single degree freedom systems, effect of damping, vibration isolation, resonance, critical speed of rotors.

Design of Machine Elements: Design for static and dynamic loading, failure theories, fatigue strength; design of bolted, riveted and welded joints; design of shafts and keys; design of spur gears, rolling and sliding contact bearings; brakes and clutches; belt, rope and chain drives.

FLUID MECHANICS AND THERMAL SCIENCES

Fluid Mechanics: Fluid properties, fluid statics, manometry, buoyancy; control-volume analysis of mass, momentum and energy; fluid acceleration; differential equations of continuity and momentum; Bernoulli's equation; viscous flow of incompressible fluids; boundary layer; elementary turbulent flow; flow through pipes, head losses in pipes, bends etc.

Heat-Transfer: Modes of heat transfer; one dimensional heat conduction, resistance concept, electrical analogy, unsteady heat conduction, fins; dimensionless parameters in free and forced convective heat transfer, various correlations for heat transfer in flow over flat plates and through pipes; thermal boundary layer; effect of turbulence; radiative heat transfer, black and grey surfaces, shape factors, network analysis; heat exchanger performance, LMTD and NTU methods.

Thermodynamics: Zeroth, First and Second laws of thermodynamics; thermodynamic system and processes; irreversibility and availability; behaviour of ideal and real gases, properties of pure substances, calculation of work and heat in ideal processes; analysis of thermodynamic cycles related to energy conversion; Carnot, Rankine, Otto, Diesel, Brayton and vapour compression cycles.

Power Plant Engineering: Steam generators; steam power cycles; steam turbines; impulse and reaction principles, velocity diagrams, pressure and velocity compounding; reheating and reheat factor; condensers and feed heaters.

I.C. Engines: Requirements and suitability of fuels in IC engines, fuel ratings, fuel-air mixture requirements; normal combustion in SI and CI engines; engine performance calculations.

Refrigeration and air-conditioning: Refrigerant compressors, expansion devices, condensers and evaporators; properties of moist air, psychrometric chart, basic psychometric processes.

Turbomachinery: Components of gas turbines; compression processes, centrifugal and axial flow compressors; axial flow turbines, elementary theory; hydraulic turbines; Euler-turbine equation; specific speed, Pelton-wheel, Francis and Kaplan turbines; centrifugal pumps.

MANUFACTURING AND INDUSTRIAL ENGINEERING

Engineering Materials: Structure and properties of engineering materials and their applications, heat treatment.

Metal Casting: Casting processes (expendable and non-expendable) -pattern, moulds and cores, heating and pouring, solidification and cooling, gating design, design considerations, defects.

Forming Processes: Stress-strain diagrams for ductile and brittle material, Plastic deformation and yield criteria, fundamentals of hot and cold working processes, Bulk metal forming processes (forging, rolling, extrusion, drawing), sheet metal working processes (punching, blanking, bending, deep drawing, coining, spinning, load estimation using homogeneous deformation methods, defects). processing of powder metals- atomization, compaction, sintering, secondary and finishing operations. forming and shaping of plastics- extrusion, injection moulding.

Joining Processes: Physics of welding, fusion and non-fusion welding processes, brazing and soldering, adhesive bonding, design considerations in welding, weld quality defects.

Machining and Machine Tool Operations: Mechanics of machining, single and multi-point cutting tools, tool geometry and materials, tool life and wear, cutting fluids, machinability, economics of machining, non-traditional machining processes.

Metrology and Inspection: Limits, fits and tolerances, linear and angular measurements, comparators, gauge design, interferometry, form and finish measurement, measurement of screw threads, alignment and testing methods.

Tool Engineering: Principles of work holding, design of jigs and fixtures.

Computer Integrated Manufacturing: Basic concepts of CAD, CAM and their integration tools.

Manufacturing Analysis: Part-print analysis, tolerance analysis in manufacturing and assembly, time and cost analysis.

Work-Study: Method study, work measurement, time study, work sampling, job evaluation, merit rating.

Production Planning and Control: Forecasting models, aggregate production planning, master scheduling, materials requirements planning.

Inventory Control: Deterministic and probabilistic models, safety stock inventory control systems.

Operations Research: Linear programming, simplex and duplex method, transportation, assignment, network flow models, simple queuing models, PERT and CPM

MN - MINING ENGINEERING

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

MINING ENGINEERING

Mechanics: Equivalent force systems, equations of equilibrium, two dimensional frames and trusses, free body diagrams, friction forces, particle kinematics and dynamics.

Mine Development, Geomechanics and Strata Control: Drivages for underground mine development, drilling methods and machines, explosives, blasting devices and practices, shaft sinking. Physico-mechanical properties of rocks, rock mass classification, ground control instrumentation and stress measurement techniques, theories of rock failure, ground vibrations, stress distribution around mine openings, subsidence, design of supports in roadways and workings, stability of open pits, slopes.

Mining Methods and Machinery: Surface mining - layout, development, loading, transportation and mechanization, continuous surface mining systems. Underground coal mining - bord and pillar system, longwall mining, thick seam mining methods. Underground metal mining: different stoping methods, stope mechanization, ore handling systems, mine filling. Generation and transmission of mechanical, hydraulic, and pneumatic power. Materials handling - haulages, conveyors, ropeways, face and development machinery, hoisting systems, and pumps.

Ventilation, Underground Hazards and Surface Environment: Underground atmosphere, heat load sources and thermal environment, air cooling, mechanics of air flow distribution, natural and mechanical ventilation, mine fans and their usage, auxiliary ventilation. Subsurface hazards from fires, explosions, gases, dust, and inundation, rescue apparatus and practices, safety in mines, accident analysis, noise, mine lighting. Air and water pollution: causes, dispersion, quality standards, and control.

Surveying, Mine Planning and Systems Engineering: Fundamentals of engineering surveying, Levels and levelling, Theodolite, tacheometry, triangulation, contouring, errors and adjustments, correlation, underground surveying, curves, photogrammetry, field astronomy, GPS fundamentals. Principles of planning - Sampling methods and practices, reserve estimation techniques, basics of geostatistics, optimization of facility location, cash flow concepts and mine valuation, open pit design. Work study, concepts of reliability, reliability of series and parallel systems. Linear programming, transportation and assignment problems, queueing, network analysis, inventory control.

MT - METALLURGICAL ENGINEERING

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

METALLURGICAL ENGINEERING

Thermodynamics and Rate Processes: Laws of thermodynamics, activity, equilibrium constant, applications to metallurgical systems, solutions, phase equilibria, basic kinetic laws, order of reactions, rate constants and rate limiting steps principles of electro chemistry, aqueous, corrosion and protection of metals, oxidation and high temperature corrosion - characterization and control; momentum transfer - concepts of viscosity, shell balances, Bernoulli's equation; heat transfer - conduction, convection and heat transfer coefficient relations, radiation, mass transfer - diffusion and Fick's laws.

Extractive Metallurgy: Flotation, gravity and other methods of mineral processing; agglomeration, pyro-hydro-and electro-metallurgical processes; material and energy balances; principles and processes for the extraction of non-ferrous metals - aluminium, copper, zinc, lead, magnesium, nickel, titanium and other rare metals; iron and steel making - principles, blast furnace, direct reduction processes, primary and secondary steel making, deoxidation and inclusion in steel; ingot and continuous casting; stainless steel making, design of furnaces; fuels and refractories.

Physical Metallurgy: Crystal structure and bonding characteristics of metals, alloys, ceramics and polymers; solid solutions; solidification; phase transformation and binary phase diagrams; principles of heat treatment of steels, aluminum alloys and cast irons; recovery, recrystallization and grain growth; industrially important ferrous and non-ferrous alloys; elements of X-ray and electron diffraction; principles of scanning and transmission electron microscopy; elements of ceramics, composites and electronic materials; electronic basis of thermal, optical, electrical and magnetic properties of materials.

Mechanical Metallurgy: Elements of elasticity and plasticity; defects in crystals; elements of dislocation theory - types of dislocations, slip and twinning, stress fields of dislocations, dislocation interactions and reactions, methods of seeing dislocations; strengthening mechanisms; tensile, fatigue and creep behaviour; superplasticity; fracture - Griffith theory, ductile to brittle transition, fracture toughness; failure analysis; mechanical testing - tension, compression, torsion, hardness, impact, creep, fatigue, fracture toughness and formability tests.

Manufacturing Processes: Metal casting - patterns, moulds, melting, gating, feeding and casting processes, defects and castings, hot and cold working of metals; Metal forming - fundamentals of metal forming, rolling wire drawing, extrusion, forming, sheet metal forming processes, defects in forming; Metal joining - soldering, brazing and welding, common welding processes, welding metallurgy, problems associated with welding of steels and aluminium alloys, defects in welding, powder metallurgy; NDT methods - ultrasonic, radiography, eddy current, acoustic emission and magnetic.

PH - PHYSICS

Mathematical Physics: Linear vector space, matrices; vector calculus; linear differential equations; elements of complex analysis; Laplace transforms, Fourier analysis, elementary ideas about tensors.

Classical Mechanics: Conservation laws; central forces; collisions and scattering in laboratory and centre of mass reference frames; mechanics of system of particles; rigid body dynamics; moment of inertia tensor; noninertial frames and pseudo forces; variational principle; Lagrange's and Hamilton's formalisms; equation of motion, cyclic coordinates, Poisson bracket; periodic motion, small oscillations, normal modes; wave equation and wave propagation; special theory of relativity - Lorentz transformations, relativistic kinematics, mass-energy equivalence.

Electromagnetic Theory: Laplace and Poisson equations; conductors and dielectrics; boundary value problems; Ampere's and Biot-Savart's laws; Faraday's law; Maxwell's equations; scalar and vector potentials; Coulomb and Lorentz gauges; boundary conditions at interfaces; electromagnetic waves; interference, diffraction and polarization; radiation from moving charges.

Quantum Mechanics: Physical basis of quantum mechanics; uncertainty principle; Schrodinger equation; one and three dimensional potential problems; Particle in a box, harmonic oscillator, hydrogen atom; linear vectors and operators in Hilbert space; angular momentum and spin; addition of angular momentum; time independent perturbation theory; elementary scattering theory.

Atomic and Molecular Physics: Spectra of one-and many-electron atoms; LS and jj coupling; hyperfine structure; Zeeman and Stark effects; electric dipole transitions and selection rules; X-ray spectra; rotational and vibrational spectra of diatomic molecules; electronic transition in diatomic molecules, Franck-Condon principle; Raman effect; NMR and ESR; lasers.

Thermodynamics and Statistical Physics: Laws of thermodynamics; macrostates, phase space; probability ensembles; partition function, free energy, calculation of thermodynamic quantities; classical and quantum statistics; degenerate Fermi gas; black body radiation and Planck's distribution law; Bose-Einstein condensation; first and second order phase transitions, critical point.

Solid State Physics: Elements of crystallography; diffraction methods for structure determination; bonding in solids; elastic properties of solids; defects in crystals; lattice vibrations and thermal properties of solids; free electron theory; band theory of solids; metals, semiconductors and insulators; transport properties; optical, dielectric and magnetic properties of solids; elements of superconductivity.

Nuclear and Particle Physics: Rutheford scattering; basic properties of nuclei; radioactive decay; nuclear forces; two nucleon problem; nuclear reactions; conservation laws; fission and fusion; nuclear models; particle accelerators, detectors; elementary particles; photons, baryons, mesons and leptons; Quark model.

Electronics: Network analysis; semiconductor devices; bipolar transistors; FETs; power supplies, amplifier, oscillators; operational amplifiers; elements of digital electronics; logic circuits.

PI - PRODUCTION AND INDUSTRIAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

GENERAL ENGINEERING:

Engineering Materials: Structure and properties of engineering materials and their applications; effect of strain, strain rate and temperature on mechanical properties of metals and alloys; heat treatment of metals and alloys.

Applied Mechanics: Engineering mechanics - equivalent force systems, free body concepts, equations of equilibrium, virtual work and minimum potential energy; strength of materials-stress, strain and their relationship, Mohr's circle, deflection of beams, bending and shear stress, Euler's theory of columns.

Theory of Machines and Design: Analysis of planar mechanisms, plane cams and followers; governers and fly wheels; design of elements-failure theories; design of bolted, riveted and welded joints; design of shafts, keys, belt drives, brakes and clutches.

Thermal Engineering: Fluid machines - fluid statics, Bernoulli's equation, flow through pipes, equations of continuity and momentum; Thermodynamics - zeroth, First and Second laws of thermodynamics, thermodynamic system and processes, calculation of work and heat for systems and control volumes; Heat transfer - fundamentals of conduction, convection and radiation.

PRODUCTION ENGINEERING

Metal Casting: Casting processes; patterns-materials; allowances; moulds and cores - materials, making and testing; melting and founding of cast iron, steels and nonferrous metals and alloys; solidification; design of casting, gating and risering; casting defects and inspection.

Metal working: Stress-strain in elastic and plastic deformation; deformation mechanisms; hot and cold working-forging, rolling, extrusion, wire and tube drawing; sheet metal working; analysis of rolling, forging, extrusion and wire /rod drawing; metal working defects, high energy rate forming processes-explosive, magnetic, electro and electrohydraulic.

Metal Joining Processes: Welding processes - gas shielded metal arc, TIG, MIG, submerged arc, electroslag, thermit, resistance, pressure and forge welding; thermal cutting; other joining processes - soldering, brazing, braze welding; welding codes, welding symbols, design of welded joints, defects and inspection; introduction to modern welding processes - friction, ultrasonic, explosive, electron beam, laser and plasma.

Machining and Machine Tool Operations: Machining processes-turning, drilling, boring, milling, shaping, planing, sawing, gear cutting, thread production, broaching, grinding, lapping, honing super finishing; mechanics of cutting- Merchant's analysis, geometry of cutting tools, cutting forces, power requirements; selection of process parameters; tool materials, tool wear and tool life, cutting fluids, machinability; nontraditional machining processes and hybrid processes- EDM, CHM, ECM, USM, LBM, EBM, AJM, PAM AND WJM; economics of machining.

Metrology and Inspection: Limits and fits, linear and angular measurements by mechanical and optical methods, comparators; design of limit gauges; interferometry; measurement of straightness, flatness, roundness, squareness and symmetry; surface finish measurement; inspection of screw threads and gears; alignment testing.

Powder Metallurgy and Processing of Plastics: Production of powders, compaction, sintering; Polymers and composites; injection, compression and blow molding, extrusion, calendaring and thermoforming; molding of composites.

Tool Engineering: Work-holding-location and clamping; principles and methods; design of jigs and fixtures; design of press working tools, forging dies.

Manufacturing Analysis: Sources of errors in manufacturing; process capability; part-print analysis; tolerance analysis in manufacturing and assembly; process planning; parameter selection and comparison of production alternatives; time and cost analysis; Issues in choosing manufacturing technologies and strategies.

Computer Integrated Manufacturing: Basic concepts of CAD, CAM, CAPP, group technology, NC, CNC, DNC, FMS, Robotics and CIM.

INDUSTRIAL ENGINEERING

Product Design and Development: Principles of good product design, component and tolerance design; efficiency, quality and cost considerations; product life cycle; standardization, simplification, diversification, value analysis, concurrent engineering.

Engineering Economy and Costing: Financial statements; elementary cost accounting, methods of depreciation; break-even analysis, techniques for evaluation of capital investments.

Work System Design: Taylor's scientific management, Gilbreths's contributions; productivity concepts and measurements; method study, micro-motion study, principles of motion economy; human factors engineering, ergonomics; work measurement - time study, PMTS, work sampling; job evaluation, merit rating, wage administration, incentive systems; business process reengineering.

Logistics and Facility Design: Facility location factors, evaluation of alternatives, types of plant layout, evaluation; computer aided layout; assembly line balancing; material handling systems; supply chain management.

Production Planning and Inventory Control: Inventory Function costs, classifications - deterministic and probabilistic models; quantity discount; safety stock; inventory control system; Forecasting techniques - causal and time series models, moving average, exponential smoothing; trend and seasonality; aggregate production planning; master scheduling; bill of materials and material requirement planning; order control and flow control, routing, scheduling and priority dispatching; JIT; Kanban PULL systems; bottleneck scheduling and theory of constraints.

Operation Research: Linear programming - problem formulation, simplex method, duality and sensitivity analysis; transportation; assignment; network flow models, constrained optimization and Lagrange multipliers; simple queuing models; dynamic programming; simulation; PERT and CPM, time-cost trade-off, resource leveling.

Quality Control: Taguchi method; design of experiments; quality costs, statistical quality assurance, process control charts, acceptance sampling, zero defects; quality circles, total quality management.

Reliability and Maintenance: Reliability, availability and maintainability; probabilistic failure and repair times; system reliability; preventive maintenance and replacement, TPM.

Management Information System: Value of information; information storage and retrieval system - database and data structures; interactive systems; knowledge based systems.

Intellectual Property System: Definition of intellectual property, importance of IPR; TRIPS, and its implications, WIPO and Global IP structure, and IPS in India; patent, copyright, industrial design and trademark; meanings, rules and procedures, terms, infringements and remedies.

PY - PHARMACEUTICAL SCIENCES

Natural Products: Pharmacognosy & Phytochemistry - Chemistry, tests, isolation, characterization and estimation of phytopharmaceuticals belonging to the group of Alkaloids, Glycosides, Terpenoids, Steroids, Bioflavanoids, Purines, Guggul lipids. Pharmacognosy of crude drugs which contain the above constituents. Standardisation of raw materials and herbal products. WHO guide lines. Quantitative microscopy including modern techniques used for evaluation. Biotechnological principles and techniques for plant development Tissue culture.

Pharmacology: General pharmacological principles including Toxicology. Drug interaction. Pharmacology of drugs acting on Central nervous system, Cardiovascular system, Autonomic nervous system, Gastro intestinal system and Respiratory system. Pharmacology of Autocoids, Hormones, Chemotherapeutic agents including anticancer drugs. Bioassays. Immuno Pharmacology.

Medicinal Chemistry: Structure, nomenclature, classification, synthesis, SAR and metabolism of the following category of drugs which are official in Indian Pharmacopoeia and British Pharmacopoeia Hypnotics and Sedatives, Analgesics, NSAIDS, Neuroleptics, Antidepressants, Anxiolytics, Anticonvulsants, Antihistaminics, Local anaesthetics, Cardio Vascular drugs - Antianginal agents Vasodilators, Adrenergic & cholinergic drugs, Cardiotonic agents, Diuretics, Antihypertensive drugs, Hypoglycemic agents, Antilipedmic agents, Coagulants, Anticoagulants, Antiplatelet agents. Chemotherapeutic agents - Antibiotics, Antibacterials, Sulphadrugs. Antiproliozoal drugs, Antiviral, Antitubercular, Antimalarial, Anticancer, Antiamoebic drugs. Diagnostic agents. Preparation and storage and uses of official Radiopharmaceuticals. Vitamins and Hormones.

Pharmaceutics: Development, manufacturing standards, labeling, packing as per the pharmacopoeal requirements, Storage of different dosage forms and new drug delivery systems. Biopharmaceutics and Pharmacokinetics and their importance in formulation. Formulation and preparation of cosmetics - lipstick, shampoo, creams, nail preparations and dentifrices. Pharmaceutical calculations.

Pharmaceutical Jurisprudence: Legal aspects of manufacture, storage, sale of drugs. D and C act and rules. Pharmacy act.

Pharmaceutical Analysis: Principles, instrumentation and applications of the following. Absorption spectroscopy (UV, visible & IR), Fluorimetry, Flame photometry, Potentiometry, Conductometry and Plarography. Pharmacopoeial assays. Principles of NMR, ESR, Mass spectroscopy, X-ray diffraction analysis and different chromatographic methods.

Biochemistry and Clinical Pharmacy: Biochemical role of hormones, Vitamins, Enzymes, Nucleic acids. Bioenergetics. General principles of immunology. Immunological techniques. Adverse drug interaction.

Microbiology: Principles and methods of microbiological assays of the Pharmacopoeia. Methods of preparation of official sera and vaccines. Serological and diagnostic tests. Applications of microorganisms in Bio Conversions and in Pharmaceutical industry.

TF - TEXTILE ENGINEERING AND FIBRE SCIENCE

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

TEXTILE ENGINEERING & FIBRE SCIENCE

Textile Fibres: Classification of textile fibres according to their nature and origin; general characteristics of textile fibres-their chemical and physical structures and their properties;

essential characteristics of fibre forming polymers; uses of natural and man-made fibres; physical and chemical methods of fibre and blend identification and blend analysis.

Melt Spinning processes with special reference to polyamide and polyester fibres; wet and dry spinning of viscose and acrylic fibres; post spinning operations-drawing, heat setting, texturing- false twist and air-jet, tow-to-top conversion. Methods of investigating fibre structure e.g. X-ray diffraction, birefringence, optical and electron microscopy, I.R. absorption, thermal methods; structure and morphology and principal natural and man-made fibres, mechanical properties of fibres, moisture sorption in fibres; fibre structure and property correlation.

Textile Testing: Sampling techniques, sample size and sampling errors; measurement of fibre length, fineness, crimp, strength and reflectance; measurement of cotton fibre maturity ad trash content; HVI and AFIS for fibre testing. Measurement of yarn count, twist and hairiness; tensile testing of fibres, yarn and fabrics; evenness testing of slivers, rovings and yarns; testing equipment for measurement test methods of fabric properties like thickness, compressibility, air permeability, drape, crease recovery, tear strength bursting strength and abrasion resistance. Correlation analysis, significance tests and analysis of variance; frequency distributions and control charts.

Yarn Manufacture and Yarn Structure: Modern methods of opening, cleaning and blending of fibrous materials; the technology of carding with particular reference to modern developments; causes of irregularity introduced by drafting, the development of modern drafting systems; principles and techniques of preparing material for combing; recent development in combers; functions and synchronization of various mechanisms concerned with roving production; forces acting on yarn and traveller, ring and traveller designs; causes of end breakages; properties of doubles yarns; new methods of yarn production such as rotor spinning, air jet spinning and friction spinning.

Yarn diameter; specific volume, packing coefficient; twist-strength relationship; fibre orientation in yarn; fibre migration.

Fabric Manufacture and Fabric Structure: Principles of cheese and cone winding processes and machines; random and precision winding; package faults and their remedies; yarn clearers and tensioners; different systems of yarn splicing; features of modern cone winding machines; different types of warping creels; features of modern beam and sectional warping machines; different sizing systems, sizing of spun and filament yarns, modern sizing machines; principles of pirn winding processes and machines; primary and secondary motions of loom, effect of their settings and timings on fabric formation, fabric appearance and weaving performance; dobby and jacquard shedding; mechanics of weft insertion with shuttle; warp and weft stop motions, warp protection, weft replenishment; functional principles of weft insertion systems of shuttleless weaving machines, principles of multiphase and circular looms. Principles of weft and warp knitting; basic weft and warp knitted structures; classification, production and areas of application of nonwoven fabrics.

Basic woven fabric constructions and their derivatives; crepe, cord, terry, gauze, lino and double cloth constructions.

Peirce's equations for fabric geometry; thickness, cover and maximum sett of woven fabrics

Textile Chemical Processing: Preparatory processes for natural-and and their blends; mercerization of cotton; machines for yarn and fabric mercerization.

Dyeing and printing of natural- and synthetic- fibre fabrics and their blends with different dye classes; dyeing and printing machines; styles of printing; fastness properties of dyed and printed textile materials.

Finishing of textile materials, wash and wear, durable press, soil release, water repellent, flame retardant and antistatic finishes; shrink-resistance finish for wool; heat setting of synthetic-fibre fabrics, finishing machines; energy efficient processes; pollution control.

XE - ENGINERING SCIENCES

The syllabi of the sections of this paper are as follows:

SECTION A. ENGINEERING MATHEMATICS (Compulsory)

Linear Algebra : Determinates, algebra of matrices, rank, inverse, system of linear equations, symmetric, skew-symmetric and orthogonal matrices. Hermitian, skew-hermitian and unitary matrices. eigenvalues and eigenvectors, diagonalisation of matrices, Cayley-Hamiltonian, quadratic forms.

Calculus : Functions of single variables, limit, continuity and differentiability, Mean value theorems, Intermediate forms and L'Hospital rule, Maxima and minima, Taylor's series, Fundamental and mean value-theorems of integral calculus. Evaluation of definite and improper integrals, Beta and Gamma functions, Functions of two variables, limit, continuity, partial derivatives, Euler's theorem for homogeneous functions, total derivatives, maxima and minima, Lagrange method of multipliers, double and triple integrals and their applications, sequence and series, tests for convergence, power series, Fourier Series, Fourier integrals.

Complex variable: Analytic functions, Cauchy's integral theorem and integral formula without proof. Taylor's and Laurent' series, Residue theorem (without proof) with application to the evaluation of real integarls.

Vector Calculus: Gradient, divergence and curl, vector identities, directional derivatives, line, surface and volume integrals, Stokes, Gauss and Green's theorems (without proofs) with applications.

Ordinary Differential Equations: First order equation (linear and nonlinear), higher order linear differential equations with constant coefficients, method of variation of paramaters, Cauchy's and Euler's equations, initial and boundary value problems, power series solutions, Legendre polynomials and Bessel's functions of the first kind.

Partial Differential Equations: Variables separable method, solutions of one dimensional heat, wave and Laplace equations.

Probability and Statistics: Definitions of probability and simple theorems, conditional probability, mean, mode and standard deviation, random variables, discrete and continuous distributions, Poisson, normal and Binomial distribution, correlation and regression

Numerical Methods: L-U decomposition for systems of linear equations,Newton-Raphson method, numerical integration(trapezoidal and Simpson's rule), numerical methods for first order differential equation (Euler method)

SECTION B. COMPUTATIONAL SCIENCE

Numerical Methods: Truncation errors, round off errors and their propagation; Interpolation; Lagrange, Newton's forward, backward and divided difference formulas, least square curve fitting, solution of non-linear equations of one variables using bisection, false position, secant and Newton Raphson methods; Rate of convergence of these methods, general iterative methods. Simple and multiple roots of polynomials. Solutions of system of linear algebraic equations using Gauss elimination methods, Jacobi and Gauss-Seidel iterative methods and their rate of convergence; ill conditioned and well conditioned system. eigen values and eigen vectors using power methods. Numerical integration using trapezoidal, Simpson's rule and other quadrature formulas. Numerical Differentiation. Solution of boundary value problems. Solution of initial value problems of ordinary differential equations using Euler's method, predictor corrector and Runge Kutta method.

Programming : Elementary concepts and terminology of a computer system and system software, Fortran77 and C programming.

Fortran : Program organization, arithmetic statements, transfer of control, Do loops, subscripted variables, functions and subroutines.

C language : Basic data types and declarations, flow of control- iterative statement, conditional statement, unconditional branching, arrays, functions and procedures.

SECTION C. ELECTRICAL SCIENCES

Electric Circuits: Ideal voltage and current sources; RLC circuits, steady state and transient analysis of DC circuits, network theorems; alternating currents and voltages, single-phase AC circuits, resonance; three-phase circuits.

Magnetic circuits: Mmf and flux, and their relationship with voltage and current; transformer, equivalent circuit of a practical transformer, three-phase transformer connections.

Electrical machines: Principle of operation, characteristics, efficiency and regulation of DC and synchronous machines; equivalent circuit and performance of three-phase and single-phase induction motors.

Electronic Circuits: Characteristics of p-n junction diodes, zener diodes, bipolar junction transistors (BJT) and junction field effect transistors (JFET); MOSFET's structure, characteristics, and operations; rectifiers, filters, and regulated power supplies; biasing circuits, different configurations of transistor amplifiers, class A, B and C of power amplifiers; linear applications of operational amplifiers; oscillators; tuned and phase shift types.

Digital circuits: Number systems, Boolean algebra; logic gates, combinational circuits, flip-flops (RS, JK, D and T) counters.

Measuring instruments: Moving coil, moving iron, and dynamometer type instruments; shunts, instrument transformers, cathode ray oscilloscopes; D/A and A/D converters.

SECTION D. FLUID MECHANICS

Fluid Properties: Relation between stress and strain rate for Newtonian fluids

Hydrostatics, buoyancy, manometry

Concept of local and convective accelerations; control volume analysis for mass, momentum and energy conservation.

Differential equations of continuity and momentum (Euler's equation of motion); concept of fluid rotation, stream function, potential function; Bernoulli's equation and its applications.

Qualitative ideas of boundary layers and its separation; streamlined and bluff bodies; drag and lift forces.

Fully-developed pipe flow; laminar and turbulent flows; friction factor; Darcy Weisbach relation; Moody's friction chart; losses in pipe fittings; flow measurements using venturimeter and orifice plates.

Dimensional analysis; similitude and concept of dynamic similarity; importance of dimensionless numbers in model studies.

SECTION E. MATERIALS SCIENCE

Atomic structure and bonding in materials: metals, ceramics and polymers.

Structure of materials: Crystal systems, unit cells and space lattice; determination of structures of simple crystals by X-ray diffraction; Miller indices for planes and directions. Packing geometry in metallic, ionic and covalent solids.

Concept of amorphous, single and polycrystalline structures and their effects on properties of materials.

Imperfections in crystalline solids and their role in influencing various properties.

Fick´s laws of diffusion and applications of diffusion in sintering, doping of semiconductors and surface hardening of metals.

Alloys: solid solution and solubility limit. Binary phase diagram, intermediate phases and intermetallic compounds; iron-iron carbide phase diagram. Phase transformation in steels. Cold and hot working of metals, recovery, recrystallization and grain growth.

Properties and applications of ferrous and nonferrous alloys.

Structure, properties, processing and applications of traditional and advanced ceramics.

Polymers: classification, polymerization, structure and properties, additives for polymer products, processing and application.

Composites: properties and application of various composites.

Corrosion and environmental degradation of materials (metals, ceramics and polymers).

Mechanical properties of materials: Stress-strain diagrams of metallic, ceramic and polymeric materials, modulus of elasticity, yield strength, plastic deformation and toughness, tensile strength and elongation at break; viscoelasticity, hardness, impact strength. ductile and brittle fracture. creep and fatigue properties of materials.

Heat capacity, thermal conductivity, thermal expansion of materials.

Concept of energy band diagram for materials; conductors, semiconductors and insulators in terms of energy bands. Electrical conductivity, effect of temperature on conductivity in materials, intrinsic and extrinsic semiconductors, dielectric properties of materials.

Refraction, reflection, absorption and transmission of electromagnetic radiation in solids.

Origin of magnetism in metallic and ceramic materials, paramagnetism, diamagnetism, antiferromagnetism, ferromagnetism, ferrimagnetism in materials and magnetic hysteresis.

Advanced materials: Smart materials exhibiting ferroelectric, piezoelectric, optoelectronic, semiconducting behaviour; lasers and optical fibers; photoconductivity and superconductivity in materials.

SECTION F. SOLID MECHANICS

Equivalent force systems; free-body diagrams; equilibrium equations; analysis of determinate and indeterminate trusses and frames; friction.

Simple relative motion of particles; force as function of position, time and speed; force acting on a body in motion; laws of motion; law of conservation of energy; law of conservation of momentum

Stresses and strains; principal stresses and strains; Mohr's circle; generalized Hooke's Law; equilibrium equations; compatibility conditions; yield criteria.

Axial, shear and bending moment diagrams; axial, shear and bending stresses; deflection (for symmetric bending); torsion in circular shafts; thin cylinders; energy methods (Castigliano's Theorems); Euler buckling.

SECTION G. THERMODYNAMICS

Basic Concepts: Continuum, macroscopic approach, thermodynamic system (closed and open or control volume); thermodynamic properties and equilibrium; state of a system, state diagram, path and process; different modes of work; Zeroth law of thermodynamics; concept of temperature; heat.

First Law of Thermodynamics: Energy, enthalpy, specific heats, first law applied to systems and control volumes, steady and unsteady flow analysis.

Second Law of Thermodynamics: Kelvin-Planck and Clausius statements, reversible and irreversible processes, Carnot theorems, thermodynamic temperature scale, Clausius inequality and concept of entropy, principle of increase of entropy; availability and irreversibility.

Properties of Pure Substances: Thermodynamic properties of pure substances in solid, liquid and vapour phases, P-V-T behaviour of simple compressible substances, phase rule, thermodynamic property tables and charts, ideal and real gases, equations of state, compressibility chart.

Thermodynamic Relations: T-ds relations, Maxwell equations, Joule-Thomson coefficient, coefficient of volume expansion, adiabatic and isothermal compressibilities, Clapeyron equation.

Ideal Gas Mixtures: Dalton's and Amagat's laws, calculations of properties, air-water vapour mixtures.

XL - LIFE SCIENCES

The syllabi of the Sections of this paper are as follows:

SECTION H. CHEMISTRY (Compulsory)

Atomic structure and periodicity: Quantum chemistry; Planck's quantum theory, wave particle duality, uncertainty principle, quantum mechanical model of hydrogen atom; electronic configuration of atoms; periodic table and periodic properties; ionization energy, election affinity, electronegativity, atomic size.

Structure and bonding: Ionic and covalent bonding M.O. and V.B. approaches for diatomic molecules, VSEPR theory and shape of molecules, hybridisation, resonance, dipole moment, structure parameters such as bond length, bond angle and bond energy, hydrogen bonding, van der Waals interactions. Ionic solids; ionic radii, lattice energy (Born-Haber Cycle).

s.p. and d Block Elements: Oxides, halides and hydrides of alkali and alkaline earth metals, B, Al, S, N, P and S, silicones, general characteristics of 3d elements, coordination complexes: valence bond and crystal field theory, color, geometry and magnetic properties.

Chemical Equilibria: Colligative properties of solutions, ionic equilibria in solution, solubility product, common ion effect, hydrolysis of salts, pH, buffer and their applications in chemical analysis.

Electrochemistry: Conductance, Kohlrausch law, Half Cell potentials, emf, Nernst equation, galvanic cells, thermodynamic aspects and their applications.

Reaction Kinetics: Rate constant, order of reaction, molecularity, activation energy, zero, first and second order kinetics, equilibrium constants (K_c, K_p and K_x) for homogeneous reactions, catalysis and elementary enzyme reactions.

Thermodynamics: First law, reversible and irreversible processes, internal energy, enthalpy, Kirchoff's equation, heat of reaction, Hess law, heat of formation, Second law, entropy, free energy, and work function. Gibbs-Helmholtz equation, Clausius-Clapeyron equation, free energy change and equilibrium constant, Troutons rule, Third law of thermodynamics.

Mechanistic Basis of Organic Reactions: Elementary treatment of SN1, SN2, E1 and E2 reactions, Hoffmann and Saytzeff rules, Addition reactions, Markonikoff rule and Kharash effect, Diels-Alder reaction, aromatic electrophilic substitution, orientation effect as exemplified by various functional groups.

Structure-Reactivity Correlations: Acids and bases, electronic and steric effects, optical and geometrical isomerism, tautomerism, concept of aromaticity

SECTION I. BIOCHEMISTRY

Organization of life. Importance of water. Cell structure and organelles. Structure and function of biomolecules: Carbohydrates, Lipids, Proteins and Nucleic acids. Biochemical separation techniques. Spectroscopic methods; UV-visible and fluorescence. Protein structure, folding and function: Myoglobin, Hemoglobin, Lysozyme, ribonuclease A, Carboxypeptidase and Chymotrypsin. Enzyme kinetics and regulation, Coenzymes.

Metabolism and bioenergitics. Generation and utilization of ATP. Photosynthesis. Major metabolic pathways and their regulation. Biological membranes. Transport across membranes. Signal transduction; hormones and neurotransmitters.

DNA replication, transcription and translation. Biochemical regulation of gene expression. Recombinant DNA technology and applications. Genomics and Proteomics.

The immune system. Active and passive immunity. Complement system. Antobody structure, function and diversity. Cells of the immune system: T, B and macrophages. T and B cell activation. Major histocompatibilty complex. T cell receptor. Immunological techniques: Immunodiffusion, immunoelectrophoresis, RIA and ELISA.

SECTION J. BIOTECHNOLOGY

Recombinant DNA technology for the production of therapeutic proteins. Micro array technology. Heterologous protein expression systems in bacteria, yeast etc.

Architecture of plant genome; plant tissue culture techniques; methods of gene transfer into plant cells; manipulation of phenotypic traits in plants; plant cell fermentations and production of secondary metabolites using suspension/ immobilized cell culture; methods for plant micro propagation; crop improvement and development of transgenic plants. Expression of animal proteins in plants.

Animal cell metabolism and regulation; cell cycle; primary cell culture; nutritional requirements for animal cell culture; techniques for the mass culture of animal cell lines; production of vaccines; growth hormones and interferons using animal cell culture; cytokines-production and therapeutic uses; hybridoma technology; vectors for gene transfer and expression in animal cells. Transgenic animals and molecular pharming.

Microbial production of industrial enzymes; methods for immobilization of enzymes; kinetics of soluble and immobilized enzymes; application of soluble and immobilized enzymes; enzyme-based sensors.

Microbial growth kinetics; batch, fed batch and continuous culture of microbial cells; media for industrial fermentations; sterilization of air and media; design features and operation of stirred tank, air-lift and fluidized bed reactors; aeration and agitation in aerobic fermentations; recovery and purification of fermentation products- filtration, centrifugation, cell disintegration, solvent extraction and chromatographic separations; industrial fermentations for the production of ethanol, citric acid, lysine, penicillin and other biomolecules; simple calculations based on material and energy balance of fermentation processes; application of microbes in the management of domestic and industrial wastes.

SECTION K. BOTANY

Anatomy: Roots, stem and leaves of land plants, meristems, vascular system, their ontogeny, structure and functions. Plant cell structure, organisation, organelles, cytoskeleton, cell wall and membranes.

Development: Cell cycle, cell division, senescence, hormonal regulation of growth; life cycle of an angiosperm, pollination, fertilization, embryogenesis, seed formation, seed storage proteins, seed dormancy and germination. Concept of cellular totipotency, organogenesis and somatic embryogenesis, somaclonal variation, embryo culture, in vitro fertilization.

Physiology and Biochemistry: Plant water relations, transport of minerals and solutes, N_2 metabolism, proteins and nucleic acid, respiration, photophysiology, photosynthesis, photorespiration; biosynthesis, mechanism of action and physiological effects of plant growth regulators.

Genetics: Principles of Mendelian inheritance, linkage, recombination and genetic mapping; extrachromosomal inheritance; eukaryotic genome organization (chromatin structure) and regulation of gene expression, gene mutation, chromosome aberrations (numerical and structural), transposons.

Plant Breeding: Principles, methods - selection, hybridization, heterosis; male sterility, self and inter-specific incompatibility; haploidy; somatic cell hybridization; molecular marker-assisted selection; gene transfer methods viz. direct and vector-mediated, transgenic plants and their applications in agriculture.

Economic Botany: Economically important plants - cereals, pulses, plants yielding fiber, timber, sugar, beverages, oils, rubber, dyes, gums, drugs and narcotics - a general account.

Systematics: Systems of classification (non-phylogenetic vs. phylogenetic - outline), plant groups, molecular systematics.

Plant Pathology: Nature and classification of plant diseases, diseases of important crops caused by fungi, bacteria and viruses, and their control measures, mechanism(s) of pathogenesis and resistance, molecular detection of pathogens; plant-microbe beneficial interactions.

Ecology and Plant Geography: Ecosystems - types, dynamics, degradation, ecological succession; food chains; vegetation types of the world; pollution and global warming; speciation and extinction, conservation strategies, cryopreservation.

SECTION L. MICROBIOLOGY

Historical perspective - Discovery of the microbial world; Controversy over spontaneous generation; Role of microorganisms in transformation of organic matter and in the causation of diseases.

Methods in microbiology - Pure culture techniques; Theory and practice of sterilization; Principles of microbial nutrition; Construction of culture media; Enrichment culture techniques for isolation of chemoautotrophs, chemoheterotrophs and photosynthetic microorganisms.

Microbial evolution, systematics and taxonomy - Evolution of earth and earliest life forms; Primitive organisms and their metabolic strategies; New approaches to bacterial taxonomic classification including ribotyping; Nomenclature.

Microbial diversity - Bacteria, archea and their broad classification; Eukaryotic microbes, yeast, fungi, slime mold and protozoa; Viruses and their classification.

Microbial growth -The definition of growth, mathematical expression of growth, growth curve, measurement of growth and growth yields; Synchronous growth; Continuous culture.

Nutrition and metabolism - Overview of metabolism; Microbial nutrition; Energy classes of microorganisms; Culture media; Energetics, modes of ATP generation; ATP generation by heterotrophs; Fermentation; Glycolysis; Respiration; The citric acid cycle; Electron transport systems; Alternate modes of energy generation; Pathways (anabolism) in the biosynthesis of amino acids, purines, pyrimidines and fatty acids.

Metabolic diversity among microorganisms - Photosynthesis in microorganisms; Role of chlorophylls, carotenoids and phycobilins; Calvin cycle; Chemolithotrophy; Hydrogen- iron-nitrite-oxidizing bacteria; Nitrate and sulfate reduction; Methanogenesis and acetogenesis.

Prokaryotic cells: structure-function - Cells walls of eubacteria (peptidoglycan) and related molecules; Outer-membrane of gram-negative bacteria; Cell wall and cell membrane synthesis; Flagella and motility; Cell inclusions like endospores, gas vesicles.

Microbial diseases and host parasite relationships - Normal microflora of skin; Oral cavity; Gastrointestinal tract; Entry of pathogens into the host; Infectious disease transmission; Respiratory infections caused by bacteria and viruses; Tuberculosis; Sexually transmitted diseases including AIDS; Diseases transmitted by animals (Rabies, plague), insects and ticks (rikettsias, Lyme disease, malaria); Food and water borne diseases; Public health and water quality; Pahtogenic fungi; Emerging and resurgent infectious diseases.

Chemotherapy/Antibiotics - Antimicrobial agents; Sulfa drugs; Antibiotics; Pencillins and cephalosporins; Broad-spectrum antibiotics; Antibiotics from prokaryotes; Antifungal antibiotics; Mode of action; Resistance to antibiotics.

Microbial genetics - Genes, mutation and mutagenesis - UV and chemical mutagnes; Types of mutations; Ames test for mutagenesis; Methods of genetic analysis. Bacterial genetic system - Transformation; Conjugation; Transduction; Recombination; Plasmids and Transposons; Bacterial genetic map with reference to E. coli. Viruses and their genetic system - Phage ? and its life cycle; RNA phages; RNA viruses; Retroviruses; Genetic systems of yeast and Neurospora; Extrachromosomal inheritance and mitochondrial genetics; Basic concept of genomics.

SECTION M. ZOOLOGY

Animal world: Animal diversity, distribution, systematic and classification of animals, the phylogenetic relationship.

Evolution: Origin of life, history of life on earth, evolutionary theories, natural selection, adaptation, speciation.

Genetics: Principles of inheritance, molecular basis of heredity, the genetic material, transmission of genetic material, mutations, cytoplasmic inheritance.

Biochemistry and Molecular Biology: Nucleic acids, proteins and other biological macromolecules. Replication, transcription and translation, regulation of gene expression, organization of genome, Kreb's cycle, glycolysis, enzyme catalysis, hormones and their action.

Cell Biology: Structure of cell, cellular organelles and their structure and function, cell cycle, cell division, cellular differentiation, chromosome and chromatin structure. Eukaryotic gene organisation and expression.

Animal Anatomy and Physiology: Comparative physiology, the respiratory system, circulatory system, digestive system, the nervous system, the excretory system, the endocrine system, the reproductive system, the skeletal system, osmoregulation.

Parasitology and Immunology: Nature of parasite, host-parasite relation, protozoan and helminthic parasites, the immune response, cellular and humoral immune response, evolution of the immune system.

Development Biology: Embryonic development, cellular differentiation, organogenesis, metamorphosis, genetic basis of development.

Ecology: The ecosystem, habitats the food chain, population dynamics, species diversity, zoogeography, biogeochemical cycles, conservation biology.

Animal Behaviour: Types of behaviours, courtship, mating and territoriality, instinct, learning and memory, social behaviour across the animal taxa, communication, pheromones, evolution of animal behaviour.

IT - INFORMATION TECHNOLOGY

ENGINEERING MATHEMATICS

Mathematical Logic: Propositional Logic; First Order Logic.

Probability: Conditional Probability; Mean, Median, Mode and Standard Deviation; Random Variables; Distributions; uniform, normal, exponential, Poisson, Binomial.

Set Theory & Algebra: Sets; Relations; Functions; Groups; Partial Orders; Lattice; Boolean Algebra.

Combinatorics: Permutations; Combinations; Counting; Summation; generating functions; recurrence relations; asymptotics.

Graph Theory: Connectivity; spanning trees; Cut vertices & edges; covering; matching; independent sets; Colouring; Planarity; Isomorphism.

Linear Algebra: Algebra of matrices, determinants, systems of linear equations, Eigen values and Eigen vectors.

Numerical Methods: LU decomposition for systems of linear equations; numerical solutions of non linear algebraic equations by Secant, Bisection and Newton-Raphson Methods; Numerical integration by trapezoidal and Simpson's rules.

Calculus: Limit, Continuity & differentiability, Mean value Theorems, Theorems of integral calculus, evaluation of definite & improper integrals, Partial derivatives, Total derivatives, maxima & minima.

FORMAL LANGUAGES AND AUTOMATA

Regular Languages: finite automata, regular expressions, regular grammar.

Context free languages: push down automata, context free grammars

COMPUTER HARDWARE

Digital Logic: Logic functions, minimization, design and synthesis of combinatorial and sequential circuits, number representation and computer arithmetic (fixed and floating point)

Computer organization: Machine instructions and addressing modes, ALU and data path, hardwired and microprogrammed control, memory interface, I/O interface (interrupt and DMA mode), serial communication interface, instruction pipelining, cache, main and secondary storage

SOFTWARE SYSTEMS

Data structures and Algorithms: the notion of abstract data types, stack, queue, list, set, string, tree, binary search tree, heap, graph, tree and graph traversals, connected components, spanning trees, shortest paths, hashing, sorting, searching, design techniques (greedy, dynamic, divide and conquer), asymptotic analysis (best, worst, average cases) of time and space, upper and lower bounds, intractability

Programming Methodology: C programming, program control (iteration, recursion, functions), scope, binding, parameter passing, elementary concepts of object oriented programming

Operating Systems (in the context of Unix): classical concepts (concurrency, synchronization, deadlock), processes, threads and interprocess communication, CPU scheduling, memory management, file systems, I/O systems, protection and security

Information Systems and Software Engineering: information gathering, requirement and feasibility analysis, data flow diagrams, process specifications, input/output design, process life cycle, planning and managing the project, design, coding, testing, implementation, maintenance.

Databases: relational model, database design, integrity constraints, normal forms, query languages (SQL), file structures (sequential, indexed), b-trees, transaction and concurrency control

Data Communication: data encoding and transmission, data link control, multiplexing, packet switching, LAN architecture, LAN systems (Ethernet, token ring), Network devices: switches, gateways, routers

Networks: ISO/OSI stack, sliding window protocols, routing protocols, TCP/UDP, application layer protocols & systems (http, smtp, dns, ftp), network security

Web technologies: three tier web based architecture; JSP, ASP, J2EE, .NET systems; html, XML

AG - AGRICULTURAL ENGINEERING

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

FARM MACHINERY AND POWER:

Sources of power on the farm-human, animal, mechanical, electrical, wind, solar and biomass; design and selection of machine elements - gears, pulleys, chains and sprockets and belts; overload safety devices used in farm machinery; measurement of force, torque, speed, displacement and acceleration on machine elements.

Soil tillage; forces acting on a tillage tool; hitch systems and hitching of tillage implements; functional requirements, principles of working, construction and operation of manual, animal and power operated equipment for tillage. sowing, planting, fertilizer application, inter-cultivation, spraying, mowing, chaff cutting, harvesting, threshing and transport; testing of agricultural machinery and equipment; calculation of performance parameters -field capacity, efficiency, application rate and losses; cost analysis of implements and tractors.

Thermodynamic principles of I.C. engines; I.C. engine cycles; engine components; fuels and combustion; lubricants and their properties; I.C. engine systems - fuel, cooling, lubrication, ignition, electrical, intake and exhaust; selection, operation, maintenance and repair of I.C. engines; power efficiencies and measurement; calculation of power, torque, fuel consumption, heat load and power losses.

Tractors and power tillers - type, selection, maintenance and repair; tractor clutches and brakes; power transmission systems - gear trains, differential, final drives and power take-off; mechanics of tractor chassis; traction theory; three point hitches- free link and restrained link operations; mechanical steering and hydraulic control systems used in tractors; human engineering and safety in tractor design; tractor tests and performance.

SOIL AND WATER CONSERVATION ENGINEERING:

Ideal and real fluids, properties of fluids; hydrostatic pressure and its measurement; hydrostatic forces on plane and curved surface; continuity equation; Bernoulli's theorem; laminar and turbulent flow in pipes, Darcy-Weisbach and Hazen-Williams equations, Moody's diagram; flow through orifices and notches; flow in open channels.

Engineering properties of soils, fundamental definitions and relationships; index properties of soils; permeability and seepage analysis; shear strength, Mohr's circle of stresses; active and passive earth pressures; stability of slopes.

Hydrological cycle; precipitation measurement, analysis of precipitation data; abstraction from precipitation; runoff; hydrograph analysis, unit hydrograph theory and application; stream flow measurement; flood routing, hydrological reservoir and channel routing.

Mechanics of soil erosion, factors affecting erosion; soil loss estimation; biological and engineering measures to control erosion, terraces and bunds; vegetative waterways; gully control structures, drop, drop inlet and chute spillways; farm ponds; earthen dams; principles of watershed management.

Water requirement of crops; consumptive use and evapo-transpiration; irrigation scheduling; irrigation efficiencies; design of prismatic and silt loaded channels; methods of irrigation water application; design and evaluation of irrigation methods; drainage coefficient; surface and subsurface drainage systems; leaching requirement and salinity control; irrigation and drainage water quality; classification of pumps; pump characteristics; pump selection; types of aquifer; evaluation of aquifer properties; well hydraulics; ground water recharge.

AGRICULTURAL PROCESSING AND FOOD ENGINEERING:

Steady state heat transfer in conduction, convection and radiation; transient heat transfer in simple geometry; condensation and boiling heat transfer; working principles of heat exchangers; diffusive and convective mass transfer; simultaneous heat and mass transfer in agricultural processing operations.

Material and energy balances in food processing systems; water activity, sorption and desorption isotherms; centrifugal separation of solids, liquids and gases; kinetics of microbial death - pasteurisation and sterilization of liquid foods; preservation of food by cooling and freezing; psychrometry - properties of air-vapour mixture; concentration and dehydration of liquid foods - evaporators, tray, drum and spray dryers.

Mechanics and energy requirement in size reduction of granular solids; particle size analysis for comminuted solids; size separation by screening; fluidisation of granular solids; cleaning and grading efficiency and effectiveness of grain cleaners; conditioning and hydrothermal treatments for grains; dehydration of food grains; processes and machines for processing of cereals, pulses and oilseeds; design considerations for grain silos.

AR - ARCHITECTURE AND PLANNING

City planning: Historical development of cities; principles of city planning; new towns; survey methods, site planning, planning regulations and building bye-laws.

Housing: Concept of shelter; housing policies and design; community planning; role of government agencies; finance and management.

Landscape Design: Principles of landscape design and site planning; history and landscape styles; landscape elements and materials; planting design.

Computer Aided Design: Application of computers in architecture and planning; understanding elements of hardware and software; computer graphics; programming languages - C and Visual Basic and usage of packages such as AutoCAD.

Environmental and Building Science: Elements of environmental science; ecological principles concerning environment; role of micro-climate in design; climatic control through design elements; thermal comfort; elements of solar architecture; principles of lighting and illumination; basic principles of architectural acoustics; air pollution, noise pollution and their control.

Visual and Urban Design: Principles of visual composition; proportion, scale, rhythm, symmetry, harmony, balance, form and colour; sense of place and space, division of space; focal point, vista, imageability, visual survey.

History of Architecture: Indian - Indus valley, Vedic, Buddhist, Indo-Aryan, Dravidian and Mughal periods; European - Egyptian, Greek, Roman, medieval and renaissance periods.

Development of Contemporary Architecture: Architectural developments and impacts on society since industrial revolution; influence of modern art on architecture; works of national and international architects; post modernism in architecture.

Building Services: Water supply, Sewerage and Drainage systems; Sanitary fittings and fixtures; principles of electrification of buildings; elevators, their standards and uses; air-conditioning systems; fire fighting systems.

Building Construction and Management: Building construction techniques, methods and details; building systems and prefabrication of building elements; principles of modular coordination; estimation, specification, valuation, professional practice; project management, PERT, CPM.

Materials and Structural Systems: Behavioural characteristics of all types of building materials e.g. mud, timber, bamboo, brick, concrete, steel, glass, FRP; principles of strength of materials; design of structural elements in wood, steel and RCC; elastic and limit state design; complex structural systems; principles of pre-stressing.

Planning Theory: Planning process; multilevel planning; comprehensive planning; central place theory; settlement pattern; land use and land utilization.

Techniques of Planning: Planning surveys; Preparation of urban and regional structure plans, development plans, action plans; site planning principles and design; statistical methods; application of remote sensing techniques in urban and regional planning.

Traffic and Transportation Planning: Principles of traffic engineering and transportation planning; methods of conducting surveys; design of roads, intersections and parking areas; hierarchy of roads and levels of services; traffic and transport management in urban areas; traffic safety and traffic laws; public transportation planning; modes of transportation.

Services and Amenities: Principles and design of water supply systems, sewerage systems, solid waste disposal systems, power supply and communication systems; Health, education, recreation and demography related standards at various levels of the settlements.

Development Administration and Management: Planning laws; development control and zoning regulations; laws relating to land acquisition; development enforcements, land ceiling; regional and urban plan preparations; planning and municipal administration; taxation, revenue resources and fiscal management; public participation and role of NGO.

CE - CIVIL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

STRUCTURAL ENGINEERING

Mechanics: Bending moments and shear forces in statically determinate beams; simple stress and strain: relationship; stress and strain in two dimensions, principal stresses, stress transformation, Mohr's circle; simple bending theory; flexural shear stress; thin-walled pressure vessels; uniform torsion.

Structural Analysis: Analysis of statically determinate trusses, arches and frames; displacements in statically determinate structures and analysis of statically indeterminate structures by force/energy methods; analysis by displacement methods (slope-deflection and moment-distribution methods); influence lines for determinate and indeterminate structures; basic concepts of matrix methods of structural analysis.

Concrete Structures: Basic working stress and limit states design concepts; analysis of ultimate load capacity and design of members subject to flexure, shear, compression and torsion (beams, columns and isolated footings); basic elements of prestressed concrete: analysis of beam sections at transfer and service loads.

Steel Structures: Analysis and design of tension and compression members, beams and beam-columns, column bases; connections - simple and eccentric, beam-column connections, plate girders and trusses; plastic analysis of beams and frames.

GEOTECHNICAL ENGINEERING

Soil Mechanics: Origin of soils; soil classification; three-phase system, fundamental definitions, relationship and inter-relationships; permeability and seepage; effective stress principle: consolidation, compaction; shear strength.

Foundation Engineering: Sub-surface investigation - scope, drilling bore holes, sampling, penetrometer tests, plate load test; earth pressure theories, effect of water table, layered soils; stability of slopes - infinite slopes, finite slopes; foundation types - foundation design requirements; shallow foundations; bearing capacity, effect of shape, water table and other factors, stress distribution, settlement analysis in sands and clays; deep foundations - pile types, dynamic and static formulae, load capacity of piles in sands and clays.

WATER RESOURCES ENGINEERING

Fluid Mechanics and Hydraulics: Hydrostatics, applications of Bernoulli equation, laminar and turbulent flow in pipes, pipe networks; concept of boundary layer and its growth; uniform flow, critical flow and gradually varied flow in channels, specific energy concept, hydraulic jump; forces on immersed bodies; flow measurement in channels; tanks and pipes; dimensional analysis and hydraulic modeling. Applications of momentum equation, potential flow, kinematics of flow; velocity triangles and specific speed of pumps and turbines.

Hydrology: Hydrologic cycle; rainfall; evaporation infiltration, unit hydrographs, flood estimation, reservoir design, reservoir and channel routing, well hydraulics.

Irrigation: Duty, delta, estimation of evapo-transpiration; crop water requirements; design of lined and unlined canals; waterways; head works, gravity dams and Ogee spillways. Designs of weirs on permeable foundation, irrigation methods.

ENVIRONMENTAL ENGINEERING

Water requirements; quality and standards, basic unit processes and operations for water treatment, distribution of water. Sewage and sewerage treatment: quantity and characteristic of waste water sewerage; primary and secondary treatment of waste water; sludge disposal; effluent discharge standards.

TRANSPORTATION ENGINEERING

Highway planning; geometric design of highways; testing and specifications of paving materials; design of flexible and rigid pavements.

CH - CHEMICAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

CHEMICAL ENGINEERING

Process Calculations and Thermodynamics: Laws of conservation of mass and energy; use of tie components; recycle, bypass and purge calculations; degree of freedom analysis.

First and Second laws of thermodynamics and their applications; equations of state and thermodynamic properties of real systems; phase equilibria; fugacity, excess properties and correlations of activity coefficients; chemical reaction equilibria.

Fluid Mechanics and Mechanical Operations: Fluid statics, Newtonian and non-Newtonian fluids, Bernoulli equation, Macroscopic friction factors, energy balance, dimensional analysis, shell balances, flow through pipeline systems, flow meters, pumps and compressors, packed and fluidized beds, elementary boundary layer theory, size reduction and size separation; free and hindered settling; centrifuge and cyclones; thickening and classification, filtration, mixing and agitation; conveying of solids.

Heat Transfer: Conduction, convection and radiation, heat transfer coefficients, steady and unsteady heat conduction, boiling, condensation and evaporation; types of heat exchangers and evaporators and their design.

Mass Transfer: Fick's law, molecular diffusion in fluids, mass transfer coefficients, film, penetration and surface renewal theories; momentum, heat and mass transfer analogies; stagewise and continuous contacting and stage efficiencies; HTU & NTU concepts design and operation of equipment for distillation, absorption, leaching, liquid-liquid extraction, crystallization, drying, humidification, dehumidification and adsorption.

Chemical Reaction Engineering: Theories of reaction rates; kinetics of homogeneous reactions, interpretation of kinetic data, single and multiple reactions in ideal reactors, non-ideal reactors; residence time; non-isothermal reactors; kinetics of heterogeneous catalytic reactions; diffusion effects in catalysis.

Instrumentation and Process Control: Measurement of process variables; sensors, transducers and their dynamics, dynamics of simple systems, dynamics such as CSTRs, transfer functions and responses of simple systems, process reaction curve, controller modes (P, PI, and PID);

control valves; analysis of closed loop systems including stability, frequency response (including Bode plots) and controller tuning, cascade, feed forward control.

Plant Design and Economics: Design and sizing of chemical engineering equipment such as compressors, heat exchangers, multistage contactors; principles of process economics and cost estimation including total annualized cost, cost indexes, rate of return, payback period, discounted cash flow, optimization in Design.

Chemical Technology: Inorganic chemical industries; sulfuric acid, NaOH, fertilizers (Ammonia, Urea, SSP and TSP); natural products industries (Pulp and Paper, Sugar, Oil, and Fats); petroleum refining and petrochemicals; polymerization industries; polyethylene, polypropylene, PVC and polyester synthetic fibers.

CS - COMPUTER SCIENCE AND ENGINEERING

ENGINEERING MATHEMATICS

Mathematical Logic: Propositional Logic; First Order Logic.

Probability: Conditional Probability; Mean, Median, Mode and Standard Deviation; Random Variables; Distributions; uniform, normal, exponential, Poisson, Binomial.

Set Theory & Algebra: Sets; Relations; Functions; Groups; Partial Orders; Lattice; Boolean Algebra.

Combinatorics: Permutations; Combinations; Counting; Summation; generating functions; recurrence relations; asymptotics.

Graph Theory: Connectivity; spanning trees; Cut vertices & edges; covering; matching; independent sets; Colouring; Planarity; Isomorphism.

Linear Algebra: Algebra of matrices, determinants, systems of linear equations, Eigen values and Eigen vectors.

Numerical Methods: LU decomposition for systems of linear equations; numerical solutions of non linear algebraic equations by Secant, Bisection and Newton-Raphson Methods; Numerical integration by trapezoidal and Simpson's rules.

Calculus: Limit, Continuity & differentiability, Mean value Theorems, Theorems of integral calculus, evaluation of definite & improper integrals, Partial derivatives, Total derivatives, maxima & minima.

THEORY OF COMPUTATION

Formal Languages and Automata Theory: Regular languages and finite automata, Context free languages and Push-down automata, Recursively enumerable sets and Turing machines, Un-decidability;

Analysis of Algorithms and Computational Complexity: Asymptotic analysis (best, worst, average case) of time and space, Upper and lower bounds on the complexity of specific problems, NP-completeness.

COMPUTER HARDWARE

Digital Logic: Logic functions, Minimization, Design and synthesis of Combinational and Sequential circuits; Number representation and Computer Arithmetic (fixed and floating point);

Computer Organization: Machine instructions and addressing modes, ALU and Data-path, hardwired and micro-programmed control, Memory interface, I/O interface (Interrupt and DMA mode), Serial communication interface, Instruction pipelining, Cache, main and secondary storage.

SOFTWARE SYSTEMS

Data structures: Notion of abstract data types, Stack, Queue, List, Set, String, Tree, Binary search tree, Heap, Graph;

Programming Methodology: C programming, Program control (iteration, recursion, Functions), Scope, Binding, Parameter passing, Elementary concepts of Object oriented, Functional and Logic Programming;

Algorithms for problem solving: Tree and graph traversals, Connected components, Spanning trees, Shortest paths; Hashing, Sorting, Searching; Design techniques (Greedy, Dynamic Programming, Divide-and-conquer);

Compiler Design: Lexical analysis, Parsing, Syntax directed translation, Runtime environment, Code generation, Linking (static and dynamic); Operating Systems: Classical concepts (concurrency, synchronization, deadlock), Processes, threads and Inter-process communication, CPU scheduling, Memory management, File systems, I/O systems, Protection and security.

Databases: Relational model (ER-model, relational algebra, tuple calculus), Database design (integrity constraints, normal forms), Query languages (SQL), File structures (sequential files, indexing, B+ trees), Transactions and concurrency control;

Computer Networks: ISO/OSI stack, sliding window protocol, LAN Technologies (Ethernet, Token ring), TCP/UDP, IP, Basic concepts of switches, gateways, and routers.

CH - CHEMISTRY

PHYSICAL CHEMISTRY

Structure: Quantum theory - principles and techniques; applications to particle in a box, harmonic oscillator, rigid rotor and hydrogen atom; valence bond and molecular orbital theories and Huckel approximation, approximate techniques: variation and perturbation; symmetry, point groups; rotational, vibrational, electronic, NMR and ESR spectroscopy.

Equilibrium: First law of thermodynamics, heat, energy and work; second law of thermodynamics and entropy; third law and absolute entropy; free energy; partial molar quantities; ideal and non-ideal solutions; phase transformation: phase rule and phase diagrams- one, two, and three component systems; activity, activity coefficient, fugacity and fugacity coefficient ; chemical equilibrium, response of chemical equilibrium to temperature and pressure; colligative properties; kinetic theory of gases; thermodynamics of electrochemical cells; standard electrode potentials: applications - corrosion and energy conversion; molecular partition function (translational, rotational, vibrational and electronic).

Kinetics: Rates of chemical reactions, theories of reaction rates, collision and transition state theory; temperature dependence of chemical reactions; elementary reactions, consecutive elementary reactions; steady state approximation, kinetics of photochemical reactions and free radical polymerization, homogenous and heterogeneous catalysis.

INORGANIC CHEMISTRY

Non-Transition Elements: General characteristics, structure and reactions of simple and industrially important compounds, boranes, carboranes, silicates, silicones, diamond and graphite; hydrides, oxides and oxoacids of N, P, S and halogens; boron nitride, borazines and phosphazenes; xenon compounds. Shapes of molecules, hard-soft acid base concept.

Transition Elements: General characteristics of d and f block elements; coordination chemistry: structure and isomerism, stability, theories of metal-ligand bonding (CFT and LFT), electronic spectra and magnetic properties of transition metal complexes and lanthanides; metal carbonyls, metal-metal bonds and metal atom clusters, metallocenes; transition metal complexes with bonds to hydrogen, alkyls, alkenes, and arenes; metal carbenes; use of organometallic compounds as catalysts in organic synthesis; mechanisms of substitution and electron transfer reactions of coordination complexes. Role of metals with special reference to Na, K, Mg, Ca, Fe, Co, Zn, and Mo in biological systems.

Solids: Crystal systems and lattices, Miller planes, crystal packing, crystal defects; Bragg's Law; ionic crystals, band theory, metals and semiconductors. Spinels.

Instrumental methods of analysis: atomic absorption, UV-visible spectrometry, chromatographic and electro-analytical methods.

ORGANIC CHEMISTRY

Synthesis, reactions and mechanisms involving the following: Alkenes, alkynes, arenes, alcohols, phenols, aldehydes, ketones, carboxylic acids and their derivatives; halides, nitro compounds and amines; stereochemical and conformational effects on reactivity and specificity; reactions with diborane and peracids. Michael reaction, Robinson annulation, reactivity umpolung, acyl anion equivalents; molecular rearrangements involving electron deficient atoms.

Photochemistry: Basic principles, photochemistry of olefins, carbonyl compounds, arenes, photo oxidation and reduction.

Pericyclic reactions: Cycloadditions, electrocyclic reactions, sigmatropic reactions; Woodward-Hoffmann rules.

Heterocycles: Structural properties and reactions of furan, pyrrole, thiophene, pyridine, indole.

Biomolecules: Structure, properties and reactions of mono- and di-saccharides, physico-chemical properties of amino acids, structural features of proteins and nucleic acids.

Spectroscopy: Principles and applications of IR, UV-visible, NMR and mass spectrometry in the determination of structures of organic compounds.

EC - ELECTRONICS AND COMMUNICATION ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix Algebra, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Mean value theorems, Theorems of integral calculus, Evaluation of definite and improper integrals, Partial Derivatives, Maxima and minima, Multiple integrals, Fourier series. Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equation (linear and nonlinear), Higher order linear differential equations with constant coefficients, Method of variation of parameters, Cauchy's and Euler's equations, Initial and boundary value problems, Partial Differential Equations and variable separable method.

Complex variables: Analytic functions, Cauchy's integral theorem and integral formula, Taylor's and Laurent' series, Residue theorem, solution integrals.

Probability and Statistics: Sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Discrete and continuous distributions, Poisson, Normal and Binomial distribution, Correlation and regression analysis.

Numerical Methods: Solutions of non-linear algebraic equations, single and multi-step methods for differential equations.

Transform Theory: Fourier transform, Laplace transform, Z-transform.

ELECTRONICS & COMMUNICATION ENGINEERING

Networks: Network graphs: matrices associated with graphs; incidence, fundamental cut set and fundamental circuit matrices. Solution methods: nodal and mesh analysis. Network theorems: superposition, Thevenin and Norton's maximum power transfer, Wye-Delta transformation. Steady state sinusoidal analysis using phasors. Linear constant coefficient differential equations; time domain analysis of simple RLC circuits, Solution of network equations using Laplace transform: frequency domain analysis of RLC circuits. 2-port network parameters: driving point and transfer functions. State equations for networks.

Electronic Devices: Energy bands in silicon, intrinsic and extrinsic silicon. Carrier transport in silicon: diffusion current, drift current, mobility, resistivity. Generation and recombination of carriers. p-n junction diode, Zener diode, tunnel diode, BJT, JFET, MOS capacitor, MOSFET, LED, p-I-n and avalanche photo diode, LASERs. Device technology: integrated circuits fabrication process, oxidation, diffusion, ion implantation, photolithography, n-tub, p-tub and twin-tub CMOS process.

Analog Circuits: Equivalent circuits (large and small-signal) of diodes, BJTs, JFETs, and MOSFETs. Simple diode circuits, clipping, clamping, rectifier. Biasing and bias stability of transistor and FET amplifiers. Amplifiers: single-and multi-stage, differential, operational, feedback and power. Analysis of amplifiers; frequency response of amplifiers. Simple op-amp circuits. Filters. Sinusoidal oscillators; criterion for oscillation; single-transistor and op-amp configurations. Function generators and wave-shaping circuits. Power supplies.

Digital circuits: Boolean algebra, minimization of Boolean functions; logic gates digital IC families (DTL, TTL, ECL, MOS, CMOS). Combinational circuits: arithmetic circuits, code converters, multiplexers and decoders. Sequential circuits: latches and flip-flops, counters and shift-registers. Sample and hold circuits, ADCs, DACs. Semiconductor memories. Microprocessor(8085): architecture, programming, memory and I/O interfacing.

Signals and Systems: Definitions and properties of Laplace transform, continuous-time and discrete-time Fourier series, continuous-time and discrete-time Fourier Transform, z-transform. Sampling theorems. Linear Time-Invariant (LTI) Systems: definitions and properties; casuality, stability, impulse response, convolution, poles and zeros frequency response, group delay, phase delay. Signal transmission through LTI systems. Random signals and noise: probability, random variables, probability density function, autocorrelation, power spectral density.

Controls Systems: Basic control system components; block diagrammatic description, reduction of block diagrams. Open loop and closed loop (feedback) systems and stability analysis of these systems. Signal flow graphs and their use in determining transfer functions of systems; transient and steady state analysis of LTI control systems and frequency response. Tools and techniques for LTI control system analysis: root loci, Routh-Hurwitz criterion, Bode and Nyquist plots. Control system compensators: elements of lead and lag compensation, elements of Proportional-Integral-Derivative(PID) control. State variable representation and solution of state equation of LTI control systems.

Communications: Analog communication systems: amplitude and angle modulation and demodulation systems, spectral analysis of these operations, superheterodyne receivers; elements of hardware, realizations of analog communication systems; signal-to-noise ratio (SNR) calculations for amplitude modulation (AM) and frequency modulation (FM) for low noise conditions. Digital communication systems: pulse code modulation (PCM), differential pulse code modulation (DPCM), delta modulation (DM); digital modulation schemes-amplitude, phase and frequency shift keying schemes (ASK, PSK, FSK), matched filter receivers, bandwith consideration and probability of error calculations for these schemes.

Electromagnetics: Elements of vector calculus: divergence and curl; Gauss' and Stokes' theorems, Maxwell's equations: differential and integral forms. Wave equation, Poynting vector. Plane waves: propagation through various media; reflection and refraction; phase and group velocity; skin depth. Transmission lines: characteristic impedance; impedance transformation; Smith chart; impedance matching; pulse excitation. Waveguides: modes in rectangular waveguides; boundary conditions; cut-off frequencies; dispersion relations. Antennas: Dipole antennas; antenna arrays; radiation pattern; reciprocity theorem, antenna gain.

EE - ELECTRICAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix Algebra, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Mean value theorems, Theorems of integral calculus, Evaluation of definite and improper integrals, Partial Derivatives, Maxima and minima, Multiple integrals, Fourier series. Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equation (linear and nonlinear), Higher order linear differential equations with constant coefficients, Method of variation of parameters, Cauchy's and Euler's equations, Initial and boundary value problems, Partial Differential Equations and variable separable method.

Complex variables: Analytic functions, Cauchy's integral theorem and integral formula, Taylor's and Laurent' series, Residue theorem, solution integrals.

Probability and Statistics: Sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Discrete and continuous distributions, Poisson, Normal and Binomial distribution, Correlation and regression analysis.

Numerical Methods: Solutions of non-linear algebraic equations, single and multi-step methods for differential equations.

Transform Theory: Fourier transform, Laplace transform, Z-transform.

ELECTRICAL ENGINEERING

Electrical Circuits and Fields: Network graph, KCL, KVL, node/ cut set, mesh/ tie set analysis, transient response of d.c. and a.c. networks; sinusoidal steady-state analysis; resonance in electrical circuits; concepts of ideal voltage and current sources, network theorems, driving point, immittance and transfer functions of two port networks, elementary concepts of filters; three phase circuits; Fourier series and its application; Gauss theorem, electric field intensity and potential due to point, line, plane and spherical charge distribution, dielectrics, capacitance calculations for simple configurations; Ampere's and Biot-Savart's law, inductance calculations for simple configurations.

Electrical Machines: Single phase transformer - equivalent circuit, phasor diagram, tests, regulation and efficiency; three phase transformers - connections, parallel operation; auto transformer and three-winding transformer; principles of energy conversion, windings of rotating machines: D. C. generators and motors - characteristics, starting and speed control, armature reaction and commutation; three phase induction motors-performance characteristics, starting and speed control; single-phase induction motors; synchronous generators-performance, regulation, parallel operation; synchronous motors - starting, characteristics, applications, synchronous condensers; fractional horse power motors; permanent magnet and stepper motors.

Power Systems: Electric power generation - thermal, hydro, nuclear; transmission line parameters; steady-state performance of overhead transmission lines and cables and surge propagation; distribution systems, insulators, bundle conductors, corona and radio interference effects; per-unit quantities; bus admittance and impedance matrices; load flow; voltage control and power factor correction; economic operation; symmetrical components, analysis of symmetrical and unsymmetrical faults; principles of over current, differential and distance protections; concept of solid state relays and digital protection; circuit breakers; concept of system stability-swing curves and equal area criterion; basic concepts of HVDC transmission.

Control Systems: Principles of feedback; transfer function; block diagrams: steady-state errors; stability-Routh and Nyquist criteria; Bode plots; compensation; root loci; elementary state variable formulation; state transition matrix and response for Linear Time Invariant systems.

Electrical and Electronic Measurements: Bridges and potentiometers, PMMC, moving iron, dynamometer and induction type instruments; measurement of voltage, current, power, energy and power factor; instrument transformers; digital voltmeters and multimeters; phase, time and frequency measurement; Q-meter, oscilloscopes, potentiometric recorders, error analysis.

Analog and Digital Electronics: Characteristics of diodes, BJT, FET, SCR; amplifiers-biasing, equivalent circuit and frequency response; oscillators and feedback amplifiers, operational amplifiers- characteristics and applications; simple active filters; VCOs and timers; combinational and sequential logic circuits, multiplexer, Schmitt trigger, multivibrators, sample and hold circuits, A/D and D/A converters; microprocessors and their applications.

Power Electronics and Electric Drives: Semiconductor power devices-diodes, transistors, thyristors, triacs, GTOs, MOSFETs and IGBTs - static characteristics and principles of operation; triggering circuits; phase control rectifiers; bridge converters-fully controlled and half controlled; principles of choppers and inverters, basic concepts of adjustable speed dc and ac drives.

GG - GEOLOGY AND GEOPHYSICS

PART - I

Earth and planetary system; size, shape, internal structure and composition of the earth; atmosphere and greenhouse effect; isostasy; elements of seismology; continents and continental processes; physical oceanography; palaeomagnetism, continental drift plate tectonics, geothermal energy.

Weathering; soil formation; action of river, wind and glacier; oceans and oceanic features; earthquakes, volcanoes, orogeny and mountain building; elements of structural geology; crystallography; classification, composition and properties of minerals and rocks; engineering properties of rocks and soils, role of geology in the construction of engineering structures.

Processes of ore formation, occurrence and distribution of ores on land and on ocean floor; coal and petroleum resources in India; ground water geology including well hydraulics, geological time scale and geochronology; stratigraphic principles and stratigraphy of India; basics concepts of gravity, magnetic and electrical prospecting for ores and ground water.

PART - IIA: GEOLOGY

Crystal symmetry, forms, twinning; crystal chemistry; optical mineralogy, classification of minerals, diagnostic properties of rock minerals.

Mineralogy, structure, texture and classification of igneous, sedimentary and metamorphic rock, their origin and evolution; application of thermodynamics; structure and petrology of sedimentary rocks; sedimentary processes and environments, sedimentary facies, basin studies; basement cover relationship;

Primary and secondary structures; geometry and genesis of folds, faults, joints, unconformities, cleavage, schistosity and lineation; methods of projection. Tectonites and their significance; shear zone; superposed folding.

Morphology, classification and geological significance of important invertebrates, vertebrates, microfossils and palaeoflora; stratigraphic principles and Indian stratigraphy; geomorphic processes and agents; development and evolution of landforms; slope and drainage; processes on deep oceanic and near-shore regions; quantitative and applied geomorphology; air photo interpretation and remote sensing; chemical and optical properties of ore minerals; formation and localization of ore deposits; prospecting and exploration of economic minerals; coal and petroleum geology; origin and distribution of mineral and fuel deposits in India; ore dressing and mineral economics.

Cosmic abundance; meteorites; geochemical evolution of the earth; geochemical cycles; distribution of major, minor and trace elements; isotope geochemistry; geochemistry of waters including solution equilibria and water rock interaction.

Engineering properties of rocks and soils; rocks as construction material; geology of dams, tunnels and excavation sites; natural hazards; the fly ash problem; ground water geology and exploration; water quality; impact of human activity; Remote sensing techniques for the interpretation of landforms and resource management.

PART - II B: GEOPHYSICS

The earth as a planet; different motions of the earth; gravity filed of the earth and its shape; geochronology; isostasy, seismology and interior of the earth; variation of density, velocity, pressure, temperature, electrical and magnetic properties inside the earth; earthquakes-causes and measurements; zonation and seismic hazards; geomagnetic field, palaeomagnetism; oceanic and continental lithosphere; plate tectonics; heat flow; upper and lower atmospheric phenomena.

Theories of scalar and vector potential fields; Laplace, Maxwell and Helmholtz equations for solution of different types of boundary value problems for Cartesian, cylindrical and spherical polar coordinates; Green's theorem; Image theory; integral equations and conformal transformations in potential theory; Eikonal equation and ray theory.

'G' and 'g' units of measurement, density of rocks, gravimeters, preparation, analysis and interpretation of gravity maps; derivative maps, analytical continuation; gravity anomaly type curves; calculation of mass.

Earth's magnetic field, units of measurement, magnetic susceptibility of rocks, magnetometers, corrections, preparation of magnetic maps, magnetic anomaly type curve, analytical continuation, interpretation and application; magnetic well logging.

Conduction of electricity through rocks, electrical conductivities of metals, metallic, non-metallic and rock forming minerals, D.C. resistivity units and methods of measurement, electrode configuration for sounding and profiling, application of filter theory, interpretation of resistivity field data, application; self potential origin, classification, field measurement, interpretation of induced polarization time frequency, phase domain; IP units and methods of measurement, interpretation and application; ground-water exploration.

Origin of electromagnetic field elliptic polarization, methods of measurement for different source-receiver configuration components in EM measurements, interpretation and applications; earth's natural electromagnetic field, tellurics, magneto-tellurics; geomagnetic depth sounding principles, methods of measurement, processing of data and interpretation.

Seismic methods of prospecting: Reflection, refraction and CDP surveys; land and marine seismic sources, generation and propagation of elastic waves, velocity increasing with depth, geophones, hydrophones, recording instruments (DFS), digital formats, field layouts, seismic noises and noise profile analysis, optimum geophone grouping, noise cancellation by shot and geophone arrays, 2D and 3D seismic data acquisition and processing, CDP stacking charts, binning, filtering, dip-moveout, static and dynamic corrections, deconvolution, migration, signal processing, Fourier and Hilbert transforms, attribute analysis, bright and dim spots, seismic stratigraphy, high resolution seismics, VSP.

Principles and techniques of geophysical well-logging, SP, resistivity, induction, micro gamma ray, neutron, density, sonic, temperature, dip meter, caliper, nuclear magnetic, cement bond logging. Quantitative evaluation of formations from well logs; well hydraulics and application of geophysical methods for groundwater study; application of bore hole geophysics in ground water, mineral and oil exploration. Remote sensing techniques and application of remote sensing methods in geophysics.

IN - INSTRUMENTATION ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix Algebra, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Mean value theorems, Theorems of integral calculus, Evaluation of definite and improper integrals, Partial Derivatives, Maxima and minima, Multiple integrals, Fourier series. Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equation (linear and nonlinear), Higher order linear differential equations with constant coefficients, Method of variation of parameters, Cauchy's and Euler's equations, Initial and boundary value problems, Partial Differential Equations and variable separable method.

Complex variables: Analytic functions, Cauchy's integral theorem and integral formula, Taylor's and Laurent' series, Residue theorem, solution integrals.

Probability and Statistics: Sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Discrete and continuous distributions, Poisson, Normal and Binomial distribution, Correlation and regression analysis.

Numerical Methods: Solutions of non-linear algebraic equations, single and multi-step methods for differential equations.

Transform Theory: Fourier transform, Laplace transform, Z-transform.

INSTRUMENTATION ENGINEERING

Measurement Basics and Metrology: Static and dynamic characteristics of measurement systems. Standards and calibration. Error and uncertainty analysis, statistical analysis of data, and curve fitting. Linear and angular measurements; Measurement of straightness, flatness, roundness and roughness.

Transducers, Mechanical Measurements and Industrial Instrumentation: Transducers - elastic, resistive, inductive, capacitive, thermo-electric, piezoelectric, photoelectric, electro-mechanical, electro-chemical, and ultrasonic. Measurement of displacement, velocity (linear and rotational), acceleration, shock, vibration, force, torque, power, strain, stress, pressure, flow, temperature, humidity, viscosity, and density. energy storing elements, suspension systems and dampers.

Analog Electronics: Characteristics of diodes, BJTs, JFETs and MOSFETs; Diode circuits; Amplifiers: single and multi-stage, feedback; Frequency response; Operational amplifiers - design, characteristic, linear and non-linear applications: difference amplifiers; instrumentation amplifiers; precision rectifiers, I-to-V converters, active filters, oscillators, comparators, signal generators, wave shaping circuits.

Digital Electronics: Combinational logic circuits, minimization of Boolean functions; IC families (TTL, MOS, CMOS), arithmetic circuits, multiplexer and decoders. Sequential circuits: flip-flops, counters, shift registers. Schmitt trigger, timers, and multivibrators. Analog switches, multiplexers, S/H circuits. Analog-to-digital and digital-to-analog converters. Basics of computer organization and architecture. 8-bit microprocessor (8085), applications, memory, I/O interfacing, and microcontrollers.

Signals and Systems: Vectors and matrices; Fourier series; Fourier transforms; Ordinary differential equations. Impulse and frequency responses of first and second order systems. Laplace transform and transfer function, convolution and correlation. Amplitude and frequency modulations and demodulations. Discrete time systems, difference equations, impulse and frequency responses; Z-transforms and transfer functions; IIR and FIR filters.

Electrical and Electronic Measurements: Measurement of R, L and C; bridges and potentiometers. Measurement of voltage, current, power, power factor, and energy; Instrument transformers; Q meter, waveform analyzers. Digital volt-meters and multi-meters. Time, phase and frequency measurements; Oscilloscope. Noise and interference in instrumentation.

Control Systems & Process Control: Principles of feedback; transfer function, signal flow graphs. Stability criteria, Bode plots, root-loci, Routh and Nyquist criteria. Compensation techniques; State space analysis. System components: mechanical, hydraulic, pneumatic, electrical and electronic; Servos and synchros; Stepper motors. On-off, cascade, P, PI, PID and feed-forward controls. Controller tuning and general frequency response.

Analytical, Optical and Biomedical Instrumentation: Principles of spectrometry, UV, visible, IR mass spectrometry, X-ray methods; nuclear radiation measurements, gas, solid and semi conductor lasers and their characteristics, interferometers, basics of fibre optics, transducers in biomedical applications, cardiovascular system measurements, instrumentation for clinical laboratory.

MA - MATHEMATICS

Linear Algebra: Finite dimensional vector spaces. Linear transformations and their matrix representations, rank; systems of linear equations, eigenvalues and eigenvectors, minimal polynomial, Cayley-Hamilton theorem, diagonalisation, Hermitian, Skew-Hermitian and unitary matrices. Finite dimensional inner product spaces, self-adjoint and Normal linear operators, spectral theorem, Quadratic forms.

Complex Analysis: Analytic functions, conformal mappings, bilinear transformations, complex integration: Cauchy's integral theorem and formula, Liouville's theorem, maximum modulus principle, Taylor and Laurent's series, residue theorem and applications for evaluating real integrals.

Real Analysis: Sequences and series of functions, uniform convergence, power series, Fourier series, functions of several variables, maxima, minima, multiple integrals, line, surface and volume integrals, theorems of Green, Stokes and Gauss; metric spaces, completeness, Weierstrass approximation theorem, compactness. Lebesgue measure, measurable functions; Lebesgue integral, Fatou's lemma, dominated convergence theorem.

Ordinary Differential Equations: First order ordinary differential equations, existence and uniqueness theorems, systems of linear first order ordinary differential equations, linear ordinary differential equations of higher order with constant coefficients; linear second order ordinary differential equations with variable coefficients, method of Laplace transforms for solving ordinary differential equations, series solutions; Legendre and Bessel functions and their orthogonality, Sturm Liouville system, Greeen's functions.

Algebra: Normal subgroups and homomorphisms theorems, automorphisms. Group actions, sylow's theorems and their applications groups of order less than or equal to 20, Finite p-groups. Euclidean domains, Principal ideal domains and unique factorizations domains. Prime ideals and maximal ideals in commutative rings.

Functional Analysis: Banach spaces, Hahn-Banach theorems, open mapping and closed graph theorems, principle of uniform boundedness; Hilbert spaces, orthonormal sets, Riesz representation theorem, self-adjoint, unitary and normal linear operators on Hilbert Spaces.

Numerical Analysis: Numerical solution of algebraic and transcendental equations; bisection, secant method, Newton-Raphson method, fixed point iteration, interpolation: existence and error of polynomial interpolation, Lagrange, Newton, Hermite(osculatory)interpolations; numerical differentiation and integration, Trapezoidal and Simpson rules; Gaussian quadrature; (Gauss-Legendre and Gauss-Chebyshev), method of undetermined parameters, least square and orthonormal polynomial approximation; numerical solution of systems of linear equations: direct and iterative methods, (Jacobi Gauss-Seidel and SOR) with convergence; matrix eigenvalue problems: Jacobi and Given's methods, numerical solution of ordinary differential equations: initial value problems, Taylor series method, Runge-Kutta methods, predictor-corrector methods; convergence and stability.

Partial Differential Equations: Linear and quasilinear first order partial differential equations, method of characteristics; second order linear equations in two variables and their classification; Cauchy, Dirichlet and Neumann problems, Green's functions; solutions of Laplace, wave and diffusion equations in two variables Fourier series and transform methods of solutions of the above equations and applications to physical problems.

Mechanics: Forces in three dimensions, Poinsot central axis, virtual work, Lagrange's equations for holonomic systems, theory of small oscillations, Hamiltonian equations;

Topology: Basic concepts of topology, product topology, connectedness, compactness, countability and separation axioms, Urysohn's Lemma, Tietze extension theorem, metrization theorems, Tychonoff theorem on compactness of product spaces.

Probability and Statistics: Probability space, conditional probability, Bayes' theorem, independence, Random variables, joint and conditional distributions, standard probability distributions and their properties, expectation, conditional expectation, moments. Weak and strong law of large numbers, central limit theorem. Sampling distributions, UMVU estimators, sufficiency and consistency, maximum likelihood estimators. Testing of hypotheses, Neyman-Pearson tests, monotone likelihood ratio, likelihood ratio tests, standard parametric tests based on normal, X2 ,t, F-distributions. Linear regression and test for linearity of regression. Interval estimation.

Linear Programming: Linear programming problem and its formulation, convex sets their properties, graphical method, basic feasible solution, simplex method, big-M and two phase methods, infeasible and unbounded LPP's, alternate optima. Dual problem and duality theorems, dual simplex method and its application in post optimality analysis, interpretation of dual variables. Balanced and unbalanced transportation problems, unimodular property and u-v method for solving transportation problems. Hungarian method for solving assignment problems.

Calculus of Variations and Integral Equations: Variational problems with fixed boundaries; sufficient conditions for extremum, Linear integral equations of Fredholm and Volterra type, their iterative solutions. Fredholm alternative.

ME - MECHANICAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

APPLIED MECHANICS AND DESIGN

Engineering Mechanics: Equivalent force systems, free-body concepts, equations of equilibrium, trusses and frames, virtual work and minimum potential energy. Kinematics and dynamics of particles and rigid bodies, impulse and momentum (linear and angular), energy methods, central force motion.

Strength of Materials: Stress and strain, stress-strain relationship and elastic constants, Mohr's circle for plane stress and plane strain, shear force and bending moment diagrams, bending and shear stresses, deflection of beams, torsion of circular shafts, thin and thick cylinders, Euler's theory of columns, strain energy methods, thermal stresses.

Theory of Machines: Displacement, velocity and acceleration, analysis of plane mechanisms, dynamic analysis of slider-crank mechanism, planar cams and followers, gear tooth profiles, kinematics of gears, governors and flywheels, balancing of reciprocating and rotating masses.

Vibrations: Free and forced vibration of single degree freedom systems, effect of damping, vibration isolation, resonance, critical speed of rotors.

Design of Machine Elements: Design for static and dynamic loading, failure theories, fatigue strength; design of bolted, riveted and welded joints; design of shafts and keys; design of spur gears, rolling and sliding contact bearings; brakes and clutches; belt, rope and chain drives.

FLUID MECHANICS AND THERMAL SCIENCES

Fluid Mechanics: Fluid properties, fluid statics, manometry, buoyancy; control-volume analysis of mass, momentum and energy; fluid acceleration; differential equations of continuity and momentum; Bernoulli's equation; viscous flow of incompressible fluids; boundary layer; elementary turbulent flow; flow through pipes, head losses in pipes, bends etc.

Heat-Transfer: Modes of heat transfer; one dimensional heat conduction, resistance concept, electrical analogy, unsteady heat conduction, fins; dimensionless parameters in free and forced convective heat transfer, various correlations for heat transfer in flow over flat plates and through pipes; thermal boundary layer; effect of turbulence; radiative heat transfer, black and grey surfaces, shape factors, network analysis; heat exchanger performance, LMTD and NTU methods.

Thermodynamics: Zeroth, First and Second laws of thermodynamics; thermodynamic system and processes; irreversibility and availability; behaviour of ideal and real gases, properties of pure substances, calculation of work and heat in ideal processes; analysis of thermodynamic cycles related to energy conversion; Carnot, Rankine, Otto, Diesel, Brayton and vapour compression cycles.

Power Plant Engineering: Steam generators; steam power cycles; steam turbines; impulse and reaction principles, velocity diagrams, pressure and velocity compounding; reheating and reheat factor; condensers and feed heaters.

I.C. Engines: Requirements and suitability of fuels in IC engines, fuel ratings, fuel-air mixture requirements; normal combustion in SI and CI engines; engine performance calculations.

Refrigeration and air-conditioning: Refrigerant compressors, expansion devices, condensers and evaporators; properties of moist air, psychrometric chart, basic psychometric processes.

Turbomachinery: Components of gas turbines; compression processes, centrifugal and axial flow compressors; axial flow turbines, elementary theory; hydraulic turbines; Euler-turbine equation; specific speed, Pelton-wheel, Francis and Kaplan turbines; centrifugal pumps.

MANUFACTURING AND INDUSTRIAL ENGINEERING

Engineering Materials: Structure and properties of engineering materials and their applications, heat treatment.

Metal Casting: Casting processes (expendable and non-expendable) -pattern, moulds and cores, heating and pouring, solidification and cooling, gating design, design considerations, defects.

Forming Processes: Stress-strain diagrams for ductile and brittle material, Plastic deformation and yield criteria, fundamentals of hot and cold working processes, Bulk metal forming processes (forging, rolling, extrusion, drawing), sheet metal working processes (punching, blanking, bending, deep drawing, coining, spinning, load estimation using homogeneous deformation methods, defects). processing of powder metals- atomization, compaction, sintering, secondary and finishing operations. forming and shaping of plastics- extrusion, injection moulding.

Joining Processes: Physics of welding, fusion and non-fusion welding processes, brazing and soldering, adhesive bonding, design considerations in welding, weld quality defects.

Machining and Machine Tool Operations: Mechanics of machining, single and multi-point cutting tools, tool geometry and materials, tool life and wear, cutting fluids, machinability, economics of machining, non-traditional machining processes.

Metrology and Inspection: Limits, fits and tolerances, linear and angular measurements, comparators, gauge design, interferometry, form and finish measurement, measurement of screw threads, alignment and testing methods.

Tool Engineering: Principles of work holding, design of jigs and fixtures.

Computer Integrated Manufacturing: Basic concepts of CAD, CAM and their integration tools.

Manufacturing Analysis: Part-print analysis, tolerance analysis in manufacturing and assembly, time and cost analysis.

Work-Study: Method study, work measurement, time study, work sampling, job evaluation, merit rating.

Production Planning and Control: Forecasting models, aggregate production planning, master scheduling, materials requirements planning.

Inventory Control: Deterministic and probabilistic models, safety stock inventory control systems.

Operations Research: Linear programming, simplex and duplex method, transportation, assignment, network flow models, simple queuing models, PERT and CPM

MN - MINING ENGINEERING

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

MINING ENGINEERING

Mechanics: Equivalent force systems, equations of equilibrium, two dimensional frames and trusses, free body diagrams, friction forces, particle kinematics and dynamics.

Mine Development, Geomechanics and Strata Control: Drivages for underground mine development, drilling methods and machines, explosives, blasting devices and practices, shaft sinking. Physico-mechanical properties of rocks, rock mass classification, ground control instrumentation and stress measurement techniques, theories of rock failure, ground vibrations, stress distribution around mine openings, subsidence, design of supports in roadways and workings, stability of open pits, slopes.

Mining Methods and Machinery: Surface mining - layout, development, loading, transportation and mechanization, continuous surface mining systems. Underground coal mining - bord and pillar system, longwall mining, thick seam mining methods. Underground metal mining: different stoping methods, stope mechanization, ore handling systems, mine filling. Generation and transmission of mechanical, hydraulic, and pneumatic power. Materials handling - haulages, conveyors, ropeways, face and development machinery, hoisting systems, and pumps.

Ventilation, Underground Hazards and Surface Environment: Underground atmosphere, heat load sources and thermal environment, air cooling, mechanics of air flow distribution, natural and mechanical ventilation, mine fans and their usage, auxiliary ventilation. Subsurface hazards from fires, explosions, gases, dust, and inundation, rescue apparatus and practices, safety in mines, accident analysis, noise, mine lighting. Air and water pollution: causes, dispersion, quality standards, and control.

Surveying, Mine Planning and Systems Engineering: Fundamentals of engineering surveying, Levels and levelling, Theodolite, tacheometry, triangulation, contouring, errors and adjustments, correlation, underground surveying, curves, photogrammetry, field astronomy, GPS fundamentals. Principles of planning - Sampling methods and practices, reserve estimation techniques, basics of geostatistics, optimization of facility location, cash flow concepts and mine valuation, open pit design. Work study, concepts of reliability, reliability of series and parallel systems. Linear programming, transportation and assignment problems, queueing, network analysis, inventory control.

MT - METALLURGICAL ENGINEERING

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

METALLURGICAL ENGINEERING

Thermodynamics and Rate Processes: Laws of thermodynamics, activity, equilibrium constant, applications to metallurgical systems, solutions, phase equilibria, basic kinetic laws, order of reactions, rate constants and rate limiting steps principles of electro chemistry, aqueous, corrosion and protection of metals, oxidation and high temperature corrosion - characterization and control; momentum transfer - concepts of viscosity, shell balances, Bernoulli's equation; heat transfer - conduction, convection and heat transfer coefficient relations, radiation, mass transfer - diffusion and Fick's laws.

Extractive Metallurgy: Flotation, gravity and other methods of mineral processing; agglomeration, pyro-hydro-and electro-metallurgical processes; material and energy balances; principles and processes for the extraction of non-ferrous metals - aluminium, copper, zinc, lead, magnesium, nickel, titanium and other rare metals; iron and steel making - principles, blast furnace, direct reduction processes, primary and secondary steel making, deoxidation and inclusion in steel; ingot and continuous casting; stainless steel making, design of furnaces; fuels and refractories.

Physical Metallurgy: Crystal structure and bonding characteristics of metals, alloys, ceramics and polymers; solid solutions; solidification; phase transformation and binary phase diagrams; principles of heat treatment of steels, aluminum alloys and cast irons; recovery, recrystallization and grain growth; industrially important ferrous and non-ferrous alloys; elements of X-ray and electron diffraction; principles of scanning and transmission electron microscopy; elements of ceramics, composites and electronic materials; electronic basis of thermal, optical, electrical and magnetic properties of materials.

Mechanical Metallurgy: Elements of elasticity and plasticity; defects in crystals; elements of dislocation theory - types of dislocations, slip and twinning, stress fields of dislocations, dislocation interactions and reactions, methods of seeing dislocations; strengthening mechanisms; tensile, fatigue and creep behaviour; superplasticity; fracture - Griffith theory, ductile to brittle transition, fracture toughness; failure analysis; mechanical testing - tension, compression, torsion, hardness, impact, creep, fatigue, fracture toughness and formability tests.

Manufacturing Processes: Metal casting - patterns, moulds, melting, gating, feeding and casting processes, defects and castings, hot and cold working of metals; Metal forming - fundamentals of metal forming, rolling wire drawing, extrusion, forming, sheet metal forming processes, defects in forming; Metal joining - soldering, brazing and welding, common welding processes, welding metallurgy, problems associated with welding of steels and aluminium alloys, defects in welding, powder metallurgy; NDT methods - ultrasonic, radiography, eddy current, acoustic emission and magnetic.

PH - PHYSICS

Mathematical Physics: Linear vector space, matrices; vector calculus; linear differential equations; elements of complex analysis; Laplace transforms, Fourier analysis, elementary ideas about tensors.

Classical Mechanics: Conservation laws; central forces; collisions and scattering in laboratory and centre of mass reference frames; mechanics of system of particles; rigid body dynamics; moment of inertia tensor; noninertial frames and pseudo forces; variational principle; Lagrange's and Hamilton's formalisms; equation of motion, cyclic coordinates, Poisson bracket; periodic motion, small oscillations, normal modes; wave equation and wave propagation; special theory of relativity - Lorentz transformations, relativistic kinematics, mass-energy equivalence.

Electromagnetic Theory: Laplace and Poisson equations; conductors and dielectrics; boundary value problems; Ampere's and Biot-Savart's laws; Faraday's law; Maxwell's equations; scalar and vector potentials; Coulomb and Lorentz gauges; boundary conditions at interfaces; electromagnetic waves; interference, diffraction and polarization; radiation from moving charges.

Quantum Mechanics: Physical basis of quantum mechanics; uncertainty principle; Schrodinger equation; one and three dimensional potential problems; Particle in a box, harmonic oscillator, hydrogen atom; linear vectors and operators in Hilbert space; angular momentum and spin; addition of angular momentum; time independent perturbation theory; elementary scattering theory.

Atomic and Molecular Physics: Spectra of one-and many-electron atoms; LS and jj coupling; hyperfine structure; Zeeman and Stark effects; electric dipole transitions and selection rules; X-ray spectra; rotational and vibrational spectra of diatomic molecules; electronic transition in diatomic molecules, Franck-Condon principle; Raman effect; NMR and ESR; lasers.

Thermodynamics and Statistical Physics: Laws of thermodynamics; macrostates, phase space; probability ensembles; partition function, free energy, calculation of thermodynamic quantities; classical and quantum statistics; degenerate Fermi gas; black body radiation and Planck's distribution law; Bose-Einstein condensation; first and second order phase transitions, critical point.

Solid State Physics: Elements of crystallography; diffraction methods for structure determination; bonding in solids; elastic properties of solids; defects in crystals; lattice vibrations and thermal properties of solids; free electron theory; band theory of solids; metals, semiconductors and insulators; transport properties; optical, dielectric and magnetic properties of solids; elements of superconductivity.

Nuclear and Particle Physics: Rutheford scattering; basic properties of nuclei; radioactive decay; nuclear forces; two nucleon problem; nuclear reactions; conservation laws; fission and fusion; nuclear models; particle accelerators, detectors; elementary particles; photons, baryons, mesons and leptons; Quark model.

Electronics: Network analysis; semiconductor devices; bipolar transistors; FETs; power supplies, amplifier, oscillators; operational amplifiers; elements of digital electronics; logic circuits.

PI - PRODUCTION AND INDUSTRIAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

GENERAL ENGINEERING:

Engineering Materials: Structure and properties of engineering materials and their applications; effect of strain, strain rate and temperature on mechanical properties of metals and alloys; heat treatment of metals and alloys.

Applied Mechanics: Engineering mechanics - equivalent force systems, free body concepts, equations of equilibrium, virtual work and minimum potential energy; strength of materials-stress, strain and their relationship, Mohr's circle, deflection of beams, bending and shear stress, Euler's theory of columns.

Theory of Machines and Design: Analysis of planar mechanisms, plane cams and followers; governers and fly wheels; design of elements-failure theories; design of bolted, riveted and welded joints; design of shafts, keys, belt drives, brakes and clutches.

Thermal Engineering: Fluid machines - fluid statics, Bernoulli's equation, flow through pipes, equations of continuity and momentum; Thermodynamics - zeroth, First and Second laws of thermodynamics, thermodynamic system and processes, calculation of work and heat for systems and control volumes; Heat transfer - fundamentals of conduction, convection and radiation.

PRODUCTION ENGINEERING

Metal Casting: Casting processes; patterns-materials; allowances; moulds and cores - materials, making and testing; melting and founding of cast iron, steels and nonferrous metals and alloys; solidification; design of casting, gating and risering; casting defects and inspection.

Metal working: Stress-strain in elastic and plastic deformation; deformation mechanisms; hot and cold working-forging, rolling, extrusion, wire and tube drawing; sheet metal working; analysis of rolling, forging, extrusion and wire /rod drawing; metal working defects, high energy rate forming processes-explosive, magnetic, electro and electrohydraulic.

Metal Joining Processes: Welding processes - gas shielded metal arc, TIG, MIG, submerged arc, electroslag, thermit, resistance, pressure and forge welding; thermal cutting; other joining processes - soldering, brazing, braze welding; welding codes, welding symbols, design of welded joints, defects and inspection; introduction to modern welding processes - friction, ultrasonic, explosive, electron beam, laser and plasma.

Machining and Machine Tool Operations: Machining processes-turning, drilling, boring, milling, shaping, planing, sawing, gear cutting, thread production, broaching, grinding, lapping, honing super finishing; mechanics of cutting- Merchant's analysis, geometry of cutting tools, cutting forces, power requirements; selection of process parameters; tool materials, tool wear and tool life, cutting fluids, machinability; nontraditional machining processes and hybrid processes- EDM, CHM, ECM, USM, LBM, EBM, AJM, PAM AND WJM; economics of machining.

Metrology and Inspection: Limits and fits, linear and angular measurements by mechanical and optical methods, comparators; design of limit gauges; interferometry; measurement of straightness, flatness, roundness, squareness and symmetry; surface finish measurement; inspection of screw threads and gears; alignment testing.

Powder Metallurgy and Processing of Plastics: Production of powders, compaction, sintering; Polymers and composites; injection, compression and blow molding, extrusion, calendaring and thermoforming; molding of composites.

Tool Engineering: Work-holding-location and clamping; principles and methods; design of jigs and fixtures; design of press working tools, forging dies.

Manufacturing Analysis: Sources of errors in manufacturing; process capability; part-print analysis; tolerance analysis in manufacturing and assembly; process planning; parameter selection and comparison of production alternatives; time and cost analysis; Issues in choosing manufacturing technologies and strategies.

Computer Integrated Manufacturing: Basic concepts of CAD, CAM, CAPP, group technology, NC, CNC, DNC, FMS, Robotics and CIM.

INDUSTRIAL ENGINEERING

Product Design and Development: Principles of good product design, component and tolerance design; efficiency, quality and cost considerations; product life cycle; standardization, simplification, diversification, value analysis, concurrent engineering.

Engineering Economy and Costing: Financial statements; elementary cost accounting, methods of depreciation; break-even analysis, techniques for evaluation of capital investments.

Work System Design: Taylor's scientific management, Gilbreths's contributions; productivity concepts and measurements; method study, micro-motion study, principles of motion economy; human factors engineering, ergonomics; work measurement - time study, PMTS, work sampling; job evaluation, merit rating, wage administration, incentive systems; business process reengineering.

Logistics and Facility Design: Facility location factors, evaluation of alternatives, types of plant layout, evaluation; computer aided layout; assembly line balancing; material handling systems; supply chain management.

Production Planning and Inventory Control: Inventory Function costs, classifications - deterministic and probabilistic models; quantity discount; safety stock; inventory control system; Forecasting techniques - causal and time series models, moving average, exponential smoothing; trend and seasonality; aggregate production planning; master scheduling; bill of materials and material requirement planning; order control and flow control, routing, scheduling and priority dispatching; JIT; Kanban PULL systems; bottleneck scheduling and theory of constraints.

Operation Research: Linear programming - problem formulation, simplex method, duality and sensitivity analysis; transportation; assignment; network flow models, constrained optimization and Lagrange multipliers; simple queuing models; dynamic programming; simulation; PERT and CPM, time-cost trade-off, resource leveling.

Quality Control: Taguchi method; design of experiments; quality costs, statistical quality assurance, process control charts, acceptance sampling, zero defects; quality circles, total quality management.

Reliability and Maintenance: Reliability, availability and maintainability; probabilistic failure and repair times; system reliability; preventive maintenance and replacement, TPM.

Management Information System: Value of information; information storage and retrieval system - database and data structures; interactive systems; knowledge based systems.

Intellectual Property System: Definition of intellectual property, importance of IPR; TRIPS, and its implications, WIPO and Global IP structure, and IPS in India; patent, copyright, industrial design and trademark; meanings, rules and procedures, terms, infringements and remedies.

PY - PHARMACEUTICAL SCIENCES

Natural Products: Pharmacognosy & Phytochemistry - Chemistry, tests, isolation, characterization and estimation of phytopharmaceuticals belonging to the group of Alkaloids, Glycosides, Terpenoids, Steroids, Bioflavanoids, Purines, Guggul lipids. Pharmacognosy of crude drugs which contain the above constituents. Standardisation of raw materials and herbal products. WHO guide lines. Quantitative microscopy including modern techniques used for evaluation. Biotechnological principles and techniques for plant development Tissue culture.

Pharmacology: General pharmacological principles including Toxicology. Drug interaction. Pharmacology of drugs acting on Central nervous system, Cardiovascular system, Autonomic nervous system, Gastro intestinal system and Respiratory system. Pharmacology of Autocoids, Hormones, Chemotherapeutic agents including anticancer drugs. Bioassays. Immuno Pharmacology.

Medicinal Chemistry: Structure, nomenclature, classification, synthesis, SAR and metabolism of the following category of drugs which are official in Indian Pharmacopoeia and British Pharmacopoeia Hypnotics and Sedatives, Analgesics, NSAIDS, Neuroleptics, Antidepressants, Anxiolytics, Anticonvulsants, Antihistaminics, Local anaesthetics, Cardio Vascular drugs - Antianginal agents Vasodilators, Adrenergic & cholinergic drugs, Cardiotonic agents, Diuretics, Antihypertensive drugs, Hypoglycemic agents, Antilipedmic agents, Coagulants, Anticoagulants, Antiplatelet agents. Chemotherapeutic agents - Antibiotics, Antibacterials, Sulphadrugs. Antiproliozoal drugs, Antiviral, Antitubercular, Antimalarial, Anticancer, Antiamoebic drugs. Diagnostic agents. Preparation and storage and uses of official Radiopharmaceuticals. Vitamins and Hormones.

Pharmaceutics: Development, manufacturing standards, labeling, packing as per the pharmacopoeal requirements, Storage of different dosage forms and new drug delivery systems. Biopharmaceutics and Pharmacokinetics and their importance in formulation. Formulation and preparation of cosmetics - lipstick, shampoo, creams, nail preparations and dentifrices. Pharmaceutical calculations.

Pharmaceutical Jurisprudence: Legal aspects of manufacture, storage, sale of drugs. D and C act and rules. Pharmacy act.

Pharmaceutical Analysis: Principles, instrumentation and applications of the following. Absorption spectroscopy (UV, visible & IR), Fluorimetry, Flame photometry, Potentiometry, Conductometry and Plarography. Pharmacopoeial assays. Principles of NMR, ESR, Mass spectroscopy, X-ray diffraction analysis and different chromatographic methods.

Biochemistry and Clinical Pharmacy: Biochemical role of hormones, Vitamins, Enzymes, Nucleic acids. Bioenergetics. General principles of immunology. Immunological techniques. Adverse drug interaction.

Microbiology: Principles and methods of microbiological assays of the Pharmacopoeia. Methods of preparation of official sera and vaccines. Serological and diagnostic tests. Applications of microorganisms in Bio Conversions and in Pharmaceutical industry.

TF - TEXTILE ENGINEERING AND FIBRE SCIENCE

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

TEXTILE ENGINEERING & FIBRE SCIENCE

Textile Fibres: Classification of textile fibres according to their nature and origin; general characteristics of textile fibres-their chemical and physical structures and their properties; essential characteristics of fibre forming polymers; uses of natural and man-made fibres; physical and chemical methods of fibre and blend identification and blend analysis.

Melt Spinning processes with special reference to polyamide and polyester fibres; wet and dry spinning of viscose and acrylic fibres; post spinning operations-drawing, heat setting, texturing- false twist and air-jet, tow-to-top conversion. Methods of investigating fibre structure e.g. X-ray diffraction, birefringence, optical and electron microscopy, I.R. absorption, thermal methods; structure and morphology and principal natural and man-made fibres, mechanical properties of fibres, moisture sorption in fibres; fibre structure and property correlation.

Textile Testing: Sampling techniques, sample size and sampling errors; measurement of fibre length, fineness, crimp, strength and reflectance; measurement of cotton fibre maturity ad trash content; HVI and AFIS for fibre testing. Measurement of yarn count, twist and hairiness; tensile testing of fibres, yarn and fabrics; evenness testing of slivers, rovings and yarns; testing equipment for measurement test methods of fabric properties like thickness, compressibility, air permeability, drape, crease recovery, tear strength bursting strength and abrasion resistance. Correlation analysis, significance tests and analysis of variance; frequency distributions and control charts.

Yarn Manufacture and Yarn Structure: Modern methods of opening, cleaning and blending of fibrous materials; the technology of carding with particular reference to modern developments; causes of irregularity introduced by drafting, the development of modern drafting systems; principles and techniques of preparing material for combing; recent development in combers; functions and synchronization of various mechanisms concerned with roving production; forces acting on yarn and traveller, ring and traveller designs; causes of end breakages; properties of doubles yarns; new methods of yarn production such as rotor spinning, air jet spinning and friction spinning.

Yarn diameter; specific volume, packing coefficient; twist-strength relationship; fibre orientation in yarn; fibre migration.

Fabric Manufacture and Fabric Structure: Principles of cheese and cone winding processes and machines; random and precision winding; package faults and their remedies; yarn clearers and tensioners; different systems of yarn splicing; features of modern cone winding machines; different types of warping creels; features of modern beam and sectional warping machines; different sizing systems, sizing of spun and filament yarns, modern sizing machines; principles of pirn winding processes and machines; primary and secondary motions of loom, effect of their settings and timings on fabric formation, fabric appearance and weaving performance; dobby and jacquard shedding; mechanics of weft insertion with shuttle; warp and weft stop motions, warp protection, weft replenishment; functional principles of weft insertion systems of shuttleless weaving machines, principles of multiphase and circular looms. Principles of weft and warp knitting; basic weft and warp knitted structures; classification, production and areas of application of nonwoven fabrics.

Basic woven fabric constructions and their derivatives; crepe, cord, terry, gauze, lino and double cloth constructions.

Peirce's equations for fabric geometry; thickness, cover and maximum sett of woven fabrics

Textile Chemical Processing: Preparatory processes for natural-and and their blends; mercerization of cotton; machines for yarn and fabric mercerization.

Dyeing and printing of natural- and synthetic- fibre fabrics and their blends with different dye classes; dyeing and printing machines; styles of printing; fastness properties of dyed and printed textile materials.

Finishing of textile materials, wash and wear, durable press, soil release, water repellent, flame retardant and antistatic finishes; shrink-resistance finish for wool; heat setting of synthetic-fibre fabrics, finishing machines; energy efficient processes; pollution control.

XE - ENGINERING SCIENCES

The syllabi of the sections of this paper are as follows:

SECTION A. ENGINEERING MATHEMATICS (Compulsory)

Linear Algebra : Determinates, algebra of matrices, rank, inverse, system of linear equations, symmetric, skew-symmetric and orthogonal matrices. Hermitian, skew-hermitian and unitary matrices. eigenvalues and eigenvectors, diagonalisation of matrices, Cayley-Hamiltonian, quadratic forms.

Calculus : Functions of single variables, limit, continuity and differentiability, Mean value theorems, Intermediate forms and L'Hospital rule, Maxima and minima, Taylor's series, Fundamental and mean value-theorems of integral calculus. Evaluation of definite and improper integrals, Beta and Gamma functions, Functions of two variables, limit, continuity, partial derivatives, Euler's theorem for homogeneous functions, total derivatives, maxima and minima, Lagrange method of multipliers, double and triple integrals and their applications, sequence and series, tests for convergence, power series, Fourier Series, Fourier integrals.

Complex variable: Analytic functions, Cauchy's integral theorem and integral formula without proof. Taylor's and Laurent' series, Residue theorem (without proof) with application to the evaluation of real integarls.

Vector Calculus: Gradient, divergence and curl, vector identities, directional derivatives, line, surface and volume integrals, Stokes, Gauss and Green's theorems (without proofs) with applications.

Ordinary Differential Equations: First order equation (linear and nonlinear), higher order linear differential equations with constant coefficients, method of variation of paramaters, Cauchy's and Euler's equations, initial and boundary value problems, power series solutions, Legendre polynomials and Bessel's functions of the first kind.

Partial Differential Equations: Variables separable method, solutions of one dimensional heat, wave and Laplace equations.

Probability and Statistics: Definitions of probability and simple theorems, conditional probability, mean, mode and standard deviation, random variables, discrete and continuous distributions, Poisson, normal and Binomial distribution, correlation and regression

Numerical Methods: L-U decomposition for systems of linear equations,Newton-Raphson method, numerical integration(trapezoidal and Simpson's rule), numerical methods for first order differential equation (Euler method)

SECTION B. COMPUTATIONAL SCIENCE

Numerical Methods: Truncation errors, round off errors and their propagation; Interpolation; Lagrange, Newton's forward, backward and divided difference formulas, least square curve fitting, solution of non-linear equations of one variables using bisection, false position, secant and Newton Raphson methods; Rate of convergence of these methods, general iterative methods. Simple and multiple roots of polynomials. Solutions of system of linear algebraic equations using Gauss elimination methods, Jacobi and Gauss-Seidel iterative methods and their rate of convergence; ill conditioned and well conditioned system. eigen values and eigen vectors using power methods. Numerical integration using trapezoidal, Simpson's rule and other quadrature formulas. Numerical Differentiation. Solution of boundary value problems. Solution of initial value problems of ordinary differential equations using Euler's method, predictor corrector and Runge Kutta method.

Programming : Elementary concepts and terminology of a computer system and system software, Fortran77 and C programming.

Fortran : Program organization, arithmetic statements, transfer of control, Do loops, subscripted variables, functions and subroutines.

C language : Basic data types and declarations, flow of control- iterative statement, conditional statement, unconditional branching, arrays, functions and procedures.

SECTION C. ELECTRICAL SCIENCES

Electric Circuits: Ideal voltage and current sources; RLC circuits, steady state and transient analysis of DC circuits, network theorems; alternating currents and voltages, single-phase AC circuits, resonance; three-phase circuits.

Magnetic circuits: Mmf and flux, and their relationship with voltage and current; transformer, equivalent circuit of a practical transformer, three-phase transformer connections.

Electrical machines: Principle of operation, characteristics, efficiency and regulation of DC and synchronous machines; equivalent circuit and performance of three-phase and single-phase induction motors.

Electronic Circuits: Characteristics of p-n junction diodes, zener diodes, bipolar junction transistors (BJT) and junction field effect transistors (JFET); MOSFET's structure, characteristics, and operations; rectifiers, filters, and regulated power supplies; biasing circuits, different configurations of transistor amplifiers, class A, B and C of power amplifiers; linear applications of operational amplifiers; oscillators; tuned and phase shift types.

Digital circuits: Number systems, Boolean algebra; logic gates, combinational circuits, flip-flops (RS, JK, D and T) counters.

Measuring instruments: Moving coil, moving iron, and dynamometer type instruments; shunts, instrument transformers, cathode ray oscilloscopes; D/A and A/D converters.

SECTION D. FLUID MECHANICS

Fluid Properties: Relation between stress and strain rate for Newtonian fluids

Hydrostatics, buoyancy, manometry

Concept of local and convective accelerations; control volume analysis for mass, momentum and energy conservation.

Differential equations of continuity and momentum (Euler's equation of motion); concept of fluid rotation, stream function, potential function; Bernoulli's equation and its applications.

Qualitative ideas of boundary layers and its separation; streamlined and bluff bodies; drag and lift forces.

Fully-developed pipe flow; laminar and turbulent flows; friction factor; Darcy Weisbach relation; Moody's friction chart; losses in pipe fittings; flow measurements using venturimeter and orifice plates.

Dimensional analysis; similitude and concept of dynamic similarity; importance of dimensionless numbers in model studies.

SECTION E. MATERIALS SCIENCE

Atomic structure and bonding in materials: metals, ceramics and polymers.

Structure of materials: Crystal systems, unit cells and space lattice; determination of structures of simple crystals by X-ray diffraction; Miller indices for planes and directions. Packing geometry in metallic, ionic and covalent solids.

Concept of amorphous, single and polycrystalline structures and their effects on properties of materials.

Imperfections in crystalline solids and their role in influencing various properties.

Fick´s laws of diffusion and applications of diffusion in sintering, doping of semiconductors and surface hardening of metals.

Alloys: solid solution and solubility limit. Binary phase diagram, intermediate phases and intermetallic compounds; iron-iron carbide phase diagram. Phase transformation in steels. Cold and hot working of metals, recovery, recrystallization and grain growth.

Properties and applications of ferrous and nonferrous alloys.

Structure, properties, processing and applications of traditional and advanced ceramics.

Polymers: classification, polymerization, structure and properties, additives for polymer products, processing and application.

Composites: properties and application of various composites.

Corrosion and environmental degradation of materials (metals, ceramics and polymers).

Mechanical properties of materials: Stress-strain diagrams of metallic, ceramic and polymeric materials, modulus of elasticity, yield strength, plastic deformation and toughness, tensile strength and elongation at break; viscoelasticity, hardness, impact strength. ductile and brittle fracture. creep and fatigue properties of materials.

Heat capacity, thermal conductivity, thermal expansion of materials.

Concept of energy band diagram for materials; conductors, semiconductors and insulators in terms of energy bands. Electrical conductivity, effect of temperature on conductivity in materials, intrinsic and extrinsic semiconductors, dielectric properties of materials.

Refraction, reflection, absorption and transmission of electromagnetic radiation in solids.

Origin of magnetism in metallic and ceramic materials, paramagnetism, diamagnetism, antiferromagnetism, ferromagnetism, ferrimagnetism in materials and magnetic hysteresis.

Advanced materials: Smart materials exhibiting ferroelectric, piezoelectric, optoelectronic, semiconducting behaviour; lasers and optical fibers; photoconductivity and superconductivity in materials.

SECTION F. SOLID MECHANICS

Equivalent force systems; free-body diagrams; equilibrium equations; analysis of determinate and indeterminate trusses and frames; friction.

Simple relative motion of particles; force as function of position, time and speed; force acting on a body in motion; laws of motion; law of conservation of energy; law of conservation of momentum

Stresses and strains; principal stresses and strains; Mohr's circle; generalized Hooke's Law; equilibrium equations; compatibility conditions; yield criteria.

Axial, shear and bending moment diagrams; axial, shear and bending stresses; deflection (for symmetric bending); torsion in circular shafts; thin cylinders; energy methods (Castigliano's Theorems); Euler buckling.

SECTION G. THERMODYNAMICS

Basic Concepts: Continuum, macroscopic approach, thermodynamic system (closed and open or control volume); thermodynamic properties and equilibrium; state of a system, state diagram, path and process; different modes of work; Zeroth law of thermodynamics; concept of temperature; heat.

First Law of Thermodynamics: Energy, enthalpy, specific heats, first law applied to systems and control volumes, steady and unsteady flow analysis.

Second Law of Thermodynamics: Kelvin-Planck and Clausius statements, reversible and irreversible processes, Carnot theorems, thermodynamic temperature scale, Clausius inequality and concept of entropy, principle of increase of entropy; availability and irreversibility.

Properties of Pure Substances: Thermodynamic properties of pure substances in solid, liquid and vapour phases, P-V-T behaviour of simple compressible substances, phase rule, thermodynamic property tables and charts, ideal and real gases, equations of state, compressibility chart.

Thermodynamic Relations: T-ds relations, Maxwell equations, Joule-Thomson coefficient, coefficient of volume expansion, adiabatic and isothermal compressibilities, Clapeyron equation.

Ideal Gas Mixtures: Dalton's and Amagat's laws, calculations of properties, air-water vapour mixtures.

XL - LIFE SCIENCES

The syllabi of the Sections of this paper are as follows:

SECTION H. CHEMISTRY (Compulsory)

Atomic structure and periodicity: Quantum chemistry; Planck's quantum theory, wave particle duality, uncertainty principle, quantum mechanical model of hydrogen atom; electronic configuration of atoms; periodic table and periodic properties; ionization energy, election affinity, electronegativity, atomic size.

Structure and bonding: Ionic and covalent bonding M.O. and V.B. approaches for diatomic molecules, VSEPR theory and shape of molecules, hybridisation, resonance, dipole moment, structure parameters such as bond length, bond angle and bond energy, hydrogen bonding, van der Waals interactions. Ionic solids; ionic radii, lattice energy (Born-Haber Cycle).

s.p. and d Block Elements: Oxides, halides and hydrides of alkali and alkaline earth metals, B, Al, S, N, P and S, silicones, general characteristics of 3d elements, coordination complexes: valence bond and crystal field theory, color, geometry and magnetic properties.

Chemical Equilibria: Colligative properties of solutions, ionic equilibria in solution, solubility product, common ion effect, hydrolysis of salts, pH, buffer and their applications in chemical analysis.

Electrochemistry: Conductance, Kohlrausch law, Half Cell potentials, emf, Nernst equation, galvanic cells, thermodynamic aspects and their applications.

Reaction Kinetics: Rate constant, order of reaction, molecularity, activation energy, zero, first and second order kinetics, equilibrium constants (Kc, Kp and Kx) for homogeneous reactions, catalysis and elementary enzyme reactions.

Thermodynamics: First law, reversible and irreversible processes, internal energy, enthalpy, Kirchoff's equation, heat of reaction, Hess law, heat of formation, Second law, entropy, free energy, and work function. Gibbs-Helmholtz equation, Clausius-Clapeyron equation, free energy change and equilibrium constant, Troutons rule, Third law of thermodynamics.

Mechanistic Basis of Organic Reactions: Elementary treatment of SN1, SN2, E1 and E2 reactions, Hoffmann and Saytzeff rules, Addition reactions, Markonikoff rule and Kharash effect, Diels-Alder reaction, aromatic electrophilic substitution, orientation effect as exemplified by various functional groups.

Structure-Reactivity Correlations: Acids and bases, electronic and steric effects, optical and geometrical isomerism, tautomerism, concept of aromaticity

SECTION I. BIOCHEMISTRY

Organization of life. Importance of water. Cell structure and organelles. Structure and function of biomolecules: Carbohydrates, Lipids, Proteins and Nucleic acids. Biochemical separation techniques. Spectroscopic methods; UV-visible and fluorescence. Protein structure, folding and function: Myoglobin, Hemoglobin, Lysozyme, ribonuclease A, Carboxypeptidase and Chymotrypsin. Enzyme kinetics and regulation, Coenzymes.

Metabolism and bioenergitics. Generation and utilization of ATP. Photosynthesis. Major metabolic pathways and their regulation. Biological membranes. Transport across membranes. Signal transduction; hormones and neurotransmitters.

DNA replication, transcription and translation. Biochemical regulation of gene expression. Recombinant DNA technology and applications. Genomics and Proteomics.

The immune system. Active and passive immunity. Complement system. Antobody structure, function and diversity. Cells of the immune system: T, B and macrophages. T and B cell activation. Major histocompatibilty complex. T cell receptor. Immunological techniques: Immunodiffusion, immunoelectrophoresis, RIA and ELISA.

SECTION J. BIOTECHNOLOGY

Recombinant DNA technology for the production of therapeutic proteins. Micro array technology. Heterologous protein expression systems in bacteria, yeast etc.

Architecture of plant genome; plant tissue culture techniques; methods of gene transfer into plant cells; manipulation of phenotypic traits in plants; plant cell fermentations and production of secondary metabolites using suspension/ immobilized cell culture; methods for plant micro propagation; crop improvement and development of transgenic plants. Expression of animal proteins in plants.

Animal cell metabolism and regulation; cell cycle; primary cell culture; nutritional requirements for animal cell culture; techniques for the mass culture of animal cell lines; production of vaccines; growth hormones and interferons using animal cell culture; cytokines-production and therapeutic uses; hybridoma technology; vectors for gene transfer and expression in animal cells. Transgenic animals and molecular pharming.

Microbial production of industrial enzymes; methods for immobilization of enzymes; kinetics of soluble and immobilized enzymes; application of soluble and immobilized enzymes; enzyme-based sensors.

Microbial growth kinetics; batch, fed batch and continuous culture of microbial cells; media for industrial fermentations; sterilization of air and media; design features and operation of stirred tank, air-lift and fluidized bed reactors; aeration and agitation in aerobic fermentations; recovery and purification of fermentation products- filtration, centrifugation, cell disintegration, solvent extraction and chromatographic separations; industrial fermentations for the production of ethanol, citric acid, lysine, penicillin and other biomolecules; simple calculations based on material and energy balance of fermentation processes; application of microbes in the management of domestic and industrial wastes.

SECTION K. BOTANY

Anatomy: Roots, stem and leaves of land plants, meristems, vascular system, their ontogeny, structure and functions. Plant cell structure, organisation, organelles, cytoskeleton, cell wall and membranes.

Development: Cell cycle, cell division, senescence, hormonal regulation of growth; life cycle of an angiosperm, pollination, fertilization, embryogenesis, seed formation, seed storage proteins, seed dormancy and germination. Concept of cellular totipotency, organogenesis and somatic embryogenesis, somaclonal variation, embryo culture, in vitro fertilization.

Physiology and Biochemistry: Plant water relations, transport of minerals and solutes, N2 metabolism, proteins and nucleic acid, respiration, photophysiology, photosynthesis, photorespiration; biosynthesis, mechanism of action and physiological effects of plant growth regulators.

Genetics: Principles of Mendelian inheritance, linkage, recombination and genetic mapping; extrachromosomal inheritance; eukaryotic genome organization (chromatin structure) and regulation of gene expression, gene mutation, chromosome aberrations (numerical and structural), transposons.

Plant Breeding: Principles, methods - selection, hybridization, heterosis; male sterility, self and inter-specific incompatibility; haploidy; somatic cell hybridization; molecular marker-assisted selection; gene transfer methods viz. direct and vector-mediated, transgenic plants and their applications in agriculture.

Economic Botany: Economically important plants - cereals, pulses, plants yielding fiber, timber, sugar, beverages, oils, rubber, dyes, gums, drugs and narcotics - a general account.

Systematics: Systems of classification (non-phylogenetic vs. phylogenetic - outline), plant groups, molecular systematics.

Plant Pathology: Nature and classification of plant diseases, diseases of important crops caused by fungi, bacteria and viruses, and their control measures, mechanism(s) of pathogenesis and resistance, molecular detection of pathogens; plant-microbe beneficial interactions.

Ecology and Plant Geography: Ecosystems - types, dynamics, degradation, ecological succession; food chains; vegetation types of the world; pollution and global warming; speciation and extinction, conservation strategies, cryopreservation.

SECTION L. MICROBIOLOGY

Historical perspective - Discovery of the microbial world; Controversy over spontaneous generation; Role of microorganisms in transformation of organic matter and in the causation of diseases.

Methods in microbiology - Pure culture techniques; Theory and practice of sterilization; Principles of microbial nutrition; Construction of culture media; Enrichment culture techniques for isolation of chemoautotrophs, chemoheterotrophs and photosynthetic microorganisms.

Microbial evolution, systematics and taxonomy - Evolution of earth and earliest life forms; Primitive organisms and their metabolic strategies; New approaches to bacterial taxonomic classification including ribotyping; Nomenclature.

Microbial diversity - Bacteria, archea and their broad classification; Eukaryotic microbes, yeast, fungi, slime mold and protozoa; Viruses and their classification.

Microbial growth -The definition of growth, mathematical expression of growth, growth curve, measurement of growth and growth yields; Synchronous growth; Continuous culture.

Nutrition and metabolism - Overview of metabolism; Microbial nutrition; Energy classes of microorganisms; Culture media; Energetics, modes of ATP generation; ATP generation by heterotrophs; Fermentation; Glycolysis; Respiration; The citric acid cycle; Electron transport systems; Alternate modes of energy generation; Pathways (anabolism) in the biosynthesis of amino acids, purines, pyrimidines and fatty acids.

Metabolic diversity among microorganisms - Photosynthesis in microorganisms; Role of chlorophylls, carotenoids and phycobilins; Calvin cycle; Chemolithotrophy; Hydrogen- iron-nitrite-oxidizing bacteria; Nitrate and sulfate reduction; Methanogenesis and acetogenesis.

Prokaryotic cells: structure-function - Cells walls of eubacteria (peptidoglycan) and related molecules; Outer-membrane of gram-negative bacteria; Cell wall and cell membrane synthesis; Flagella and motility; Cell inclusions like endospores, gas vesicles.

Microbial diseases and host parasite relationships - Normal microflora of skin; Oral cavity; Gastrointestinal tract; Entry of pathogens into the host; Infectious disease transmission; Respiratory infections caused by bacteria and viruses; Tuberculosis; Sexually transmitted diseases including AIDS; Diseases transmitted by animals (Rabies, plague), insects and ticks (rikettsias, Lyme disease, malaria); Food and water borne diseases; Public health and water quality; Pahtogenic fungi; Emerging and resurgent infectious diseases.

Chemotherapy/Antibiotics - Antimicrobial agents; Sulfa drugs; Antibiotics; Pencillins and cephalosporins; Broad-spectrum antibiotics; Antibiotics from prokaryotes; Antifungal antibiotics; Mode of action; Resistance to antibiotics.

Microbial genetics - Genes, mutation and mutagenesis - UV and chemical mutagnes; Types of mutations; Ames test for mutagenesis; Methods of genetic analysis. Bacterial genetic system - Transformation; Conjugation; Transduction; Recombination; Plasmids and Transposons; Bacterial genetic map with reference to E. coli. Viruses and their genetic system - Phage ? and its life cycle; RNA phages; RNA viruses; Retroviruses; Genetic systems of yeast and Neurospora; Extrachromosomal inheritance and mitochondrial genetics; Basic concept of genomics.

SECTION M. ZOOLOGY

Animal world: Animal diversity, distribution, systematic and classification of animals, the phylogenetic relationship.

Evolution: Origin of life, history of life on earth, evolutionary theories, natural selection, adaptation, speciation.

Genetics: Principles of inheritance, molecular basis of heredity, the genetic material, transmission of genetic material, mutations, cytoplasmic inheritance.

Biochemistry and Molecular Biology: Nucleic acids, proteins and other biological macromolecules. Replication, transcription and translation, regulation of gene expression, organization of genome, Kreb's cycle, glycolysis, enzyme catalysis, hormones and their action.

Cell Biology: Structure of cell, cellular organelles and their structure and function, cell cycle, cell division, cellular differentiation, chromosome and chromatin structure. Eukaryotic gene organisation and expression.

Animal Anatomy and Physiology: Comparative physiology, the respiratory system, circulatory system, digestive system, the nervous system, the excretory system, the endocrine system, the reproductive system, the skeletal system, osmoregulation.

Parasitology and Immunology: Nature of parasite, host-parasite relation, protozoan and helminthic parasites, the immune response, cellular and humoral immune response, evolution of the immune system.

Development Biology: Embryonic development, cellular differentiation, organogenesis, metamorphosis, genetic basis of development.

Ecology: The ecosystem, habitats the food chain, population dynamics, species diversity, zoogeography, biogeochemical cycles, conservation biology.

Animal Behaviour: Types of behaviours, courtship, mating and territoriality, instinct, learning and memory, social behaviour across the animal taxa, communication, pheromones, evolution of animal behaviour.

IT - INFORMATION TECHNOLOGY

ENGINEERING MATHEMATICS

Mathematical Logic: Propositional Logic; First Order Logic.

Probability: Conditional Probability; Mean, Median, Mode and Standard Deviation; Random Variables; Distributions; uniform, normal, exponential, Poisson, Binomial.

Set Theory & Algebra: Sets; Relations; Functions; Groups; Partial Orders; Lattice; Boolean Algebra.

Combinatorics: Permutations; Combinations; Counting; Summation; generating functions; recurrence relations; asymptotics.

Graph Theory: Connectivity; spanning trees; Cut vertices & edges; covering; matching; independent sets; Colouring; Planarity; Isomorphism.

Linear Algebra: Algebra of matrices, determinants, systems of linear equations, Eigen values and Eigen vectors.

Numerical Methods: LU decomposition for systems of linear equations; numerical solutions of non linear algebraic equations by Secant, Bisection and Newton-Raphson Methods; Numerical integration by trapezoidal and Simpson's rules.

Calculus: Limit, Continuity & differentiability, Mean value Theorems, Theorems of integral calculus, evaluation of definite & improper integrals, Partial derivatives, Total derivatives, maxima & minima.

FORMAL LANGUAGES AND AUTOMATA

Regular Languages: finite automata, regular expressions, regular grammar.

Context free languages: push down automata, context free grammars

COMPUTER HARDWARE

Digital Logic: Logic functions, minimization, design and synthesis of combinatorial and sequential circuits, number representation and computer arithmetic (fixed and floating point)

Computer organization: Machine instructions and addressing modes, ALU and data path, hardwired and microprogrammed control, memory interface, I/O interface (interrupt and DMA mode), serial communication interface, instruction pipelining, cache, main and secondary storage

SOFTWARE SYSTEMS

Data structures and Algorithms: the notion of abstract data types, stack, queue, list, set, string, tree, binary search tree, heap, graph, tree and graph traversals, connected components, spanning trees, shortest paths, hashing, sorting, searching, design techniques (greedy, dynamic, divide and conquer), asymptotic analysis (best, worst, average cases) of time and space, upper and lower bounds, intractability

Programming Methodology: C programming, program control (iteration, recursion, functions), scope, binding, parameter passing, elementary concepts of object oriented programming

Operating Systems (in the context of Unix): classical concepts (concurrency, synchronization, deadlock), processes, threads and interprocess communication, CPU scheduling, memory management, file systems, I/O systems, protection and security

Information Systems and Software Engineering: information gathering, requirement and feasibility analysis, data flow diagrams, process specifications, input/output design, process life cycle, planning and managing the project, design, coding, testing, implementation, maintenance.

Databases: relational model, database design, integrity constraints, normal forms, query languages (SQL), file structures (sequential, indexed), b-trees, transaction and concurrency control

Data Communication: data encoding and transmission, data link control, multiplexing, packet switching, LAN architecture, LAN systems (Ethernet, token ring), Network devices: switches, gateways, routers

Networks: ISO/OSI stack, sliding window protocols, routing protocols, TCP/UDP, application layer protocols & systems (http, smtp, dns, ftp), network security

Web technologies: three tier web based architecture; JSP, ASP, J2EE, .NET systems; html, XML

AG - AGRICULTURAL ENGINEERING

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

FARM MACHINERY AND POWER:

Sources of power on the farm-human, animal, mechanical, electrical, wind, solar and biomass;

design and selection of machine elements - gears, pulleys, chains and sprockets and belts; overload safety devices used in farm machinery; measurement of force, torque, speed, displacement and acceleration on machine elements.

Soil tillage; forces acting on a tillage tool; hitch systems and hitching of tillage implements; functional requirements, principles of working, construction and operation of manual, animal and power operated equipment for tillage. sowing, planting, fertilizer application, inter-cultivation, spraying, mowing, chaff cutting, harvesting, threshing and transport; testing of agricultural machinery and equipment; calculation of performance parameters -field capacity, efficiency, application rate and losses; cost analysis of implements and tractors.

Thermodynamic principles of I.C. engines; I.C. engine cycles; engine components; fuels and combustion; lubricants and their properties; I.C. engine systems - fuel, cooling, lubrication, ignition, electrical, intake and exhaust; selection, operation, maintenance and repair of I.C. engines; power efficiencies and measurement; calculation of power, torque, fuel consumption, heat load and power losses.

Tractors and power tillers - type, selection, maintenance and repair; tractor clutches and brakes; power transmission systems - gear trains, differential, final drives and power take-off; mechanics of tractor chassis; traction theory; three point hitches- free link and restrained link operations; mechanical steering and hydraulic control systems used in tractors; human engineering and safety in tractor design; tractor tests and performance.

SOIL AND WATER CONSERVATION ENGINEERING:

Ideal and real fluids, properties of fluids; hydrostatic pressure and its measurement; hydrostatic forces on plane and curved surface; continuity equation; Bernoulli's theorem; laminar and turbulent flow in pipes, Darcy-Weisbach and Hazen-Williams equations, Moody's diagram; flow through orifices and notches; flow in open channels.

Engineering properties of soils, fundamental definitions and relationships; index properties of soils; permeability and seepage analysis; shear strength, Mohr's circle of stresses; active and passive earth pressures; stability of slopes.

Hydrological cycle; precipitation measurement, analysis of precipitation data; abstraction from precipitation; runoff; hydrograph analysis, unit hydrograph theory and application; stream flow measurement; flood routing, hydrological reservoir and channel routing.

Mechanics of soil erosion, factors affecting erosion; soil loss estimation; biological and engineering measures to control erosion, terraces and bunds; vegetative waterways; gully control structures, drop, drop inlet and chute spillways; farm ponds; earthen dams; principles of watershed management.

Water requirement of crops; consumptive use and evapo-transpiration; irrigation scheduling; irrigation efficiencies; design of prismatic and silt loaded channels; methods of irrigation water application; design and evaluation of irrigation methods; drainage coefficient; surface and subsurface drainage systems; leaching requirement and salinity control; irrigation and drainage water quality; classification of pumps; pump characteristics; pump selection; types of aquifer; evaluation of aquifer properties; well hydraulics; ground water recharge.

AGRICULTURAL PROCESSING AND FOOD ENGINEERING:

Steady state heat transfer in conduction, convection and radiation; transient heat transfer in simple geometry; condensation and boiling heat transfer; working principles of heat exchangers; diffusive and convective mass transfer; simultaneous heat and mass transfer in agricultural processing operations.

Material and energy balances in food processing systems; water activity, sorption and desorption isotherms; centrifugal separation of solids, liquids and gases; kinetics of microbial death - pasteurisation and sterilization of liquid foods; preservation of food by cooling and freezing; psychrometry - properties of air-vapour mixture; concentration and dehydration of liquid foods - evaporators, tray, drum and spray dryers.

Mechanics and energy requirement in size reduction of granular solids; particle size analysis for comminuted solids; size separation by screening; fluidisation of granular solids; cleaning and grading efficiency and effectiveness of grain cleaners; conditioning and hydrothermal treatments for grains; dehydration of food grains; processes and machines for processing of cereals, pulses and oilseeds; design considerations for grain silos.

AR - ARCHITECTURE AND PLANNING

City planning: Historical development of cities; principles of city planning; new towns; survey methods, site planning, planning regulations and building bye-laws.

Housing: Concept of shelter; housing policies and design; community planning; role of government agencies; finance and management.

Landscape Design: Principles of landscape design and site planning; history and landscape styles; landscape elements and materials; planting design.

Computer Aided Design: Application of computers in architecture and planning; understanding elements of hardware and software; computer graphics; programming languages - C and Visual Basic and usage of packages such as AutoCAD.

Environmental and Building Science: Elements of environmental science; ecological principles concerning environment; role of micro-climate in design; climatic control through design elements; thermal comfort; elements of solar architecture; principles of lighting and illumination; basic principles of architectural acoustics; air pollution, noise pollution and their control.

Visual and Urban Design: Principles of visual composition; proportion, scale, rhythm, symmetry, harmony, balance, form and colour; sense of place and space, division of space; focal point, vista, imageability, visual survey.

History of Architecture: Indian - Indus valley, Vedic, Buddhist, Indo-Aryan, Dravidian and Mughal periods; European - Egyptian, Greek, Roman, medieval and renaissance periods.

Development of Contemporary Architecture: Architectural developments and impacts on society since industrial revolution; influence of modern art on architecture; works of national and international architects; post modernism in architecture.

Building Services: Water supply, Sewerage and Drainage systems; Sanitary fittings and fixtures; principles of electrification of buildings; elevators, their standards and uses; air-conditioning systems; fire fighting systems.

Building Construction and Management: Building construction techniques, methods and details; building systems and prefabrication of building elements; principles of modular coordination; estimation, specification, valuation, professional practice; project management, PERT, CPM.

Materials and Structural Systems: Behavioural characteristics of all types of building materials e.g. mud, timber, bamboo, brick, concrete, steel, glass, FRP; principles of strength of materials; design of structural elements in wood, steel and RCC; elastic and limit state design; complex structural systems; principles of pre-stressing.

Planning Theory: Planning process; multilevel planning; comprehensive planning; central place theory; settlement pattern; land use and land utilization.

Techniques of Planning: Planning surveys; Preparation of urban and regional structure plans, development plans, action plans; site planning principles and design; statistical methods; application of remote sensing techniques in urban and regional planning.

Traffic and Transportation Planning: Principles of traffic engineering and transportation planning; methods of conducting surveys; design of roads, intersections and parking areas; hierarchy of roads and levels of services; traffic and transport management in urban areas; traffic safety and traffic laws; public transportation planning; modes of transportation.

Services and Amenities: Principles and design of water supply systems, sewerage systems, solid waste disposal systems, power supply and communication systems; Health, education, recreation and demography related standards at various levels of the settlements.

Development Administration and Management: Planning laws; development control and zoning regulations; laws relating to land acquisition; development enforcements, land ceiling; regional and urban plan preparations; planning and municipal administration; taxation, revenue resources and fiscal management; public participation and role of NGO.

CE - CIVIL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

STRUCTURAL ENGINEERING

Mechanics: Bending moments and shear forces in statically determinate beams; simple stress and strain: relationship; stress and strain in two dimensions, principal stresses, stress transformation, Mohr's circle; simple bending theory; flexural shear stress; thin-walled pressure vessels; uniform torsion.

Structural Analysis: Analysis of statically determinate trusses, arches and frames; displacements in statically determinate structures and analysis of statically indeterminate structures by force/energy methods; analysis by displacement methods (slope-deflection and moment-distribution methods); influence lines for determinate and indeterminate structures; basic concepts of matrix methods of structural analysis.

Concrete Structures: Basic working stress and limit states design concepts; analysis of ultimate load capacity and design of members subject to flexure, shear, compression and torsion (beams, columns and isolated footings); basic elements of prestressed concrete: analysis of beam sections at transfer and service loads.

Steel Structures: Analysis and design of tension and compression members, beams and beam-columns, column bases; connections - simple and eccentric, beam-column connections, plate girders and trusses; plastic analysis of beams and frames.

GEOTECHNICAL ENGINEERING

Soil Mechanics: Origin of soils; soil classification; three-phase system, fundamental definitions, relationship and inter-relationships; permeability and seepage; effective stress principle: consolidation, compaction; shear strength.

Foundation Engineering: Sub-surface investigation - scope, drilling bore holes, sampling, penetrometer tests, plate load test; earth pressure theories, effect of water table, layered soils; stability of slopes - infinite slopes, finite slopes; foundation types - foundation design requirements; shallow foundations; bearing capacity, effect of shape, water table and other factors, stress distribution, settlement analysis in sands and clays; deep foundations - pile types, dynamic and static formulae, load capacity of piles in sands and clays.

WATER RESOURCES ENGINEERING

Fluid Mechanics and Hydraulics: Hydrostatics, applications of Bernoulli equation, laminar and turbulent flow in pipes, pipe networks; concept of boundary layer and its growth; uniform flow, critical flow and gradually varied flow in channels, specific energy concept, hydraulic jump; forces on immersed bodies; flow measurement in channels; tanks and pipes; dimensional analysis and hydraulic modeling. Applications of momentum equation, potential flow, kinematics of flow; velocity triangles and specific speed of pumps and turbines.

Hydrology: Hydrologic cycle; rainfall; evaporation infiltration, unit hydrographs, flood estimation, reservoir design, reservoir and channel routing, well hydraulics.

Irrigation: Duty, delta, estimation of evapo-transpiration; crop water requirements; design of lined and unlined canals; waterways; head works, gravity dams and Ogee spillways. Designs of weirs on permeable foundation, irrigation methods.

ENVIRONMENTAL ENGINEERING

Water requirements; quality and standards, basic unit processes and operations for water treatment, distribution of water. Sewage and sewerage treatment: quantity and characteristic of waste water sewerage; primary and secondary treatment of waste water; sludge disposal; effluent discharge standards.

TRANSPORTATION ENGINEERING

Highway planning; geometric design of highways; testing and specifications of paving materials; design of flexible and rigid pavements.

CH - CHEMICAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative,

Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

CHEMICAL ENGINEERING

Process Calculations and Thermodynamics: Laws of conservation of mass and energy; use of tie components; recycle, bypass and purge calculations; degree of freedom analysis.

First and Second laws of thermodynamics and their applications; equations of state and thermodynamic properties of real systems; phase equilibria; fugacity, excess properties and correlations of activity coefficients; chemical reaction equilibria.

Fluid Mechanics and Mechanical Operations: Fluid statics, Newtonian and non-Newtonian fluids, Bernoulli equation, Macroscopic friction factors, energy balance, dimensional analysis, shell balances, flow through pipeline systems, flow meters, pumps and compressors, packed and fluidized beds, elementary boundary layer theory, size reduction and size separation; free and hindered settling; centrifuge and cyclones; thickening and classification, filtration, mixing and agitation; conveying of solids.

Heat Transfer: Conduction, convection and radiation, heat transfer coefficients, steady and unsteady heat conduction, boiling, condensation and evaporation; types of heat exchangers and evaporators and their design.

Mass Transfer: Fick's law, molecular diffusion in fluids, mass transfer coefficients, film, penetration and surface renewal theories; momentum, heat and mass transfer analogies; stagewise and continuous contacting and stage efficiencies; HTU & NTU concepts design and operation of equipment for distillation, absorption, leaching, liquid-liquid extraction, crystallization, drying, humidification, dehumidification and adsorption.

Chemical Reaction Engineering: Theories of reaction rates; kinetics of homogeneous reactions, interpretation of kinetic data, single and multiple reactions in ideal reactors, non-ideal reactors; residence time; non-isothermal reactors; kinetics of heterogeneous catalytic reactions; diffusion effects in catalysis.

Instrumentation and Process Control: Measurement of process variables; sensors, transducers and their dynamics, dynamics of simple systems, dynamics such as CSTRs, transfer functions and responses of simple systems, process reaction curve, controller modes (P, PI, and PID); control valves; analysis of closed loop systems including stability, frequency response (including Bode plots) and controller tuning, cascade, feed forward control.

Plant Design and Economics: Design and sizing of chemical engineering equipment such as compressors, heat exchangers, multistage contactors; principles of process economics and cost estimation including total annualized cost, cost indexes, rate of return, payback period, discounted cash flow, optimization in Design.

Chemical Technology: Inorganic chemical industries; sulfuric acid, NaOH, fertilizers (Ammonia, Urea, SSP and TSP); natural products industries (Pulp and Paper, Sugar, Oil, and Fats); petroleum refining and petrochemicals; polymerization industries; polyethylene, polypropylene, PVC and polyester synthetic fibers.

CS - COMPUTER SCIENCE AND ENGINEERING

ENGINEERING MATHEMATICS

Mathematical Logic: Propositional Logic; First Order Logic.

Probability: Conditional Probability; Mean, Median, Mode and Standard Deviation; Random Variables; Distributions; uniform, normal, exponential, Poisson, Binomial.

Set Theory & Algebra: Sets; Relations; Functions; Groups; Partial Orders; Lattice; Boolean Algebra.

Combinatorics: Permutations; Combinations; Counting; Summation; generating functions; recurrence relations; asymptotics.

Graph Theory: Connectivity; spanning trees; Cut vertices & edges; covering; matching; independent sets; Colouring; Planarity; Isomorphism.

Linear Algebra: Algebra of matrices, determinants, systems of linear equations, Eigen values and Eigen vectors.

Numerical Methods: LU decomposition for systems of linear equations; numerical solutions of non linear algebraic equations by Secant, Bisection and Newton-Raphson Methods; Numerical integration by trapezoidal and Simpson's rules.

Calculus: Limit, Continuity & differentiability, Mean value Theorems, Theorems of integral calculus, evaluation of definite & improper integrals, Partial derivatives, Total derivatives, maxima & minima.

THEORY OF COMPUTATION

Formal Languages and Automata Theory: Regular languages and finite automata, Context free languages and Push-down automata, Recursively enumerable sets and Turing machines, Un-decidability;

Analysis of Algorithms and Computational Complexity: Asymptotic analysis (best, worst, average case) of time and space, Upper and lower bounds on the complexity of specific problems, NP-completeness.

COMPUTER HARDWARE

Digital Logic: Logic functions, Minimization, Design and synthesis of Combinational and Sequential circuits; Number representation and Computer Arithmetic (fixed and floating point);

Computer Organization: Machine instructions and addressing modes, ALU and Data-path, hardwired and micro-programmed control, Memory interface, I/O interface (Interrupt and DMA mode), Serial communication interface, Instruction pipelining, Cache, main and secondary storage.

SOFTWARE SYSTEMS

Data structures: Notion of abstract data types, Stack, Queue, List, Set, String, Tree, Binary search tree, Heap, Graph;

Programming Methodology: C programming, Program control (iteration, recursion, Functions), Scope, Binding, Parameter passing, Elementary concepts of Object oriented, Functional and Logic Programming;

Algorithms for problem solving: Tree and graph traversals, Connected components, Spanning trees, Shortest paths; Hashing, Sorting, Searching; Design techniques (Greedy, Dynamic Programming, Divide-and-conquer);

Compiler Design: Lexical analysis, Parsing, Syntax directed translation, Runtime environment, Code generation, Linking (static and dynamic); Operating Systems: Classical concepts (concurrency, synchronization, deadlock), Processes, threads and Inter-process communication, CPU scheduling, Memory management, File systems, I/O systems, Protection and security.

Databases: Relational model (ER-model, relational algebra, tuple calculus), Database design (integrity constraints, normal forms), Query languages (SQL), File structures (sequential files, indexing, B+ trees), Transactions and concurrency control;

Computer Networks: ISO/OSI stack, sliding window protocol, LAN Technologies (Ethernet, Token ring), TCP/UDP, IP, Basic concepts of switches, gateways, and routers.

CH - CHEMISTRY

PHYSICAL CHEMISTRY

Structure: Quantum theory - principles and techniques; applications to particle in a box, harmonic oscillator, rigid rotor and hydrogen atom; valence bond and molecular orbital theories and Huckel approximation, approximate techniques: variation and perturbation; symmetry, point groups; rotational, vibrational, electronic, NMR and ESR spectroscopy.

Equilibrium: First law of thermodynamics, heat, energy and work; second law of thermodynamics and entropy; third law and absolute entropy; free energy; partial molar quantities; ideal and non-ideal solutions; phase transformation: phase rule and phase diagrams- one, two, and three component systems; activity, activity coefficient, fugacity and fugacity coefficient ; chemical equilibrium, response of chemical equilibrium to temperature and pressure; colligative properties; kinetic theory of gases; thermodynamics of electrochemical cells; standard electrode potentials: applications - corrosion and energy conversion; molecular partition function (translational, rotational, vibrational and electronic).

Kinetics: Rates of chemical reactions, theories of reaction rates, collision and transition state theory; temperature dependence of chemical reactions; elementary reactions, consecutive elementary reactions; steady state approximation, kinetics of photochemical reactions and free radical polymerization, homogenous and heterogeneous catalysis.

INORGANIC CHEMISTRY

Non-Transition Elements: General characteristics, structure and reactions of simple and industrially important compounds, boranes, carboranes, silicates, silicones, diamond and graphite; hydrides, oxides and oxoacids of N, P, S and halogens; boron nitride, borazines and phosphazenes; xenon compounds. Shapes of molecules, hard-soft acid base concept.

Transition Elements: General characteristics of d and f block elements; coordination chemistry: structure and isomerism, stability, theories of metal-ligand bonding (CFT and LFT), electronic spectra and magnetic properties of transition metal complexes and lanthanides; metal carbonyls, metal-metal bonds and metal atom clusters, metallocenes; transition metal complexes with bonds to hydrogen, alkyls, alkenes, and arenes; metal carbenes; use of organometallic compounds as catalysts in organic synthesis; mechanisms of substitution and electron transfer reactions of coordination complexes. Role of metals with special reference to Na, K, Mg, Ca, Fe, Co, Zn, and Mo in biological systems.

Solids: Crystal systems and lattices, Miller planes, crystal packing, crystal defects; Bragg's Law; ionic crystals, band theory, metals and semiconductors. Spinels.

Instrumental methods of analysis: atomic absorption, UV-visible spectrometry, chromatographic and electro-analytical methods.

ORGANIC CHEMISTRY

Synthesis, reactions and mechanisms involving the following: Alkenes, alkynes, arenes, alcohols, phenols, aldehydes, ketones, carboxylic acids and their derivatives; halides, nitro compounds and amines; stereochemical and conformational effects on reactivity and specificity; reactions with diborane and peracids. Michael reaction, Robinson annulation, reactivity umpolung, acyl anion equivalents; molecular rearrangements involving electron deficient atoms.

Photochemistry: Basic principles, photochemistry of olefins, carbonyl compounds, arenes, photo oxidation and reduction.

Pericyclic reactions: Cycloadditions, electrocyclic reactions, sigmatropic reactions; Woodward-Hoffmann rules.

Heterocycles: Structural properties and reactions of furan, pyrrole, thiophene, pyridine, indole.

Biomolecules: Structure, properties and reactions of mono- and di-saccharides, physico-chemical properties of amino acids, structural features of proteins and nucleic acids.

Spectroscopy: Principles and applications of IR, UV-visible, NMR and mass spectrometry in the determination of structures of organic compounds.

EC - ELECTRONICS AND COMMUNICATION ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix Algebra, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Mean value theorems, Theorems of integral calculus, Evaluation of definite and improper integrals, Partial Derivatives, Maxima and minima, Multiple integrals, Fourier series. Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equation (linear and nonlinear), Higher order linear differential equations with constant coefficients, Method of variation of parameters, Cauchy's and Euler's equations, Initial and boundary value problems, Partial Differential Equations and variable separable method.

Complex variables: Analytic functions, Cauchy's integral theorem and integral formula, Taylor's and Laurent' series, Residue theorem, solution integrals.

Probability and Statistics: Sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Discrete and continuous distributions, Poisson, Normal and Binomial distribution, Correlation and regression analysis.

Numerical Methods: Solutions of non-linear algebraic equations, single and multi-step methods for differential equations.

Transform Theory: Fourier transform, Laplace transform, Z-transform.

ELECTRONICS & COMMUNICATION ENGINEERING

Networks: Network graphs: matrices associated with graphs; incidence, fundamental cut set and fundamental circuit matrices. Solution methods: nodal and mesh analysis. Network theorems: superposition, Thevenin and Norton's maximum power transfer, Wye-Delta transformation. Steady state sinusoidal analysis using phasors. Linear constant coefficient differential equations; time domain analysis of simple RLC circuits, Solution of network equations using Laplace transform: frequency domain analysis of RLC circuits. 2-port network parameters: driving point and transfer functions. State equations for networks.

Electronic Devices: Energy bands in silicon, intrinsic and extrinsic silicon. Carrier transport in silicon: diffusion current, drift current, mobility, resistivity. Generation and recombination of carriers. p-n junction diode, Zener diode, tunnel diode, BJT, JFET, MOS capacitor, MOSFET, LED, p-I-n and avalanche photo diode, LASERs. Device technology: integrated circuits fabrication process, oxidation, diffusion, ion implantation, photolithography, n-tub, p-tub and twin-tub CMOS process.

Analog Circuits: Equivalent circuits (large and small-signal) of diodes, BJTs, JFETs, and MOSFETs. Simple diode circuits, clipping, clamping, rectifier. Biasing and bias stability of transistor and FET amplifiers. Amplifiers: single-and multi-stage, differential, operational, feedback and power. Analysis of amplifiers; frequency response of amplifiers. Simple op-amp circuits. Filters. Sinusoidal oscillators; criterion for oscillation; single-transistor and op-amp configurations. Function generators and wave-shaping circuits. Power supplies.

Digital circuits: Boolean algebra, minimization of Boolean functions; logic gates digital IC families (DTL, TTL, ECL, MOS, CMOS). Combinational circuits: arithmetic circuits, code converters, multiplexers and decoders. Sequential circuits: latches and flip-flops, counters and shift-registers. Sample and hold circuits, ADCs, DACs. Semiconductor memories. Microprocessor(8085): architecture, programming, memory and I/O interfacing.

Signals and Systems: Definitions and properties of Laplace transform, continuous-time and discrete-time Fourier series, continuous-time and discrete-time Fourier Transform, z-transform. Sampling theorems. Linear Time-Invariant (LTI) Systems: definitions and properties; casuality, stability, impulse response, convolution, poles and zeros frequency response, group delay, phase delay. Signal transmission through LTI systems. Random signals and noise: probability, random variables, probability density function, autocorrelation, power spectral density.

Controls Systems: Basic control system components; block diagrammatic description, reduction of block diagrams. Open loop and closed loop (feedback) systems and stability analysis of these systems. Signal flow graphs and their use in determining transfer functions of systems; transient and steady state analysis of LTI control systems and frequency response. Tools and techniques for LTI control system analysis: root loci, Routh-Hurwitz criterion, Bode and Nyquist plots. Control system compensators: elements of lead and lag compensation, elements of Proportional-Integral-Derivative(PID) control. State variable representation and solution of state equation of LTI control systems.

Communications: Analog communication systems: amplitude and angle modulation and demodulation systems, spectral analysis of these operations, superheterodyne receivers; elements of hardware, realizations of analog communication systems; signal-to-noise ratio (SNR) calculations for amplitude modulation (AM) and frequency modulation (FM) for low noise conditions. Digital communication systems: pulse code modulation (PCM), differential pulse code modulation (DPCM), delta modulation (DM); digital modulation schemes-amplitude, phase and frequency shift keying schemes (ASK, PSK, FSK), matched filter receivers, bandwith consideration and probability of error calculations for these schemes.

Electromagnetics: Elements of vector calculus: divergence and curl; Gauss' and Stokes' theorems, Maxwell's equations: differential and integral forms. Wave equation, Poynting vector. Plane waves: propagation through various media; reflection and refraction; phase and group velocity; skin depth. Transmission lines: characteristic impedance; impedance transformation; Smith chart; impedance matching; pulse excitation. Waveguides: modes in rectangular waveguides; boundary conditions; cut-off frequencies; dispersion relations. Antennas: Dipole antennas; antenna arrays; radiation pattern; reciprocity theorem, antenna gain.

EE - ELECTRICAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix Algebra, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Mean value theorems, Theorems of integral calculus, Evaluation of definite and improper integrals, Partial Derivatives, Maxima and minima, Multiple integrals, Fourier series. Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equation (linear and nonlinear), Higher order linear differential equations with constant coefficients, Method of variation of parameters, Cauchy's and Euler's equations, Initial and boundary value problems, Partial Differential Equations and variable separable method.

Complex variables: Analytic functions, Cauchy's integral theorem and integral formula, Taylor's and Laurent' series, Residue theorem, solution integrals.

Probability and Statistics: Sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Discrete and continuous distributions, Poisson, Normal and Binomial distribution, Correlation and regression analysis.

Numerical Methods: Solutions of non-linear algebraic equations, single and multi-step methods for differential equations.

Transform Theory: Fourier transform, Laplace transform, Z-transform.

ELECTRICAL ENGINEERING

Electrical Circuits and Fields: Network graph, KCL, KVL, node/ cut set, mesh/ tie set analysis, transient response of d.c. and a.c. networks; sinusoidal steady-state analysis; resonance in electrical circuits; concepts of ideal voltage and current sources, network theorems, driving point, immittance and transfer functions of two port networks, elementary concepts of filters; three phase circuits; Fourier series and its application; Gauss theorem, electric field intensity and potential due to point, line, plane and spherical charge distribution, dielectrics, capacitance calculations for simple configurations; Ampere's and Biot-Savart's law, inductance calculations for simple configurations.

Electrical Machines: Single phase transformer - equivalent circuit, phasor diagram, tests, regulation and efficiency; three phase transformers - connections, parallel operation; auto transformer and three-winding transformer; principles of energy conversion, windings of rotating machines: D. C. generators and motors - characteristics, starting and speed control, armature reaction and commutation; three phase induction motors-performance characteristics, starting and speed control; single-phase induction motors; synchronous generators-performance, regulation, parallel operation; synchronous motors - starting, characteristics, applications, synchronous condensers; fractional horse power motors; permanent magnet and stepper motors.

Power Systems: Electric power generation - thermal, hydro, nuclear; transmission line parameters; steady-state performance of overhead transmission lines and cables and surge propagation; distribution systems, insulators, bundle conductors, corona and radio interference effects; per-unit quantities; bus admittance and impedance matrices; load flow; voltage control and power factor correction; economic operation; symmetrical components, analysis of symmetrical and unsymmetrical faults; principles of over current, differential and distance protections; concept of solid state relays and digital protection; circuit breakers; concept of system stability-swing curves and equal area criterion; basic concepts of HVDC transmission.

Control Systems: Principles of feedback; transfer function; block diagrams: steady-state errors; stability-Routh and Nyquist criteria; Bode plots; compensation; root loci; elementary state variable formulation; state transition matrix and response for Linear Time Invariant systems.

Electrical and Electronic Measurements: Bridges and potentiometers, PMMC, moving iron, dynamometer and induction type instruments; measurement of voltage, current, power, energy and power factor; instrument transformers; digital voltmeters and multimeters; phase, time and frequency measurement; Q-meter, oscilloscopes, potentiometric recorders, error analysis.

Analog and Digital Electronics: Characteristics of diodes, BJT, FET, SCR; amplifiers-biasing, equivalent circuit and frequency response; oscillators and feedback amplifiers, operational amplifiers- characteristics and applications; simple active filters; VCOs and timers; combinational and sequential logic circuits, multiplexer, Schmitt trigger, multivibrators, sample and hold circuits, A/D and D/A converters; microprocessors and their applications.

Power Electronics and Electric Drives: Semiconductor power devices-diodes, transistors, thyristors, triacs, GTOs, MOSFETs and IGBTs - static characteristics and principles of operation; triggering circuits; phase control rectifiers; bridge converters-fully controlled and half controlled; principles of choppers and inverters, basic concepts of adjustable speed dc and ac drives.

GG - GEOLOGY AND GEOPHYSICS

PART - I

Earth and planetary system; size, shape, internal structure and composition of the earth; atmosphere and greenhouse effect; isostasy; elements of seismology; continents and continental processes; physical oceanography; palaeomagnetism, continental drift plate tectonics, geothermal energy.

Weathering; soil formation; action of river, wind and glacier; oceans and oceanic features; earthquakes, volcanoes, orogeny and mountain building; elements of structural geology; crystallography; classification, composition and properties of minerals and rocks; engineering properties of rocks and soils, role of geology in the construction of engineering structures.

Processes of ore formation, occurrence and distribution of ores on land and on ocean floor; coal and petroleum resources in India; ground water geology including well hydraulics, geological time scale and geochronology; stratigraphic principles and stratigraphy of India; basics concepts of gravity, magnetic and electrical prospecting for ores and ground water.

PART - IIA: GEOLOGY

Crystal symmetry, forms, twinning; crystal chemistry; optical mineralogy, classification of minerals, diagnostic properties of rock minerals.

Mineralogy, structure, texture and classification of igneous, sedimentary and metamorphic rock, their origin and evolution; application of thermodynamics; structure and petrology of sedimentary rocks; sedimentary processes and environments, sedimentary facies, basin studies; basement cover relationship;

Primary and secondary structures; geometry and genesis of folds, faults, joints, unconformities, cleavage, schistosity and lineation; methods of projection. Tectonites and their significance; shear zone; superposed folding.

Morphology, classification and geological significance of important invertebrates, vertebrates, microfossils and palaeoflora; stratigraphic principles and Indian stratigraphy; geomorphic processes and agents; development and evolution of landforms; slope and drainage; processes on deep oceanic and near-shore regions; quantitative and applied geomorphology; air photo interpretation and remote sensing; chemical and optical properties of ore minerals; formation and localization of ore deposits; prospecting and exploration of economic minerals; coal and petroleum geology; origin and distribution of mineral and fuel deposits in India; ore dressing and mineral economics.

Cosmic abundance; meteorites; geochemical evolution of the earth; geochemical cycles; distribution of major, minor and trace elements; isotope geochemistry; geochemistry of waters including solution equilibria and water rock interaction.

Engineering properties of rocks and soils; rocks as construction material; geology of dams, tunnels and excavation sites; natural hazards; the fly ash problem; ground water geology and exploration; water quality; impact of human activity; Remote sensing techniques for the interpretation of landforms and resource management.

PART - II B: GEOPHYSICS

The earth as a planet; different motions of the earth; gravity filed of the earth and its shape; geochronology; isostasy, seismology and interior of the earth; variation of density, velocity, pressure, temperature, electrical and magnetic properties inside the earth; earthquakes-causes and measurements; zonation and seismic hazards; geomagnetic field, palaeomagnetism; oceanic and continental lithosphere; plate tectonics; heat flow; upper and lower atmospheric phenomena.

Theories of scalar and vector potential fields; Laplace, Maxwell and Helmholtz equations for solution of different types of boundary value problems for Cartesian, cylindrical and spherical polar coordinates; Green's theorem; Image theory; integral equations and conformal transformations in potential theory; Eikonal equation and ray theory.

'G' and 'g' units of measurement, density of rocks, gravimeters, preparation, analysis and interpretation of gravity maps; derivative maps, analytical continuation; gravity anomaly type curves; calculation of mass.

Earth's magnetic field, units of measurement, magnetic susceptibility of rocks, magnetometers, corrections, preparation of magnetic maps, magnetic anomaly type curve, analytical continuation, interpretation and application; magnetic well logging.

Conduction of electricity through rocks, electrical conductivities of metals, metallic, non-metallic and rock forming minerals, D.C. resistivity units and methods of measurement, electrode configuration for sounding and profiling, application of filter theory, interpretation of resistivity field data, application; self potential origin, classification, field measurement, interpretation of induced polarization time frequency, phase domain; IP units and methods of measurement, interpretation and application; ground-water exploration.

Origin of electromagnetic field elliptic polarization, methods of measurement for different source-receiver configuration components in EM measurements, interpretation and applications; earth's natural electromagnetic field, tellurics, magneto-tellurics; geomagnetic depth sounding principles, methods of measurement, processing of data and interpretation.

Seismic methods of prospecting: Reflection, refraction and CDP surveys; land and marine seismic sources, generation and propagation of elastic waves, velocity increasing with depth, geophones, hydrophones, recording instruments (DFS), digital formats, field layouts, seismic noises and noise profile analysis, optimum geophone grouping, noise cancellation by shot and geophone arrays, 2D and 3D seismic data acquisition and processing, CDP stacking charts, binning, filtering, dip-moveout, static and dynamic corrections, deconvolution, migration, signal processing, Fourier and Hilbert transforms, attribute analysis, bright and dim spots, seismic stratigraphy, high resolution seismics, VSP.

Principles and techniques of geophysical well-logging, SP, resistivity, induction, micro gamma ray, neutron, density, sonic, temperature, dip meter, caliper, nuclear magnetic, cement bond logging. Quantitative evaluation of formations from well logs; well hydraulics and application of geophysical methods for groundwater study; application of bore hole geophysics in ground water, mineral and oil exploration. Remote sensing techniques and application of remote sensing methods in geophysics.

IN - INSTRUMENTATION ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix Algebra, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Mean value theorems, Theorems of integral calculus, Evaluation of definite and improper integrals, Partial Derivatives, Maxima and minima, Multiple integrals, Fourier series. Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equation (linear and nonlinear), Higher order linear differential equations with constant coefficients, Method of variation of parameters, Cauchy's and Euler's equations, Initial and boundary value problems, Partial Differential Equations and variable separable method.

Complex variables: Analytic functions, Cauchy's integral theorem and integral formula, Taylor's and Laurent' series, Residue theorem, solution integrals.

Probability and Statistics: Sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Discrete and continuous distributions, Poisson, Normal and Binomial distribution, Correlation and regression analysis.

Numerical Methods: Solutions of non-linear algebraic equations, single and multi-step methods for differential equations.

Transform Theory: Fourier transform, Laplace transform, Z-transform.

INSTRUMENTATION ENGINEERING

Measurement Basics and Metrology: Static and dynamic characteristics of measurement systems. Standards and calibration. Error and uncertainty analysis, statistical analysis of data, and curve fitting. Linear and angular measurements; Measurement of straightness, flatness, roundness and roughness.

Transducers, Mechanical Measurements and Industrial Instrumentation: Transducers - elastic, resistive, inductive, capacitive, thermo-electric, piezoelectric, photoelectric, electro-mechanical, electro-chemical, and ultrasonic. Measurement of displacement, velocity (linear and rotational), acceleration, shock, vibration, force, torque, power, strain, stress, pressure, flow, temperature, humidity, viscosity, and density. energy storing elements, suspension systems and dampers.

Analog Electronics: Characteristics of diodes, BJTs, JFETs and MOSFETs; Diode circuits; Amplifiers: single and multi-stage, feedback; Frequency response; Operational amplifiers - design, characteristic, linear and non-linear applications: difference amplifiers; instrumentation amplifiers; precision rectifiers, I-to-V converters, active filters, oscillators, comparators, signal generators, wave shaping circuits.

Digital Electronics: Combinational logic circuits, minimization of Boolean functions; IC families (TTL, MOS, CMOS), arithmetic circuits, multiplexer and decoders. Sequential circuits: flip-flops, counters, shift registers. Schmitt trigger, timers, and multivibrators. Analog switches, multiplexers, S/H circuits. Analog-to-digital and digital-to-analog converters. Basics of computer organization and architecture. 8-bit microprocessor (8085), applications, memory, I/O interfacing, and microcontrollers.

Signals and Systems: Vectors and matrices; Fourier series; Fourier transforms; Ordinary differential equations. Impulse and frequency responses of first and second order systems. Laplace transform and transfer function, convolution and correlation. Amplitude and frequency modulations and demodulations. Discrete time systems, difference equations, impulse and frequency responses; Z-transforms and transfer functions; IIR and FIR filters.

Electrical and Electronic Measurements: Measurement of R, L and C; bridges and potentiometers. Measurement of voltage, current, power, power factor, and energy; Instrument transformers; Q meter, waveform analyzers. Digital volt-meters and multi-meters. Time, phase and frequency measurements; Oscilloscope. Noise and interference in instrumentation.

Control Systems & Process Control: Principles of feedback; transfer function, signal flow graphs. Stability criteria, Bode plots, root-loci, Routh and Nyquist criteria. Compensation techniques; State space analysis. System components: mechanical, hydraulic, pneumatic, electrical and electronic; Servos and synchros; Stepper motors. On-off, cascade, P, PI, PID and feed-forward controls. Controller tuning and general frequency response.

Analytical, Optical and Biomedical Instrumentation: Principles of spectrometry, UV, visible, IR mass spectrometry, X-ray methods; nuclear radiation measurements, gas, solid and semi conductor lasers and their characteristics, interferometers, basics of fibre optics, transducers in biomedical applications, cardiovascular system measurements, instrumentation for clinical laboratory.

MA - MATHEMATICS

Linear Algebra: Finite dimensional vector spaces. Linear transformations and their matrix representations, rank; systems of linear equations, eigenvalues and eigenvectors, minimal polynomial, Cayley-Hamilton theorem, diagonalisation, Hermitian, Skew-Hermitian and unitary matrices. Finite dimensional inner product spaces, self-adjoint and Normal linear operators, spectral theorem, Quadratic forms.

Complex Analysis: Analytic functions, conformal mappings, bilinear transformations, complex integration: Cauchy's integral theorem and formula, Liouville's theorem, maximum modulus principle, Taylor and Laurent's series, residue theorem and applications for evaluating real integrals.

Real Analysis: Sequences and series of functions, uniform convergence, power series, Fourier series, functions of several variables, maxima, minima, multiple integrals, line, surface and volume integrals, theorems of Green, Stokes and Gauss; metric spaces, completeness, Weierstrass approximation theorem, compactness. Lebesgue measure, measurable functions; Lebesgue integral, Fatou's lemma, dominated convergence theorem.

Ordinary Differential Equations: First order ordinary differential equations, existence and uniqueness theorems, systems of linear first order ordinary differential equations, linear ordinary differential equations of higher order with constant coefficients; linear second order ordinary differential equations with variable coefficients, method of Laplace transforms for solving ordinary differential equations, series solutions; Legendre and Bessel functions and their orthogonality, Sturm Liouville system, Greeen's functions.

Algebra: Normal subgroups and homomorphisms theorems, automorphisms. Group actions, sylow's theorems and their applications groups of order less than or equal to 20, Finite p-groups. Euclidean domains, Principal ideal domains and unique factorizations domains. Prime ideals and maximal ideals in commutative rings.

Functional Analysis: Banach spaces, Hahn-Banach theorems, open mapping and closed graph theorems, principle of uniform boundedness; Hilbert spaces, orthonormal sets, Riesz representation theorem, self-adjoint, unitary and normal linear operators on Hilbert Spaces.

Numerical Analysis: Numerical solution of algebraic and transcendental equations; bisection, secant method, Newton-Raphson method, fixed point iteration, interpolation: existence and error of polynomial interpolation, Lagrange, Newton, Hermite(osculatory)interpolations; numerical differentiation and integration, Trapezoidal and Simpson rules; Gaussian quadrature; (Gauss-Legendre and Gauss-Chebyshev), method of undetermined parameters, least square and orthonormal polynomial approximation; numerical solution of systems of linear equations: direct and iterative methods, (Jacobi Gauss-Seidel and SOR) with convergence; matrix eigenvalue problems: Jacobi and Given's methods, numerical solution of ordinary differential equations: initial value problems, Taylor series method, Runge-Kutta methods, predictor-corrector methods; convergence and stability.

Partial Differential Equations: Linear and quasilinear first order partial differential equations, method of characteristics; second order linear equations in two variables and their classification; Cauchy, Dirichlet and Neumann problems, Green's functions; solutions of Laplace, wave and diffusion equations in two variables Fourier series and transform methods of solutions of the above equations and applications to physical problems.

Mechanics: Forces in three dimensions, Poinsot central axis, virtual work, Lagrange's equations for holonomic systems, theory of small oscillations, Hamiltonian equations;

Topology: Basic concepts of topology, product topology, connectedness, compactness, countability and separation axioms, Urysohn's Lemma, Tietze extension theorem, metrization theorems, Tychonoff theorem on compactness of product spaces.

Probability and Statistics: Probability space, conditional probability, Bayes' theorem, independence, Random variables, joint and conditional distributions, standard probability distributions and their properties, expectation, conditional expectation, moments. Weak and strong law of large numbers, central limit theorem. Sampling distributions, UMVU estimators, sufficiency and consistency, maximum likelihood estimators. Testing of hypotheses, Neyman-Pearson tests, monotone likelihood ratio, likelihood ratio tests, standard parametric tests based on normal, X2 ,t, F-distributions. Linear regression and test for linearity of regression. Interval estimation.

Linear Programming: Linear programming problem and its formulation, convex sets their properties, graphical method, basic feasible solution, simplex method, big-M and two phase methods, infeasible and unbounded LPP's, alternate optima. Dual problem and duality theorems, dual simplex method and its application in post optimality analysis, interpretation of dual variables. Balanced and unbalanced transportation problems, unimodular property and u-v method for solving transportation problems. Hungarian method for solving assignment problems.

Calculus of Variations and Integral Equations: Variational problems with fixed boundaries; sufficient conditions for extremum, Linear integral equations of Fredholm and Volterra type, their iterative solutions. Fredholm alternative.

ME - MECHANICAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

APPLIED MECHANICS AND DESIGN

Engineering Mechanics: Equivalent force systems, free-body concepts, equations of equilibrium, trusses and frames, virtual work and minimum potential energy. Kinematics and dynamics of particles and rigid bodies, impulse and momentum (linear and angular), energy methods, central force motion.

Strength of Materials: Stress and strain, stress-strain relationship and elastic constants, Mohr's circle for plane stress and plane strain, shear force and bending moment diagrams, bending and shear stresses, deflection of beams, torsion of circular shafts, thin and thick cylinders, Euler's theory of columns, strain energy methods, thermal stresses.

Theory of Machines: Displacement, velocity and acceleration, analysis of plane mechanisms, dynamic analysis of slider-crank mechanism, planar cams and followers, gear tooth profiles, kinematics of gears, governors and flywheels, balancing of reciprocating and rotating masses.

Vibrations: Free and forced vibration of single degree freedom systems, effect of damping, vibration isolation, resonance, critical speed of rotors.

Design of Machine Elements: Design for static and dynamic loading, failure theories, fatigue strength; design of bolted, riveted and welded joints; design of shafts and keys; design of spur gears, rolling and sliding contact bearings; brakes and clutches; belt, rope and chain drives.

FLUID MECHANICS AND THERMAL SCIENCES

Fluid Mechanics: Fluid properties, fluid statics, manometry, buoyancy; control-volume analysis of mass, momentum and energy; fluid acceleration; differential equations of continuity and momentum; Bernoulli's equation; viscous flow of incompressible fluids; boundary layer; elementary turbulent flow; flow through pipes, head losses in pipes, bends etc.

Heat-Transfer: Modes of heat transfer; one dimensional heat conduction, resistance concept, electrical analogy, unsteady heat conduction, fins; dimensionless parameters in free and forced convective heat transfer, various correlations for heat transfer in flow over flat plates and through pipes; thermal boundary layer; effect of turbulence; radiative heat transfer, black and grey surfaces, shape factors, network analysis; heat exchanger performance, LMTD and NTU methods.

Thermodynamics: Zeroth, First and Second laws of thermodynamics; thermodynamic system and processes; irreversibility and availability; behaviour of ideal and real gases, properties of pure substances, calculation of work and heat in ideal processes; analysis of thermodynamic cycles related to energy conversion; Carnot, Rankine, Otto, Diesel, Brayton and vapour compression cycles.

Power Plant Engineering: Steam generators; steam power cycles; steam turbines; impulse and reaction principles, velocity diagrams, pressure and velocity compounding; reheating and reheat factor; condensers and feed heaters.

I.C. Engines: Requirements and suitability of fuels in IC engines, fuel ratings, fuel-air mixture requirements; normal combustion in SI and CI engines; engine performance calculations.

Refrigeration and air-conditioning: Refrigerant compressors, expansion devices, condensers and evaporators; properties of moist air, psychrometric chart, basic psychometric processes.

Turbomachinery: Components of gas turbines; compression processes, centrifugal and axial flow compressors; axial flow turbines, elementary theory; hydraulic turbines; Euler-turbine equation; specific speed, Pelton-wheel, Francis and Kaplan turbines; centrifugal pumps.

MANUFACTURING AND INDUSTRIAL ENGINEERING

Engineering Materials: Structure and properties of engineering materials and their applications, heat treatment.

Metal Casting: Casting processes (expendable and non-expendable) -pattern, moulds and cores, heating and pouring, solidification and cooling, gating design, design considerations, defects.

Forming Processes: Stress-strain diagrams for ductile and brittle material, Plastic deformation and yield criteria, fundamentals of hot and cold working processes, Bulk metal forming processes (forging, rolling, extrusion, drawing), sheet metal working processes (punching, blanking, bending, deep drawing, coining, spinning, load estimation using homogeneous deformation methods, defects). processing of powder metals- atomization, compaction, sintering, secondary and finishing operations. forming and shaping of plastics- extrusion, injection moulding.

Joining Processes: Physics of welding, fusion and non-fusion welding processes, brazing and soldering, adhesive bonding, design considerations in welding, weld quality defects.

Machining and Machine Tool Operations: Mechanics of machining, single and multi-point cutting tools, tool geometry and materials, tool life and wear, cutting fluids, machinability, economics of machining, non-traditional machining processes.

Metrology and Inspection: Limits, fits and tolerances, linear and angular measurements, comparators, gauge design, interferometry, form and finish measurement, measurement of screw threads, alignment and testing methods.

Tool Engineering: Principles of work holding, design of jigs and fixtures.

Computer Integrated Manufacturing: Basic concepts of CAD, CAM and their integration tools.

Manufacturing Analysis: Part-print analysis, tolerance analysis in manufacturing and assembly, time and cost analysis.

Work-Study: Method study, work measurement, time study, work sampling, job evaluation, merit rating.

Production Planning and Control: Forecasting models, aggregate production planning, master scheduling, materials requirements planning.

Inventory Control: Deterministic and probabilistic models, safety stock inventory control systems.

Operations Research: Linear programming, simplex and duplex method, transportation, assignment, network flow models, simple queuing models, PERT and CPM

MN - MINING ENGINEERING

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

MINING ENGINEERING

Mechanics: Equivalent force systems, equations of equilibrium, two dimensional frames and trusses, free body diagrams, friction forces, particle kinematics and dynamics.

Mine Development, Geomechanics and Strata Control: Drivages for underground mine development, drilling methods and machines, explosives, blasting devices and practices, shaft sinking. Physico-mechanical properties of rocks, rock mass classification, ground control instrumentation and stress measurement techniques, theories of rock failure, ground vibrations, stress distribution around mine openings, subsidence, design of supports in roadways and workings, stability of open pits, slopes.

Mining Methods and Machinery: Surface mining - layout, development, loading, transportation and mechanization, continuous surface mining systems. Underground coal mining - bord and pillar system, longwall mining, thick seam mining methods. Underground metal mining: different stoping methods, stope mechanization, ore handling systems, mine filling. Generation and transmission of mechanical, hydraulic, and pneumatic power. Materials handling - haulages, conveyors, ropeways, face and development machinery, hoisting systems, and pumps.

Ventilation, Underground Hazards and Surface Environment: Underground atmosphere, heat load sources and thermal environment, air cooling, mechanics of air flow distribution, natural and mechanical ventilation, mine fans and their usage, auxiliary ventilation. Subsurface hazards from fires, explosions, gases, dust, and inundation, rescue apparatus and practices, safety in mines, accident analysis, noise, mine lighting. Air and water pollution: causes, dispersion, quality standards, and control.

Surveying, Mine Planning and Systems Engineering: Fundamentals of engineering surveying, Levels and levelling, Theodolite, tacheometry, triangulation, contouring, errors and adjustments, correlation, underground surveying, curves, photogrammetry, field astronomy, GPS fundamentals. Principles of planning - Sampling methods and practices, reserve estimation techniques, basics of geostatistics, optimization of facility location, cash flow concepts and mine valuation, open pit design. Work study, concepts of reliability, reliability of series and parallel systems. Linear programming, transportation and assignment problems, queueing, network analysis, inventory control.

MT - METALLURGICAL ENGINEERING

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

METALLURGICAL ENGINEERING

Thermodynamics and Rate Processes: Laws of thermodynamics, activity, equilibrium constant, applications to metallurgical systems, solutions, phase equilibria, basic kinetic laws, order of reactions, rate constants and rate limiting steps principles of electro chemistry, aqueous, corrosion and protection of metals, oxidation and high temperature corrosion - characterization and control; momentum transfer - concepts of viscosity, shell balances, Bernoulli's equation; heat transfer - conduction, convection and heat transfer coefficient relations, radiation, mass transfer - diffusion and Fick's laws.

Extractive Metallurgy: Flotation, gravity and other methods of mineral processing; agglomeration, pyro-hydro-and electro-metallurgical processes; material and energy balances; principles and processes for the extraction of non-ferrous metals - aluminium, copper, zinc, lead, magnesium, nickel, titanium and other rare metals; iron and steel making - principles, blast furnace, direct reduction processes, primary and secondary steel making, deoxidation and inclusion in steel; ingot and continuous casting; stainless steel making, design of furnaces; fuels and refractories.

Physical Metallurgy: Crystal structure and bonding characteristics of metals, alloys, ceramics and polymers; solid solutions; solidification; phase transformation and binary phase diagrams; principles of heat treatment of steels, aluminum alloys and cast irons; recovery, recrystallization and grain growth; industrially important ferrous and non-ferrous alloys; elements of X-ray and electron diffraction; principles of scanning and transmission electron microscopy; elements of ceramics, composites and electronic materials; electronic basis of thermal, optical, electrical and magnetic properties of materials.

Mechanical Metallurgy: Elements of elasticity and plasticity; defects in crystals; elements of dislocation theory - types of dislocations, slip and twinning, stress fields of dislocations, dislocation interactions and reactions, methods of seeing dislocations; strengthening mechanisms; tensile, fatigue and creep behaviour; superplasticity; fracture - Griffith theory, ductile to brittle transition, fracture toughness; failure analysis; mechanical testing - tension, compression, torsion, hardness, impact, creep, fatigue, fracture toughness and formability tests.

Manufacturing Processes: Metal casting - patterns, moulds, melting, gating, feeding and casting processes, defects and castings, hot and cold working of metals; Metal forming - fundamentals of metal forming, rolling wire drawing, extrusion, forming, sheet metal forming processes, defects in forming; Metal joining - soldering, brazing and welding, common welding processes, welding metallurgy, problems associated with welding of steels and aluminium alloys, defects in welding, powder metallurgy; NDT methods - ultrasonic, radiography, eddy current, acoustic emission and magnetic.

PH - PHYSICS

Mathematical Physics: Linear vector space, matrices; vector calculus; linear differential equations; elements of complex analysis; Laplace transforms, Fourier analysis, elementary ideas about tensors.

Classical Mechanics: Conservation laws; central forces; collisions and scattering in laboratory and centre of mass reference frames; mechanics of system of particles; rigid body dynamics; moment of inertia tensor; noninertial frames and pseudo forces; variational principle; Lagrange's and Hamilton's formalisms; equation of motion, cyclic coordinates, Poisson bracket; periodic motion, small oscillations, normal modes; wave equation and wave propagation; special theory of relativity - Lorentz transformations, relativistic kinematics, mass-energy equivalence.

Electromagnetic Theory: Laplace and Poisson equations; conductors and dielectrics; boundary value problems; Ampere's and Biot-Savart's laws; Faraday's law; Maxwell's equations; scalar and vector potentials; Coulomb and Lorentz gauges; boundary conditions at interfaces; electromagnetic waves; interference, diffraction and polarization; radiation from moving charges.

Quantum Mechanics: Physical basis of quantum mechanics; uncertainty principle; Schrodinger equation; one and three dimensional potential problems; Particle in a box, harmonic oscillator, hydrogen atom; linear vectors and operators in Hilbert space; angular momentum and spin; addition of angular momentum; time independent perturbation theory; elementary scattering theory.

Atomic and Molecular Physics: Spectra of one-and many-electron atoms; LS and jj coupling; hyperfine structure; Zeeman and Stark effects; electric dipole transitions and selection rules; X-ray spectra; rotational and vibrational spectra of diatomic molecules; electronic transition in diatomic molecules, Franck-Condon principle; Raman effect; NMR and ESR; lasers.

Thermodynamics and Statistical Physics: Laws of thermodynamics; macrostates, phase space; probability ensembles; partition function, free energy, calculation of thermodynamic quantities; classical and quantum statistics; degenerate Fermi gas; black body radiation and Planck's distribution law; Bose-Einstein condensation; first and second order phase transitions, critical point.

Solid State Physics: Elements of crystallography; diffraction methods for structure determination; bonding in solids; elastic properties of solids; defects in crystals; lattice vibrations and thermal properties of solids; free electron theory; band theory of solids; metals, semiconductors and insulators; transport properties; optical, dielectric and magnetic properties of solids; elements of superconductivity.

Nuclear and Particle Physics: Rutheford scattering; basic properties of nuclei; radioactive decay; nuclear forces; two nucleon problem; nuclear reactions; conservation laws; fission and fusion; nuclear models; particle accelerators, detectors; elementary particles; photons, baryons, mesons and leptons; Quark model.

Electronics: Network analysis; semiconductor devices; bipolar transistors; FETs; power supplies, amplifier, oscillators; operational amplifiers; elements of digital electronics; logic circuits.

PI - PRODUCTION AND INDUSTRIAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

GENERAL ENGINEERING:

Engineering Materials: Structure and properties of engineering materials and their applications; effect of strain, strain rate and temperature on mechanical properties of metals and alloys; heat treatment of metals and alloys.

Applied Mechanics: Engineering mechanics - equivalent force systems, free body concepts, equations of equilibrium, virtual work and minimum potential energy; strength of materials-stress, strain and their relationship, Mohr's circle, deflection of beams, bending and shear stress, Euler's theory of columns.

Theory of Machines and Design: Analysis of planar mechanisms, plane cams and followers; governers and fly wheels; design of elements-failure theories; design of bolted, riveted and welded joints; design of shafts, keys, belt drives, brakes and clutches.

Thermal Engineering: Fluid machines - fluid statics, Bernoulli's equation, flow through pipes, equations of continuity and momentum; Thermodynamics - zeroth, First and Second laws of thermodynamics, thermodynamic system and processes, calculation of work and heat for systems and control volumes; Heat transfer - fundamentals of conduction, convection and radiation.

PRODUCTION ENGINEERING

Metal Casting: Casting processes; patterns-materials; allowances; moulds and cores -

materials, making and testing; melting and founding of cast iron, steels and nonferrous metals and alloys; solidification; design of casting, gating and risering; casting defects and inspection.

Metal working: Stress-strain in elastic and plastic deformation; deformation mechanisms; hot and cold working-forging, rolling, extrusion, wire and tube drawing; sheet metal working; analysis of rolling, forging, extrusion and wire /rod drawing; metal working defects, high energy rate forming processes-explosive, magnetic, electro and electrohydraulic.

Metal Joining Processes: Welding processes - gas shielded metal arc, TIG, MIG, submerged arc, electroslag, thermit, resistance, pressure and forge welding; thermal cutting; other joining processes - soldering, brazing, braze welding; welding codes, welding symbols, design of welded joints, defects and inspection; introduction to modern welding processes - friction, ultrasonic, explosive, electron beam, laser and plasma.

Machining and Machine Tool Operations: Machining processes-turning, drilling, boring, milling, shaping, planing, sawing, gear cutting, thread production, broaching, grinding, lapping, honing super finishing; mechanics of cutting- Merchant's analysis, geometry of cutting tools, cutting forces, power requirements; selection of process parameters; tool materials, tool wear and tool life, cutting fluids, machinability; nontraditional machining processes and hybrid processes- EDM, CHM, ECM, USM, LBM, EBM, AJM, PAM AND WJM; economics of machining.

Metrology and Inspection: Limits and fits, linear and angular measurements by mechanical and optical methods, comparators; design of limit gauges; interferometry; measurement of straightness, flatness, roundness, squareness and symmetry; surface finish measurement; inspection of screw threads and gears; alignment testing.

Powder Metallurgy and Processing of Plastics: Production of powders, compaction, sintering; Polymers and composites; injection, compression and blow molding, extrusion, calendaring and thermoforming; molding of composites.

Tool Engineering: Work-holding-location and clamping; principles and methods; design of jigs and fixtures; design of press working tools, forging dies.

Manufacturing Analysis: Sources of errors in manufacturing; process capability; part-print analysis; tolerance analysis in manufacturing and assembly; process planning; parameter selection and comparison of production alternatives; time and cost analysis; Issues in choosing manufacturing technologies and strategies.

Computer Integrated Manufacturing: Basic concepts of CAD, CAM, CAPP, group technology, NC, CNC, DNC, FMS, Robotics and CIM.

INDUSTRIAL ENGINEERING

Product Design and Development: Principles of good product design, component and tolerance design; efficiency, quality and cost considerations; product life cycle; standardization, simplification, diversification, value analysis, concurrent engineering.

Engineering Economy and Costing: Financial statements; elementary cost accounting, methods of depreciation; break-even analysis, techniques for evaluation of capital investments.

Work System Design: Taylor's scientific management, Gilbreths's contributions; productivity concepts and measurements; method study, micro-motion study, principles of motion economy; human factors engineering, ergonomics; work measurement - time study, PMTS, work sampling; job evaluation, merit rating, wage administration, incentive systems; business process reengineering.

Logistics and Facility Design: Facility location factors, evaluation of alternatives, types of plant layout, evaluation; computer aided layout; assembly line balancing; material handling systems; supply chain management.

Production Planning and Inventory Control: Inventory Function costs, classifications - deterministic and probabilistic models; quantity discount; safety stock; inventory control system; Forecasting techniques - causal and time series models, moving average, exponential smoothing; trend and seasonality; aggregate production planning; master scheduling; bill of materials and material requirement planning; order control and flow control, routing, scheduling and priority dispatching; JIT; Kanban PULL systems; bottleneck scheduling and theory of constraints.

Operation Research: Linear programming - problem formulation, simplex method, duality and sensitivity analysis; transportation; assignment; network flow models, constrained optimization and Lagrange multipliers; simple queuing models; dynamic programming; simulation; PERT and CPM, time-cost trade-off, resource leveling.

Quality Control: Taguchi method; design of experiments; quality costs, statistical quality assurance, process control charts, acceptance sampling, zero defects; quality circles, total quality management.

Reliability and Maintenance: Reliability, availability and maintainability; probabilistic failure and repair times; system reliability; preventive maintenance and replacement, TPM.

Management Information System: Value of information; information storage and retrieval system - database and data structures; interactive systems; knowledge based systems.

Intellectual Property System: Definition of intellectual property, importance of IPR; TRIPS, and its implications, WIPO and Global IP structure, and IPS in India; patent, copyright, industrial design and trademark; meanings, rules and procedures, terms, infringements and remedies.

PY - PHARMACEUTICAL SCIENCES

Natural Products: Pharmacognosy & Phytochemistry - Chemistry, tests, isolation, characterization and estimation of phytopharmaceuticals belonging to the group of Alkaloids, Glycosides, Terpenoids, Steroids, Bioflavanoids, Purines, Guggul lipids. Pharmacognosy of crude drugs which contain the above constituents. Standardisation of raw materials and herbal products. WHO guide lines. Quantitative microscopy including modern techniques used for evaluation. Biotechnological principles and techniques for plant development Tissue culture.

Pharmacology: General pharmacological principles including Toxicology. Drug interaction. Pharmacology of drugs acting on Central nervous system, Cardiovascular system, Autonomic nervous system, Gastro intestinal system and Respiratory system. Pharmacology of Autocoids, Hormones, Chemotherapeutic agents including anticancer drugs. Bioassays. Immuno Pharmacology.

Medicinal Chemistry: Structure, nomenclature, classification, synthesis, SAR and metabolism of the following category of drugs which are official in Indian Pharmacopoeia and British Pharmacopoeia Hypnotics and Sedatives, Analgesics, NSAIDS, Neuroleptics, Antidepressants, Anxiolytics, Anticonvulsants, Antihistaminics, Local anaesthetics, Cardio Vascular drugs - Antianginal agents Vasodilators, Adrenergic & cholinergic drugs, Cardiotonic agents, Diuretics, Antihypertensive drugs, Hypoglycemic agents, Antilipedmic agents, Coagulants, Anticoagulants, Antiplatelet agents. Chemotherapeutic agents - Antibiotics, Antibacterials, Sulphadrugs. Antiproliozoal drugs, Antiviral, Antitubercular, Antimalarial, Anticancer, Antiamoebic drugs. Diagnostic agents. Preparation and storage and uses of official Radiopharmaceuticals. Vitamins and Hormones.

Pharmaceutics: Development, manufacturing standards, labeling, packing as per the pharmacopoeal requirements, Storage of different dosage forms and new drug delivery systems. Biopharmaceutics and Pharmacokinetics and their importance in formulation. Formulation and preparation of cosmetics - lipstick, shampoo, creams, nail preparations and dentifrices. Pharmaceutical calculations.

Pharmaceutical Jurisprudence: Legal aspects of manufacture, storage, sale of drugs. D and C act and rules. Pharmacy act.

Pharmaceutical Analysis: Principles, instrumentation and applications of the following. Absorption spectroscopy (UV, visible & IR), Fluorimetry, Flame photometry, Potentiometry, Conductometry and Plarography. Pharmacopoeial assays. Principles of NMR, ESR, Mass spectroscopy, X-ray diffraction analysis and different chromatographic methods.

Biochemistry and Clinical Pharmacy: Biochemical role of hormones, Vitamins, Enzymes, Nucleic acids. Bioenergetics. General principles of immunology. Immunological techniques. Adverse drug interaction.

Microbiology: Principles and methods of microbiological assays of the Pharmacopoeia. Methods of preparation of official sera and vaccines. Serological and diagnostic tests. Applications of microorganisms in Bio Conversions and in Pharmaceutical industry.

TF - TEXTILE ENGINEERING AND FIBRE SCIENCE

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

TEXTILE ENGINEERING & FIBRE SCIENCE

Textile Fibres: Classification of textile fibres according to their nature and origin; general characteristics of textile fibres-their chemical and physical structures and their properties; essential characteristics of fibre forming polymers; uses of natural and man-made fibres; physical and chemical methods of fibre and blend identification and blend analysis.

Melt Spinning processes with special reference to polyamide and polyester fibres; wet and dry spinning of viscose and acrylic fibres; post spinning operations-drawing, heat setting, texturing- false twist and air-jet, tow-to-top conversion. Methods of investigating fibre structure e.g. X-ray diffraction, birefringence, optical and electron microscopy, I.R. absorption, thermal methods; structure and morphology and principal natural and man-made fibres, mechanical properties of fibres, moisture sorption in fibres; fibre structure and property correlation.

Textile Testing: Sampling techniques, sample size and sampling errors; measurement of fibre length, fineness, crimp, strength and reflectance; measurement of cotton fibre maturity ad trash content; HVI and AFIS for fibre testing. Measurement of yarn count, twist and hairiness;

tensile testing of fibres, yarn and fabrics; evenness testing of slivers, rovings and yarns; testing equipment for measurement test methods of fabric properties like thickness, compressibility, air permeability, drape, crease recovery, tear strength bursting strength and abrasion resistance. Correlation analysis, significance tests and analysis of variance; frequency distributions and control charts.

Yarn Manufacture and Yarn Structure: Modern methods of opening, cleaning and blending of fibrous materials; the technology of carding with particular reference to modern developments; causes of irregularity introduced by drafting, the development of modern drafting systems; principles and techniques of preparing material for combing; recent development in combers; functions and synchronization of various mechanisms concerned with roving production; forces acting on yarn and traveller, ring and traveller designs; causes of end breakages; properties of doubles yarns; new methods of yarn production such as rotor spinning, air jet spinning and friction spinning.

Yarn diameter; specific volume, packing coefficient; twist-strength relationship; fibre orientation in yarn; fibre migration.

Fabric Manufacture and Fabric Structure: Principles of cheese and cone winding processes and machines; random and precision winding; package faults and their remedies; yarn clearers and tensioners; different systems of yarn splicing; features of modern cone winding machines; different types of warping creels; features of modern beam and sectional warping machines; different sizing systems, sizing of spun and filament yarns, modern sizing machines; principles of pirn winding processes and machines; primary and secondary motions of loom, effect of their settings and timings on fabric formation, fabric appearance and weaving performance; dobby and jacquard shedding; mechanics of weft insertion with shuttle; warp and weft stop motions, warp protection, weft replenishment; functional principles of weft insertion systems of shuttleless weaving machines, principles of multiphase and circular looms. Principles of weft and warp knitting; basic weft and warp knitted structures; classification, production and areas of application of nonwoven fabrics.

Basic woven fabric constructions and their derivatives; crepe, cord, terry, gauze, lino and double cloth constructions.

Peirce's equations for fabric geometry; thickness, cover and maximum sett of woven fabrics

Textile Chemical Processing: Preparatory processes for natural-and and their blends; mercerization of cotton; machines for yarn and fabric mercerization.

Dyeing and printing of natural- and synthetic- fibre fabrics and their blends with different dye classes; dyeing and printing machines; styles of printing; fastness properties of dyed and printed textile materials.

Finishing of textile materials, wash and wear, durable press, soil release, water repellent, flame retardant and antistatic finishes; shrink-resistance finish for wool; heat setting of synthetic-fibre fabrics, finishing machines; energy efficient processes; pollution control.

XE - ENGINERING SCIENCES

The syllabi of the sections of this paper are as follows:

SECTION A. ENGINEERING MATHEMATICS (Compulsory)

Linear Algebra : Determinates, algebra of matrices, rank, inverse, system of linear equations, symmetric, skew-symmetric and orthogonal matrices. Hermitian, skew-hermitian and unitary matrices. eigenvalues and eigenvectors, diagonalisation of matrices, Cayley-Hamiltonian, quadratic forms.

Calculus : Functions of single variables, limit, continuity and differentiability, Mean value theorems, Intermediate forms and L'Hospital rule, Maxima and minima, Taylor's series, Fundamental and mean value-theorems of integral calculus. Evaluation of definite and improper integrals, Beta and Gamma functions, Functions of two variables, limit, continuity, partial derivatives, Euler's theorem for homogeneous functions, total derivatives, maxima and minima, Lagrange method of multipliers, double and triple integrals and their applications, sequence and series, tests for convergence, power series, Fourier Series, Fourier integrals.

Complex variable: Analytic functions, Cauchy's integral theorem and integral formula without proof. Taylor's and Laurent' series, Residue theorem (without proof) with application to the evaluation of real integarls.

Vector Calculus: Gradient, divergence and curl, vector identities, directional derivatives, line, surface and volume integrals, Stokes, Gauss and Green's theorems (without proofs) with applications.

Ordinary Differential Equations: First order equation (linear and nonlinear), higher order linear differential equations with constant coefficients, method of variation of paramaters, Cauchy's and Euler's equations, initial and boundary value problems, power series solutions, Legendre polynomials and Bessel's functions of the first kind.

Partial Differential Equations: Variables separable method, solutions of one dimensional heat, wave and Laplace equations.

Probability and Statistics: Definitions of probability and simple theorems, conditional probability, mean, mode and standard deviation, random variables, discrete and continuous distributions, Poisson, normal and Binomial distribution, correlation and regression

Numerical Methods: L-U decomposition for systems of linear equations,Newton-Raphson method, numerical integration(trapezoidal and Simpson's rule), numerical methods for first order differential equation (Euler method)

SECTION B. COMPUTATIONAL SCIENCE

Numerical Methods: Truncation errors, round off errors and their propagation; Interpolation; Lagrange, Newton's forward, backward and divided difference formulas, least square curve fitting, solution of non-linear equations of one variables using bisection, false position, secant and Newton Raphson methods; Rate of convergence of these methods, general iterative methods. Simple and multiple roots of polynomials. Solutions of system of linear algebraic equations using Gauss elimination methods, Jacobi and Gauss-Seidel iterative methods and their rate of convergence; ill conditioned and well conditioned system. eigen values and eigen vectors using power methods. Numerical integration using trapezoidal, Simpson's rule and other quadrature formulas. Numerical Differentiation. Solution of boundary value problems. Solution of initial value problems of ordinary differential equations using Euler's method, predictor corrector and Runge Kutta method.

Programming : Elementary concepts and terminology of a computer system and system software, Fortran77 and C programming.

Fortran : Program organization, arithmetic statements, transfer of control, Do loops, subscripted variables, functions and subroutines.

C language : Basic data types and declarations, flow of control- iterative statement, conditional statement, unconditional branching, arrays, functions and procedures.

SECTION C. ELECTRICAL SCIENCES

Electric Circuits: Ideal voltage and current sources; RLC circuits, steady state and transient analysis of DC circuits, network theorems; alternating currents and voltages, single-phase AC circuits, resonance; three-phase circuits.

Magnetic circuits: Mmf and flux, and their relationship with voltage and current; transformer, equivalent circuit of a practical transformer, three-phase transformer connections.

Electrical machines: Principle of operation, characteristics, efficiency and regulation of DC and synchronous machines; equivalent circuit and performance of three-phase and single-phase induction motors.

Electronic Circuits: Characteristics of p-n junction diodes, zener diodes, bipolar junction transistors (BJT) and junction field effect transistors (JFET); MOSFET's structure, characteristics, and operations; rectifiers, filters, and regulated power supplies; biasing circuits, different configurations of transistor amplifiers, class A, B and C of power amplifiers; linear applications of operational amplifiers; oscillators; tuned and phase shift types.

Digital circuits: Number systems, Boolean algebra; logic gates, combinational circuits, flip-flops (RS, JK, D and T) counters.

Measuring instruments: Moving coil, moving iron, and dynamometer type instruments; shunts, instrument transformers, cathode ray oscilloscopes; D/A and A/D converters.

SECTION D. FLUID MECHANICS

Fluid Properties: Relation between stress and strain rate for Newtonian fluids

Hydrostatics, buoyancy, manometry

Concept of local and convective accelerations; control volume analysis for mass, momentum and energy conservation.

Differential equations of continuity and momentum (Euler's equation of motion); concept of fluid rotation, stream function, potential function; Bernoulli's equation and its applications.

Qualitative ideas of boundary layers and its separation; streamlined and bluff bodies; drag and lift forces.

Fully-developed pipe flow; laminar and turbulent flows; friction factor; Darcy Weisbach relation; Moody's friction chart; losses in pipe fittings; flow measurements using venturimeter and orifice plates.

Dimensional analysis; similitude and concept of dynamic similarity; importance of dimensionless numbers in model studies.

SECTION E. MATERIALS SCIENCE

Atomic structure and bonding in materials: metals, ceramics and polymers.

Structure of materials: Crystal systems, unit cells and space lattice; determination of structures of simple crystals by X-ray diffraction; Miller indices for planes and directions. Packing geometry in metallic, ionic and covalent solids.

Concept of amorphous, single and polycrystalline structures and their effects on properties of materials.

Imperfections in crystalline solids and their role in influencing various properties.

Fick´s laws of diffusion and applications of diffusion in sintering, doping of semiconductors and surface hardening of metals.

Alloys: solid solution and solubility limit. Binary phase diagram, intermediate phases and intermetallic compounds; iron-iron carbide phase diagram. Phase transformation in steels. Cold and hot working of metals, recovery, recrystallization and grain growth.

Properties and applications of ferrous and nonferrous alloys.

Structure, properties, processing and applications of traditional and advanced ceramics.

Polymers: classification, polymerization, structure and properties, additives for polymer products, processing and application.

Composites: properties and application of various composites.

Corrosion and environmental degradation of materials (metals, ceramics and polymers).

Mechanical properties of materials: Stress-strain diagrams of metallic, ceramic and polymeric materials, modulus of elasticity, yield strength, plastic deformation and toughness, tensile strength and elongation at break; viscoelasticity, hardness, impact strength. ductile and brittle fracture. creep and fatigue properties of materials.

Heat capacity, thermal conductivity, thermal expansion of materials.

Concept of energy band diagram for materials; conductors, semiconductors and insulators in terms of energy bands. Electrical conductivity, effect of temperature on conductivity in materials, intrinsic and extrinsic semiconductors, dielectric properties of materials.

Refraction, reflection, absorption and transmission of electromagnetic radiation in solids.

Origin of magnetism in metallic and ceramic materials, paramagnetism, diamagnetism, antiferromagnetism, ferromagnetism, ferrimagnetism in materials and magnetic hysteresis.

Advanced materials: Smart materials exhibiting ferroelectric, piezoelectric, optoelectronic, semiconducting behaviour; lasers and optical fibers; photoconductivity and superconductivity in materials.

SECTION F. SOLID MECHANICS

Equivalent force systems; free-body diagrams; equilibrium equations; analysis of determinate and indeterminate trusses and frames; friction.

Simple relative motion of particles; force as function of position, time and speed; force acting on a body in motion; laws of motion; law of conservation of energy; law of conservation of momentum

Stresses and strains; principal stresses and strains; Mohr's circle; generalized Hooke's Law; equilibrium equations; compatibility conditions; yield criteria.

Axial, shear and bending moment diagrams; axial, shear and bending stresses; deflection (for symmetric bending); torsion in circular shafts; thin cylinders; energy methods (Castigliano's Theorems); Euler buckling.

SECTION G. THERMODYNAMICS

Basic Concepts: Continuum, macroscopic approach, thermodynamic system (closed and open or control volume); thermodynamic properties and equilibrium; state of a system, state diagram, path and process; different modes of work; Zeroth law of thermodynamics; concept of temperature; heat.

First Law of Thermodynamics: Energy, enthalpy, specific heats, first law applied to systems and control volumes, steady and unsteady flow analysis.

Second Law of Thermodynamics: Kelvin-Planck and Clausius statements, reversible and irreversible processes, Carnot theorems, thermodynamic temperature scale, Clausius inequality and concept of entropy, principle of increase of entropy; availability and irreversibility.

Properties of Pure Substances: Thermodynamic properties of pure substances in solid, liquid and vapour phases, P-V-T behaviour of simple compressible substances, phase rule, thermodynamic property tables and charts, ideal and real gases, equations of state, compressibility chart.

Thermodynamic Relations: T-ds relations, Maxwell equations, Joule-Thomson coefficient, coefficient of volume expansion, adiabatic and isothermal compressibilities, Clapeyron equation.

Ideal Gas Mixtures: Dalton's and Amagat's laws, calculations of properties, air-water vapour mixtures.

XL - LIFE SCIENCES

The syllabi of the Sections of this paper are as follows:

SECTION H. CHEMISTRY (Compulsory)

Atomic structure and periodicity: Quantum chemistry; Planck's quantum theory, wave particle duality, uncertainty principle, quantum mechanical model of hydrogen atom; electronic configuration of atoms; periodic table and periodic properties; ionization energy, election affinity, electronegativity, atomic size.

Structure and bonding: Ionic and covalent bonding M.O. and V.B. approaches for diatomic molecules, VSEPR theory and shape of molecules, hybridisation, resonance, dipole moment, structure parameters such as bond length, bond angle and bond energy, hydrogen bonding, van der Waals interactions. Ionic solids; ionic radii, lattice energy (Born-Haber Cycle).

s.p. and d Block Elements: Oxides, halides and hydrides of alkali and alkaline earth metals, B, Al, S, N, P and S, silicones, general characteristics of 3d elements, coordination complexes: valence bond and crystal field theory, color, geometry and magnetic properties.

Chemical Equilibria: Colligative properties of solutions, ionic equilibria in solution, solubility product, common ion effect, hydrolysis of salts, pH, buffer and their applications in chemical analysis.

Electrochemistry: Conductance, Kohlrausch law, Half Cell potentials, emf, Nernst equation, galvanic cells, thermodynamic aspects and their applications.

Reaction Kinetics: Rate constant, order of reaction, molecularity, activation energy, zero, first and second order kinetics, equilibrium constants (K_c, K_p and K_x) for homogeneous reactions, catalysis and elementary enzyme reactions.

Thermodynamics: First law, reversible and irreversible processes, internal energy, enthalpy, Kirchoff's equation, heat of reaction, Hess law, heat of formation, Second law, entropy, free energy, and work function. Gibbs-Helmholtz equation, Clausius-Clapeyron equation, free energy change and equilibrium constant, Troutons rule, Third law of thermodynamics.

Mechanistic Basis of Organic Reactions: Elementary treatment of SN1, SN2, E1 and E2 reactions, Hoffmann and Saytzeff rules, Addition reactions, Markonikoff rule and Kharash effect, Diels-Alder reaction, aromatic electrophilic substitution, orientation effect as exemplified by various functional groups.

Structure-Reactivity Correlations: Acids and bases, electronic and steric effects, optical and geometrical isomerism, tautomerism, concept of aromaticity

SECTION I. BIOCHEMISTRY

Organization of life. Importance of water. Cell structure and organelles. Structure and function of biomolecules: Carbohydrates, Lipids, Proteins and Nucleic acids. Biochemical separation techniques. Spectroscopic methods; UV-visible and fluorescence. Protein structure, folding and function: Myoglobin, Hemoglobin, Lysozyme, ribonuclease A, Carboxypeptidase and Chymotrypsin. Enzyme kinetics and regulation, Coenzymes.

Metabolism and bioenergitics. Generation and utilization of ATP. Photosynthesis. Major metabolic pathways and their regulation. Biological membranes. Transport across membranes. Signal transduction; hormones and neurotransmitters.

DNA replication, transcription and translation. Biochemical regulation of gene expression. Recombinant DNA technology and applications. Genomics and Proteomics.

The immune system. Active and passive immunity. Complement system. Antobody structure, function and diversity. Cells of the immune system: T, B and macrophages. T and B cell activation. Major histocompatibilty complex. T cell receptor. Immunological techniques: Immunodiffusion, immunoelectrophoresis, RIA and ELISA.

SECTION J. BIOTECHNOLOGY

Recombinant DNA technology for the production of therapeutic proteins. Micro array technology. Heterologous protein expression systems in bacteria, yeast etc.

Architecture of plant genome; plant tissue culture techniques; methods of gene transfer into plant cells; manipulation of phenotypic traits in plants; plant cell fermentations and production of secondary metabolites using suspension/ immobilized cell culture; methods for plant micro propagation; crop improvement and development of transgenic plants. Expression of animal proteins in plants.

Animal cell metabolism and regulation; cell cycle; primary cell culture; nutritional requirements for animal cell culture; techniques for the mass culture of animal cell lines; production of vaccines; growth hormones and interferons using animal cell culture; cytokines-production and therapeutic uses; hybridoma technology; vectors for gene transfer and expression in animal cells. Transgenic animals and molecular pharming.

Microbial production of industrial enzymes; methods for immobilization of enzymes; kinetics of soluble and immobilized enzymes; application of soluble and immobilized enzymes; enzyme-based sensors.

Microbial growth kinetics; batch, fed batch and continuous culture of microbial cells; media for industrial fermentations; sterilization of air and media; design features and operation of stirred tank, air-lift and fluidized bed reactors; aeration and agitation in aerobic fermentations; recovery and purification of fermentation products- filtration, centrifugation, cell disintegration, solvent extraction and chromatographic separations; industrial fermentations for the production of ethanol, citric acid, lysine, penicillin and other biomolecules; simple calculations based on material and energy balance of fermentation processes; application of microbes in the management of domestic and industrial wastes.

SECTION K. BOTANY

Anatomy: Roots, stem and leaves of land plants, meristems, vascular system, their ontogeny, structure and functions. Plant cell structure, organisation, organelles, cytoskeleton, cell wall and membranes.

Development: Cell cycle, cell division, senescence, hormonal regulation of growth; life cycle of an angiosperm, pollination, fertilization, embryogenesis, seed formation, seed storage proteins, seed dormancy and germination. Concept of cellular totipotency, organogenesis and somatic embryogenesis, somaclonal variation, embryo culture, in vitro fertilization.

Physiology and Biochemistry: Plant water relations, transport of minerals and solutes, N2 metabolism, proteins and nucleic acid, respiration, photophysiology, photosynthesis, photorespiration; biosynthesis, mechanism of action and physiological effects of plant growth regulators.

Genetics: Principles of Mendelian inheritance, linkage, recombination and genetic mapping; extrachromosomal inheritance; eukaryotic genome organization (chromatin structure) and regulation of gene expression, gene mutation, chromosome aberrations (numerical and structural), transposons.

Plant Breeding: Principles, methods - selection, hybridization, heterosis; male sterility, self and inter-specific incompatibility; haploidy; somatic cell hybridization; molecular marker-assisted selection; gene transfer methods viz. direct and vector-mediated, transgenic plants and their applications in agriculture.

Economic Botany: Economically important plants - cereals, pulses, plants yielding fiber, timber, sugar, beverages, oils, rubber, dyes, gums, drugs and narcotics - a general account.

Systematics: Systems of classification (non-phylogenetic vs. phylogenetic - outline), plant groups, molecular systematics.

Plant Pathology: Nature and classification of plant diseases, diseases of important crops caused by fungi, bacteria and viruses, and their control measures, mechanism(s) of pathogenesis and resistance, molecular detection of pathogens; plant-microbe beneficial interactions.

Ecology and Plant Geography: Ecosystems - types, dynamics, degradation, ecological succession; food chains; vegetation types of the world; pollution and global warming; speciation and extinction, conservation strategies, cryopreservation.

SECTION L. MICROBIOLOGY

Historical perspective - Discovery of the microbial world; Controversy over spontaneous generation; Role of microorganisms in transformation of organic matter and in the causation of diseases.

Methods in microbiology - Pure culture techniques; Theory and practice of sterilization; Principles of microbial nutrition; Construction of culture media; Enrichment culture techniques for isolation of chemoautotrophs, chemoheterotrophs and photosynthetic microorganisms.

Microbial evolution, systematics and taxonomy - Evolution of earth and earliest life forms; Primitive organisms and their metabolic strategies; New approaches to bacterial taxonomic classification including ribotyping; Nomenclature.

Microbial diversity - Bacteria, archea and their broad classification; Eukaryotic microbes, yeast, fungi, slime mold and protozoa; Viruses and their classification.

Microbial growth -The definition of growth, mathematical expression of growth, growth curve, measurement of growth and growth yields; Synchronous growth; Continuous culture.

Nutrition and metabolism - Overview of metabolism; Microbial nutrition; Energy classes of microorganisms; Culture media; Energetics, modes of ATP generation; ATP generation by heterotrophs; Fermentation; Glycolysis; Respiration; The citric acid cycle; Electron transport systems; Alternate modes of energy generation; Pathways (anabolism) in the biosynthesis of amino acids, purines, pyrimidines and fatty acids.

Metabolic diversity among microorganisms - Photosynthesis in microorganisms; Role of chlorophylls, carotenoids and phycobilins; Calvin cycle; Chemolithotrophy; Hydrogen- iron- nitrite-oxidizing bacteria; Nitrate and sulfate reduction; Methanogenesis and acetogenesis.

Prokaryotic cells: structure-function - Cells walls of eubacteria (peptidoglycan) and related molecules; Outer-membrane of gram-negative bacteria; Cell wall and cell membrane synthesis; Flagella and motility; Cell inclusions like endospores, gas vesicles.

Microbial diseases and host parasite relationships - Normal microflora of skin; Oral cavity; Gastrointestinal tract; Entry of pathogens into the host; Infectious disease transmission; Respiratory infections caused by bacteria and viruses; Tuberculosis; Sexually transmitted diseases including AIDS; Diseases transmitted by animals (Rabies, plague), insects and ticks (rikettsias, Lyme disease, malaria); Food and water borne diseases; Public health and water quality; Pahtogenic fungi; Emerging and resurgent infectious diseases.

Chemotherapy/Antibiotics - Antimicrobial agents; Sulfa drugs; Antibiotics; Pencillins and cephalosporins; Broad-spectrum antibiotics; Antibiotics from prokaryotes; Antifungal antibiotics; Mode of action; Resistance to antibiotics.

Microbial genetics - Genes, mutation and mutagenesis - UV and chemical mutagnes; Types of mutations; Ames test for mutagenesis; Methods of genetic analysis. Bacterial genetic system - Transformation; Conjugation; Transduction; Recombination; Plasmids and Transposons; Bacterial genetic map with reference to E. coli. Viruses and their genetic system - Phage ? and its life cycle; RNA phages; RNA viruses; Retroviruses; Genetic systems of yeast and Neurospora; Extrachromosomal inheritance and mitochondrial genetics; Basic concept of genomics.

SECTION M. ZOOLOGY

Animal world: Animal diversity, distribution, systematic and classification of animals, the phylogenetic relationship.

Evolution: Origin of life, history of life on earth, evolutionary theories, natural selection, adaptation, speciation.

Genetics: Principles of inheritance, molecular basis of heredity, the genetic material, transmission of genetic material, mutations, cytoplasmic inheritance.

Biochemistry and Molecular Biology: Nucleic acids, proteins and other biological macromolecules. Replication, transcription and translation, regulation of gene expression, organization of genome, Kreb's cycle, glycolysis, enzyme catalysis, hormones and their action.

Cell Biology: Structure of cell, cellular organelles and their structure and function, cell cycle, cell division, cellular differentiation, chromosome and chromatin structure. Eukaryotic gene organisation and expression.

Animal Anatomy and Physiology: Comparative physiology, the respiratory system, circulatory system, digestive system, the nervous system, the excretory system, the endocrine system, the reproductive system, the skeletal system, osmoregulation.

Parasitology and Immunology: Nature of parasite, host-parasite relation, protozoan and helminthic parasites, the immune response, cellular and humoral immune response, evolution of the immune system.

Development Biology: Embryonic development, cellular differentiation, organogenesis, metamorphosis, genetic basis of development.

Ecology: The ecosystem, habitats the food chain, population dynamics, species diversity, zoogeography, biogeochemical cycles, conservation biology.

Animal Behaviour: Types of behaviours, courtship, mating and territoriality, instinct, learning and memory, social behaviour across the animal taxa, communication, pheromones, evolution of animal behaviour.

IT - INFORMATION TECHNOLOGY

ENGINEERING MATHEMATICS

Mathematical Logic: Propositional Logic; First Order Logic.

Probability: Conditional Probability; Mean, Median, Mode and Standard Deviation; Random Variables; Distributions; uniform, normal, exponential, Poisson, Binomial.

Set Theory & Algebra: Sets; Relations; Functions; Groups; Partial Orders; Lattice; Boolean Algebra.

Combinatorics: Permutations; Combinations; Counting; Summation; generating functions; recurrence relations; asymptotics.

Graph Theory: Connectivity; spanning trees; Cut vertices & edges; covering; matching; independent sets; Colouring; Planarity; Isomorphism.

Linear Algebra: Algebra of matrices, determinants, systems of linear equations, Eigen values and Eigen vectors.

Numerical Methods: LU decomposition for systems of linear equations; numerical solutions of non linear algebraic equations by Secant, Bisection and Newton-Raphson Methods; Numerical integration by trapezoidal and Simpson's rules.

Calculus: Limit, Continuity & differentiability, Mean value Theorems, Theorems of integral calculus, evaluation of definite & improper integrals, Partial derivatives, Total derivatives, maxima & minima.

FORMAL LANGUAGES AND AUTOMATA

Regular Languages: finite automata, regular expressions, regular grammar.

Context free languages: push down automata, context free grammars

COMPUTER HARDWARE

Digital Logic: Logic functions, minimization, design and synthesis of combinatorial and sequential circuits, number representation and computer arithmetic (fixed and floating point)

Computer organization: Machine instructions and addressing modes, ALU and data path, hardwired and microprogrammed control, memory interface, I/O interface (interrupt and DMA mode), serial communication interface, instruction pipelining, cache, main and secondary storage

SOFTWARE SYSTEMS

Data structures and Algorithms: the notion of abstract data types, stack, queue, list, set, string, tree, binary search tree, heap, graph, tree and graph traversals, connected components, spanning trees, shortest paths, hashing, sorting, searching, design techniques (greedy, dynamic, divide and conquer), asymptotic analysis (best, worst, average cases) of time and space, upper and lower bounds, intractability

Programming Methodology: C programming, program control (iteration, recursion, functions), scope, binding, parameter passing, elementary concepts of object oriented programming

Operating Systems (in the context of Unix): classical concepts (concurrency, synchronization, deadlock), processes, threads and interprocess communication, CPU scheduling, memory management, file systems, I/O systems, protection and security

Information Systems and Software Engineering: information gathering, requirement and feasibility analysis, data flow diagrams, process specifications, input/output design, process life cycle, planning and managing the project, design, coding, testing, implementation, maintenance.

Databases: relational model, database design, integrity constraints, normal forms, query languages (SQL), file structures (sequential, indexed), b-trees, transaction and concurrency control

Data Communication: data encoding and transmission, data link control, multiplexing, packet switching, LAN architecture, LAN systems (Ethernet, token ring), Network devices: switches, gateways, routers

Networks: ISO/OSI stack, sliding window protocols, routing protocols, TCP/UDP, application layer protocols & systems (http, smtp, dns, ftp), network security

Web technologies: three tier web based architecture; JSP, ASP, J2EE, .NET systems; html, XML

AG - AGRICULTURAL ENGINEERING

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

FARM MACHINERY AND POWER:

Sources of power on the farm-human, animal, mechanical, electrical, wind, solar and biomass; design and selection of machine elements - gears, pulleys, chains and sprockets and belts; overload safety devices used in farm machinery; measurement of force, torque, speed, displacement and acceleration on machine elements.

Soil tillage; forces acting on a tillage tool; hitch systems and hitching of tillage implements; functional requirements, principles of working, construction and operation of manual, animal and power operated equipment for tillage. sowing, planting, fertilizer application, inter-cultivation, spraying, mowing, chaff cutting, harvesting, threshing and transport; testing of agricultural machinery and equipment; calculation of performance parameters -field capacity, efficiency, application rate and losses; cost analysis of implements and tractors.

Thermodynamic principles of I.C. engines; I.C. engine cycles; engine components; fuels and combustion; lubricants and their properties; I.C. engine systems - fuel, cooling, lubrication, ignition, electrical, intake and exhaust; selection, operation, maintenance and repair of I.C. engines; power efficiencies and measurement; calculation of power, torque, fuel consumption, heat load and power losses.

Tractors and power tillers - type, selection, maintenance and repair; tractor clutches and brakes; power transmission systems - gear trains, differential, final drives and power take-off; mechanics of tractor chassis; traction theory; three point hitches- free link and restrained link operations; mechanical steering and hydraulic control systems used in tractors; human engineering and safety in tractor design; tractor tests and performance.

SOIL AND WATER CONSERVATION ENGINEERING:

Ideal and real fluids, properties of fluids; hydrostatic pressure and its measurement; hydrostatic forces on plane and curved surface; continuity equation; Bernoulli's theorem; laminar and turbulent flow in pipes, Darcy-Weisbach and Hazen-Williams equations, Moody's diagram; flow through orifices and notches; flow in open channels.

Engineering properties of soils, fundamental definitions and relationships; index properties of soils; permeability and seepage analysis; shear strength, Mohr's circle of stresses; active and passive earth pressures; stability of slopes.

Hydrological cycle; precipitation measurement, analysis of precipitation data; abstraction from precipitation; runoff; hydrograph analysis, unit hydrograph theory and application; stream flow measurement; flood routing, hydrological reservoir and channel routing.

Mechanics of soil erosion, factors affecting erosion; soil loss estimation; biological and engineering measures to control erosion, terraces and bunds; vegetative waterways; gully control structures, drop, drop inlet and chute spillways; farm ponds; earthen dams; principles of watershed management.

Water requirement of crops; consumptive use and evapo-transpiration; irrigation scheduling; irrigation efficiencies; design of prismatic and silt loaded channels; methods of irrigation water application; design and evaluation of irrigation methods; drainage coefficient; surface and subsurface drainage systems; leaching requirement and salinity control; irrigation and drainage water quality; classification of pumps; pump characteristics; pump selection; types of aquifer; evaluation of aquifer properties; well hydraulics; ground water recharge.

AGRICULTURAL PROCESSING AND FOOD ENGINEERING:

Steady state heat transfer in conduction, convection and radiation; transient heat transfer in simple geometry; condensation and boiling heat transfer; working principles of heat exchangers; diffusive and convective mass transfer; simultaneous heat and mass transfer in agricultural processing operations.

Material and energy balances in food processing systems; water activity, sorption and desorption isotherms; centrifugal separation of solids, liquids and gases; kinetics of microbial death - pasteurisation and sterilization of liquid foods; preservation of food by cooling and freezing; psychrometry - properties of air-vapour mixture; concentration and dehydration of liquid foods - evaporators, tray, drum and spray dryers.

Mechanics and energy requirement in size reduction of granular solids; particle size analysis for comminuted solids; size separation by screening; fluidisation of granular solids; cleaning and grading efficiency and effectiveness of grain cleaners; conditioning and hydrothermal treatments for grains; dehydration of food grains; processes and machines for processing of cereals, pulses and oilseeds; design considerations for grain silos.

AR - ARCHITECTURE AND PLANNING

City planning: Historical development of cities; principles of city planning; new towns; survey methods, site planning, planning regulations and building bye-laws.

Housing: Concept of shelter; housing policies and design; community planning; role of government agencies; finance and management.

Landscape Design: Principles of landscape design and site planning; history and landscape styles; landscape elements and materials; planting design.

Computer Aided Design: Application of computers in architecture and planning; understanding elements of hardware and software; computer graphics; programming languages - C and Visual Basic and usage of packages such as AutoCAD.

Environmental and Building Science: Elements of environmental science; ecological principles concerning environment; role of micro-climate in design; climatic control through design elements; thermal comfort; elements of solar architecture; principles of lighting and illumination; basic principles of architectural acoustics; air pollution, noise pollution and their control.

Visual and Urban Design: Principles of visual composition; proportion, scale, rhythm, symmetry, harmony, balance, form and colour; sense of place and space, division of space; focal point, vista, imageability, visual survey.

History of Architecture: Indian - Indus valley, Vedic, Buddhist, Indo-Aryan, Dravidian and Mughal periods; European - Egyptian, Greek, Roman, medieval and renaissance periods.

Development of Contemporary Architecture: Architectural developments and impacts on society since industrial revolution; influence of modern art on architecture; works of national and international architects; post modernism in architecture.

Building Services: Water supply, Sewerage and Drainage systems; Sanitary fittings and fixtures; principles of electrification of buildings; elevators, their standards and uses; air-conditioning systems; fire fighting systems.

Building Construction and Management: Building construction techniques, methods and details; building systems and prefabrication of building elements; principles of modular coordination; estimation, specification, valuation, professional practice; project management, PERT, CPM.

Materials and Structural Systems: Behavioural characteristics of all types of building materials e.g. mud, timber, bamboo, brick, concrete, steel, glass, FRP; principles of strength of materials; design of structural elements in wood, steel and RCC; elastic and limit state design; complex structural systems; principles of pre-stressing.

Planning Theory: Planning process; multilevel planning; comprehensive planning; central place theory; settlement pattern; land use and land utilization.

Techniques of Planning: Planning surveys; Preparation of urban and regional structure plans, development plans, action plans; site planning principles and design; statistical methods; application of remote sensing techniques in urban and regional planning.

Traffic and Transportation Planning: Principles of traffic engineering and transportation planning; methods of conducting surveys; design of roads, intersections and parking areas;

hierarchy of roads and levels of services; traffic and transport management in urban areas; traffic safety and traffic laws; public transportation planning; modes of transportation.

Services and Amenities: Principles and design of water supply systems, sewerage systems, solid waste disposal systems, power supply and communication systems; Health, education, recreation and demography related standards at various levels of the settlements.

Development Administration and Management: Planning laws; development control and zoning regulations; laws relating to land acquisition; development enforcements, land ceiling; regional and urban plan preparations; planning and municipal administration; taxation, revenue resources and fiscal management; public participation and role of NGO.

CE - CIVIL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

STRUCTURAL ENGINEERING

Mechanics: Bending moments and shear forces in statically determinate beams; simple stress and strain: relationship; stress and strain in two dimensions, principal stresses, stress transformation, Mohr's circle; simple bending theory; flexural shear stress; thin-walled pressure vessels; uniform torsion.

Structural Analysis: Analysis of statically determinate trusses, arches and frames; displacements in statically determinate structures and analysis of statically indeterminate structures by force/energy methods; analysis by displacement methods (slope-deflection and moment-distribution methods); influence lines for determinate and indeterminate structures; basic concepts of matrix methods of structural analysis.

Concrete Structures: Basic working stress and limit states design concepts; analysis of ultimate load capacity and design of members subject to flexure, shear, compression and torsion (beams, columns and isolated footings); basic elements of prestressed concrete: analysis of beam sections at transfer and service loads.

Steel Structures: Analysis and design of tension and compression members, beams and beam-columns, column bases; connections - simple and eccentric, beam-column connections, plate girders and trusses; plastic analysis of beams and frames.

GEOTECHNICAL ENGINEERING

Soil Mechanics: Origin of soils; soil classification; three-phase system, fundamental definitions, relationship and inter-relationships; permeability and seepage; effective stress principle: consolidation, compaction; shear strength.

Foundation Engineering: Sub-surface investigation - scope, drilling bore holes, sampling, penetrometer tests, plate load test; earth pressure theories, effect of water table, layered soils; stability of slopes - infinite slopes, finite slopes; foundation types - foundation design requirements; shallow foundations; bearing capacity, effect of shape, water table and other factors, stress distribution, settlement analysis in sands and clays; deep foundations - pile types, dynamic and static formulae, load capacity of piles in sands and clays.

WATER RESOURCES ENGINEERING

Fluid Mechanics and Hydraulics: Hydrostatics, applications of Bernoulli equation, laminar and turbulent flow in pipes, pipe networks; concept of boundary layer and its growth; uniform flow, critical flow and gradually varied flow in channels, specific energy concept, hydraulic jump; forces on immersed bodies; flow measurement in channels; tanks and pipes; dimensional analysis and hydraulic modeling. Applications of momentum equation, potential flow, kinematics of flow; velocity triangles and specific speed of pumps and turbines.

Hydrology: Hydrologic cycle; rainfall; evaporation infiltration, unit hydrographs, flood estimation, reservoir design, reservoir and channel routing, well hydraulics.

Irrigation: Duty, delta, estimation of evapo-transpiration; crop water requirements; design of lined and unlined canals; waterways; head works, gravity dams and Ogee spillways. Designs of weirs on permeable foundation, irrigation methods.

ENVIRONMENTAL ENGINEERING

Water requirements; quality and standards, basic unit processes and operations for water treatment, distribution of water. Sewage and sewerage treatment: quantity and characteristic of waste water sewerage; primary and secondary treatment of waste water; sludge disposal; effluent discharge standards.

TRANSPORTATION ENGINEERING

Highway planning; geometric design of highways; testing and specifications of paving materials; design of flexible and rigid pavements.

CH - CHEMICAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

CHEMICAL ENGINEERING

Process Calculations and Thermodynamics: Laws of conservation of mass and energy; use of tie components; recycle, bypass and purge calculations; degree of freedom analysis.

First and Second laws of thermodynamics and their applications; equations of state and thermodynamic properties of real systems; phase equilibria; fugacity, excess properties and correlations of activity coefficients; chemical reaction equilibria.

Fluid Mechanics and Mechanical Operations: Fluid statics, Newtonian and non-Newtonian fluids, Bernoulli equation, Macroscopic friction factors, energy balance, dimensional analysis, shell balances, flow through pipeline systems, flow meters, pumps and compressors, packed and fluidized beds, elementary boundary layer theory, size reduction and size separation; free and hindered settling; centrifuge and cyclones; thickening and classification, filtration, mixing and agitation; conveying of solids.

Heat Transfer: Conduction, convection and radiation, heat transfer coefficients, steady and unsteady heat conduction, boiling, condensation and evaporation; types of heat exchangers and evaporators and their design.

Mass Transfer: Fick's law, molecular diffusion in fluids, mass transfer coefficients, film, penetration and surface renewal theories; momentum, heat and mass transfer analogies; stagewise and continuous contacting and stage efficiencies; HTU & NTU concepts design and operation of equipment for distillation, absorption, leaching, liquid-liquid extraction, crystallization, drying, humidification, dehumidification and adsorption.

Chemical Reaction Engineering: Theories of reaction rates; kinetics of homogeneous reactions, interpretation of kinetic data, single and multiple reactions in ideal reactors, non-ideal reactors; residence time; non-isothermal reactors; kinetics of heterogeneous catalytic reactions; diffusion effects in catalysis.

Instrumentation and Process Control: Measurement of process variables; sensors, transducers and their dynamics, dynamics of simple systems, dynamics such as CSTRs, transfer functions and responses of simple systems, process reaction curve, controller modes (P, PI, and PID); control valves; analysis of closed loop systems including stability, frequency response (including Bode plots) and controller tuning, cascade, feed forward control.

Plant Design and Economics: Design and sizing of chemical engineering equipment such as compressors, heat exchangers, multistage contactors; principles of process economics and cost estimation including total annualized cost, cost indexes, rate of return, payback period, discounted cash flow, optimization in Design.

Chemical Technology: Inorganic chemical industries; sulfuric acid, NaOH, fertilizers (Ammonia, Urea, SSP and TSP); natural products industries (Pulp and Paper, Sugar, Oil, and Fats); petroleum refining and petrochemicals; polymerization industries; polyethylene, polypropylene, PVC and polyester synthetic fibers.

CS - COMPUTER SCIENCE AND ENGINEERING

ENGINEERING MATHEMATICS

Mathematical Logic: Propositional Logic; First Order Logic.

Probability: Conditional Probability; Mean, Median, Mode and Standard Deviation; Random Variables; Distributions; uniform, normal, exponential, Poisson, Binomial.

Set Theory & Algebra: Sets; Relations; Functions; Groups; Partial Orders; Lattice; Boolean Algebra.

Combinatorics: Permutations; Combinations; Counting; Summation; generating functions; recurrence relations; asymptotics.

Graph Theory: Connectivity; spanning trees; Cut vertices & edges; covering; matching; independent sets; Colouring; Planarity; Isomorphism.

Linear Algebra: Algebra of matrices, determinants, systems of linear equations, Eigen values and Eigen vectors.

Numerical Methods: LU decomposition for systems of linear equations; numerical solutions of non linear algebraic equations by Secant, Bisection and Newton-Raphson Methods; Numerical integration by trapezoidal and Simpson's rules.

Calculus: Limit, Continuity & differentiability, Mean value Theorems, Theorems of integral calculus, evaluation of definite & improper integrals, Partial derivatives, Total derivatives, maxima & minima.

THEORY OF COMPUTATION

Formal Languages and Automata Theory: Regular languages and finite automata, Context free languages and Push-down automata, Recursively enumerable sets and Turing machines, Un-decidability;

Analysis of Algorithms and Computational Complexity: Asymptotic analysis (best, worst, average case) of time and space, Upper and lower bounds on the complexity of specific problems, NP-completeness.

COMPUTER HARDWARE

Digital Logic: Logic functions, Minimization, Design and synthesis of Combinational and Sequential circuits; Number representation and Computer Arithmetic (fixed and floating point);

Computer Organization: Machine instructions and addressing modes, ALU and Data-path, hardwired and micro-programmed control, Memory interface, I/O interface (Interrupt and DMA mode), Serial communication interface, Instruction pipelining, Cache, main and secondary storage.

SOFTWARE SYSTEMS

Data structures: Notion of abstract data types, Stack, Queue, List, Set, String, Tree, Binary search tree, Heap, Graph;

Programming Methodology: C programming, Program control (iteration, recursion, Functions), Scope, Binding, Parameter passing, Elementary concepts of Object oriented, Functional and Logic Programming;

Algorithms for problem solving: Tree and graph traversals, Connected components, Spanning trees, Shortest paths; Hashing, Sorting, Searching; Design techniques (Greedy, Dynamic Programming, Divide-and-conquer);

Compiler Design: Lexical analysis, Parsing, Syntax directed translation, Runtime environment, Code generation, Linking (static and dynamic); Operating Systems: Classical concepts (concurrency, synchronization, deadlock), Processes, threads and Inter-process communication, CPU scheduling, Memory management, File systems, I/O systems, Protection and security.

Databases: Relational model (ER-model, relational algebra, tuple calculus), Database design (integrity constraints, normal forms), Query languages (SQL), File structures (sequential files, indexing, B+ trees), Transactions and concurrency control;

Computer Networks: ISO/OSI stack, sliding window protocol, LAN Technologies (Ethernet, Token ring), TCP/UDP, IP, Basic concepts of switches, gateways, and routers.

CH - CHEMISTRY

PHYSICAL CHEMISTRY

Structure: Quantum theory - principles and techniques; applications to particle in a box, harmonic oscillator, rigid rotor and hydrogen atom; valence bond and molecular orbital theories and Huckel approximation, approximate techniques: variation and perturbation; symmetry, point groups; rotational, vibrational, electronic, NMR and ESR spectroscopy.

Equilibrium: First law of thermodynamics, heat, energy and work; second law of thermodynamics and entropy; third law and absolute entropy; free energy; partial molar quantities; ideal and non-ideal solutions; phase transformation: phase rule and phase diagrams- one, two, and three component systems; activity, activity coefficient, fugacity and fugacity coefficient ; chemical equilibrium, response of chemical equilibrium to temperature and pressure; colligative properties; kinetic theory of gases; thermodynamics of electrochemical cells; standard electrode potentials: applications - corrosion and energy conversion; molecular partition function (translational, rotational, vibrational and electronic).

Kinetics: Rates of chemical reactions, theories of reaction rates, collision and transition state theory; temperature dependence of chemical reactions; elementary reactions, consecutive elementary reactions; steady state approximation, kinetics of photochemical reactions and free radical polymerization, homogenous and heterogeneous catalysis.

INORGANIC CHEMISTRY

Non-Transition Elements: General characteristics, structure and reactions of simple and industrially important compounds, boranes, carboranes, silicates, silicones, diamond and graphite; hydrides, oxides and oxoacids of N, P, S and halogens; boron nitride, borazines and phosphazenes; xenon compounds. Shapes of molecules, hard-soft acid base concept.

Transition Elements: General characteristics of d and f block elements; coordination chemistry: structure and isomerism, stability, theories of metal-ligand bonding (CFT and LFT), electronic spectra and magnetic properties of transition metal complexes and lanthanides; metal carbonyls, metal-metal bonds and metal atom clusters, metallocenes; transition metal complexes with bonds to hydrogen, alkyls, alkenes, and arenes; metal carbenes; use of organometallic compounds as catalysts in organic synthesis; mechanisms of substitution and electron transfer reactions of coordination complexes. Role of metals with special reference to Na, K, Mg, Ca, Fe, Co, Zn, and Mo in biological systems.

Solids: Crystal systems and lattices, Miller planes, crystal packing, crystal defects; Bragg's Law; ionic crystals, band theory, metals and semiconductors. Spinels.

Instrumental methods of analysis: atomic absorption, UV-visible spectrometry, chromatographic and electro-analytical methods.

ORGANIC CHEMISTRY

Synthesis, reactions and mechanisms involving the following: Alkenes, alkynes, arenes, alcohols, phenols, aldehydes, ketones, carboxylic acids and their derivatives; halides, nitro compounds and amines; stereochemical and conformational effects on reactivity and specificity; reactions with diborane and peracids. Michael reaction, Robinson annulation, reactivity umpolung, acyl anion equivalents; molecular rearrangements involving electron deficient atoms.

Photochemistry: Basic principles, photochemistry of olefins, carbonyl compounds, arenes, photo oxidation and reduction.

Pericyclic reactions: Cycloadditions, electrocyclic reactions, sigmatropic reactions; Woodward-Hoffmann rules.

Heterocycles: Structural properties and reactions of furan, pyrrole, thiophene, pyridine, indole.

Biomolecules: Structure, properties and reactions of mono- and di-saccharides, physico-chemical properties of amino acids, structural features of proteins and nucleic acids.

Spectroscopy: Principles and applications of IR, UV-visible, NMR and mass spectrometry in the determination of structures of organic compounds.

EC - ELECTRONICS AND COMMUNICATION ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix Algebra, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Mean value theorems, Theorems of integral calculus, Evaluation of definite and improper integrals, Partial Derivatives, Maxima and minima, Multiple integrals, Fourier series. Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equation (linear and nonlinear), Higher order linear differential equations with constant coefficients, Method of variation of parameters, Cauchy's and Euler's equations, Initial and boundary value problems, Partial Differential Equations and variable separable method.

Complex variables: Analytic functions, Cauchy's integral theorem and integral formula, Taylor's and Laurent' series, Residue theorem, solution integrals.

Probability and Statistics: Sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Discrete and continuous distributions, Poisson, Normal and Binomial distribution, Correlation and regression analysis.

Numerical Methods: Solutions of non-linear algebraic equations, single and multi-step methods for differential equations.

Transform Theory: Fourier transform, Laplace transform, Z-transform.

ELECTRONICS & COMMUNICATION ENGINEERING

Networks: Network graphs: matrices associated with graphs; incidence, fundamental cut set and fundamental circuit matrices. Solution methods: nodal and mesh analysis. Network theorems: superposition, Thevenin and Norton's maximum power transfer, Wye-Delta transformation. Steady state sinusoidal analysis using phasors. Linear constant coefficient differential equations; time domain analysis of simple RLC circuits, Solution of network equations using Laplace transform: frequency domain analysis of RLC circuits. 2-port network parameters: driving point and transfer functions. State equations for networks.

Electronic Devices: Energy bands in silicon, intrinsic and extrinsic silicon. Carrier transport in silicon: diffusion current, drift current, mobility, resistivity. Generation and recombination of carriers. p-n junction diode, Zener diode, tunnel diode, BJT, JFET, MOS capacitor, MOSFET, LED, p-I-n and avalanche photo diode, LASERs. Device technology: integrated circuits fabrication process, oxidation, diffusion, ion implantation, photolithography, n-tub, p-tub and twin-tub CMOS process.

Analog Circuits: Equivalent circuits (large and small-signal) of diodes, BJTs, JFETs, and MOSFETs. Simple diode circuits, clipping, clamping, rectifier. Biasing and bias stability of transistor and FET amplifiers. Amplifiers: single-and multi-stage, differential, operational, feedback and power. Analysis of amplifiers; frequency response of amplifiers. Simple op-amp circuits. Filters. Sinusoidal oscillators; criterion for oscillation; single-transistor and op-amp configurations. Function generators and wave-shaping circuits. Power supplies.

Digital circuits: Boolean algebra, minimization of Boolean functions; logic gates digital IC families (DTL, TTL, ECL, MOS, CMOS). Combinational circuits: arithmetic circuits, code converters, multiplexers and decoders. Sequential circuits: latches and flip-flops, counters and shift-registers. Sample and hold circuits, ADCs, DACs. Semiconductor memories. Microprocessor(8085): architecture, programming, memory and I/O interfacing.

Signals and Systems: Definitions and properties of Laplace transform, continuous-time and discrete-time Fourier series, continuous-time and discrete-time Fourier Transform, z-transform. Sampling theorems. Linear Time-Invariant (LTI) Systems: definitions and properties; casuality, stability, impulse response, convolution, poles and zeros frequency response, group delay, phase delay. Signal transmission through LTI systems. Random signals and noise: probability, random variables, probability density function, autocorrelation, power spectral density.

Controls Systems: Basic control system components; block diagrammatic description, reduction of block diagrams. Open loop and closed loop (feedback) systems and stability analysis of these systems. Signal flow graphs and their use in determining transfer functions of systems; transient and steady state analysis of LTI control systems and frequency response. Tools and techniques for LTI control system analysis: root loci, Routh-Hurwitz criterion, Bode and Nyquist plots. Control system compensators: elements of lead and lag compensation, elements of Proportional-Integral-Derivative(PID) control. State variable representation and solution of state equation of LTI control systems.

Communications: Analog communication systems: amplitude and angle modulation and demodulation systems, spectral analysis of these operations, superheterodyne receivers; elements of hardware, realizations of analog communication systems; signal-to-noise ratio (SNR) calculations for amplitude modulation (AM) and frequency modulation (FM) for low noise conditions. Digital communication systems: pulse code modulation (PCM), differential pulse code modulation (DPCM), delta modulation (DM); digital modulation schemes-amplitude, phase and frequency shift keying schemes (ASK, PSK, FSK), matched filter receivers, bandwith consideration and probability of error calculations for these schemes.

Electromagnetics: Elements of vector calculus: divergence and curl; Gauss' and Stokes' theorems, Maxwell's equations: differential and integral forms. Wave equation, Poynting vector. Plane waves: propagation through various media; reflection and refraction; phase and group velocity; skin depth. Transmission lines: characteristic impedance; impedance transformation; Smith chart; impedance matching; pulse excitation. Waveguides: modes in rectangular waveguides; boundary conditions; cut-off frequencies; dispersion relations. Antennas: Dipole antennas; antenna arrays; radiation pattern; reciprocity theorem, antenna gain.

EE - ELECTRICAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix Algebra, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Mean value theorems, Theorems of integral calculus, Evaluation of definite and improper integrals, Partial Derivatives, Maxima and minima, Multiple integrals, Fourier series. Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equation (linear and nonlinear), Higher order linear differential equations with constant coefficients, Method of variation of parameters, Cauchy's and Euler's equations, Initial and boundary value problems, Partial Differential Equations and variable separable method.

Complex variables: Analytic functions, Cauchy's integral theorem and integral formula, Taylor's and Laurent' series, Residue theorem, solution integrals.

Probability and Statistics: Sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Discrete and continuous distributions, Poisson, Normal and Binomial distribution, Correlation and regression analysis.

Numerical Methods: Solutions of non-linear algebraic equations, single and multi-step methods for differential equations.

Transform Theory: Fourier transform, Laplace transform, Z-transform.

ELECTRICAL ENGINEERING

Electrical Circuits and Fields: Network graph, KCL, KVL, node/ cut set, mesh/ tie set analysis, transient response of d.c. and a.c. networks; sinusoidal steady-state analysis; resonance in electrical circuits; concepts of ideal voltage and current sources, network theorems, driving point, immittance and transfer functions of two port networks, elementary concepts of filters; three phase circuits; Fourier series and its application; Gauss theorem, electric field intensity and potential due to point, line, plane and spherical charge distribution, dielectrics, capacitance calculations for simple configurations; Ampere's and Biot-Savart's law, inductance calculations for simple configurations.

Electrical Machines: Single phase transformer - equivalent circuit, phasor diagram, tests, regulation and efficiency; three phase transformers - connections, parallel operation; auto transformer and three-winding transformer; principles of energy conversion, windings of rotating machines: D. C. generators and motors - characteristics, starting and speed control, armature reaction and commutation; three phase induction motors-performance characteristics, starting and speed control; single-phase induction motors; synchronous generators-performance, regulation, parallel operation; synchronous motors - starting, characteristics, applications, synchronous condensers; fractional horse power motors; permanent magnet and stepper motors.

Power Systems: Electric power generation - thermal, hydro, nuclear; transmission line parameters; steady-state performance of overhead transmission lines and cables and surge propagation; distribution systems, insulators, bundle conductors, corona and radio interference effects; per-unit quantities; bus admittance and impedance matrices; load flow; voltage control and power factor correction; economic operation; symmetrical components, analysis of symmetrical and unsymmetrical faults; principles of over current, differential and distance protections; concept of solid state relays and digital protection; circuit breakers; concept of system stability-swing curves and equal area criterion; basic concepts of HVDC transmission.

Control Systems: Principles of feedback; transfer function; block diagrams: steady-state errors; stability-Routh and Nyquist criteria; Bode plots; compensation; root loci; elementary state variable formulation; state transition matrix and response for Linear Time Invariant systems.

Electrical and Electronic Measurements: Bridges and potentiometers, PMMC, moving iron, dynamometer and induction type instruments; measurement of voltage, current, power, energy and power factor; instrument transformers; digital voltmeters and multimeters; phase, time and frequency measurement; Q-meter, oscilloscopes, potentiometric recorders, error analysis.

Analog and Digital Electronics: Characteristics of diodes, BJT, FET, SCR; amplifiers-biasing, equivalent circuit and frequency response; oscillators and feedback amplifiers, operational amplifiers- characteristics and applications; simple active filters; VCOs and timers; combinational and sequential logic circuits, multiplexer, Schmitt trigger, multivibrators, sample and hold circuits, A/D and D/A converters; microprocessors and their applications.

Power Electronics and Electric Drives: Semiconductor power devices-diodes, transistors, thyristors, triacs, GTOs, MOSFETs and IGBTs - static characteristics and principles of operation; triggering circuits; phase control rectifiers; bridge converters-fully controlled and half controlled; principles of choppers and inverters, basic concepts of adjustable speed dc and ac drives.

GG - GEOLOGY AND GEOPHYSICS

PART - I

Earth and planetary system; size, shape, internal structure and composition of the earth; atmosphere and greenhouse effect; isostasy; elements of seismology; continents and continental processes; physical oceanography; palaeomagnetism, continental drift plate tectonics, geothermal energy.

Weathering; soil formation; action of river, wind and glacier; oceans and oceanic features; earthquakes, volcanoes, orogeny and mountain building; elements of structural geology; crystallography; classification, composition and properties of minerals and rocks; engineering properties of rocks and soils, role of geology in the construction of engineering structures.

Processes of ore formation, occurrence and distribution of ores on land and on ocean floor; coal and petroleum resources in India; ground water geology including well hydraulics, geological time scale and geochronology; stratigraphic principles and stratigraphy of India; basics concepts of gravity, magnetic and electrical prospecting for ores and ground water.

PART - IIA: GEOLOGY

Crystal symmetry, forms, twinning; crystal chemistry; optical mineralogy, classification of minerals, diagnostic properties of rock minerals.

Mineralogy, structure, texture and classification of igneous, sedimentary and metamorphic rock, their origin and evolution; application of thermodynamics; structure and petrology of sedimentary rocks; sedimentary processes and environments, sedimentary facies, basin studies; basement cover relationship;

Primary and secondary structures; geometry and genesis of folds, faults, joints, unconformities, cleavage, schistosity and lineation; methods of projection. Tectonites and their significance; shear zone; superposed folding.

Morphology, classification and geological significance of important invertebrates, vertebrates, microfossils and palaeoflora; stratigraphic principles and Indian stratigraphy; geomorphic processes and agents; development and evolution of landforms; slope and drainage;

processes on deep oceanic and near-shore regions; quantitative and applied geomorphology; air photo interpretation and remote sensing; chemical and optical properties of ore minerals; formation and localization of ore deposits; prospecting and exploration of economic minerals; coal and petroleum geology; origin and distribution of mineral and fuel deposits in India; ore dressing and mineral economics.

Cosmic abundance; meteorites; geochemical evolution of the earth; geochemical cycles; distribution of major, minor and trace elements; isotope geochemistry; geochemistry of waters including solution equilibria and water rock interaction.

Engineering properties of rocks and soils; rocks as construction material; geology of dams, tunnels and excavation sites; natural hazards; the fly ash problem; ground water geology and exploration; water quality; impact of human activity; Remote sensing techniques for the interpretation of landforms and resource management.

PART - II B: GEOPHYSICS

The earth as a planet; different motions of the earth; gravity filed of the earth and its shape; geochronology; isostasy, seismology and interior of the earth; variation of density, velocity, pressure, temperature, electrical and magnetic properties inside the earth; earthquakes-causes and measurements; zonation and seismic hazards; geomagnetic field, palaeomagnetism; oceanic and continental lithosphere; plate tectonics; heat flow; upper and lower atmospheric phenomena.

Theories of scalar and vector potential fields; Laplace, Maxwell and Helmholtz equations for solution of different types of boundary value problems for Cartesian, cylindrical and spherical polar coordinates; Green's theorem; Image theory; integral equations and conformal transformations in potential theory; Eikonal equation and ray theory.

'G' and 'g' units of measurement, density of rocks, gravimeters, preparation, analysis and interpretation of gravity maps; derivative maps, analytical continuation; gravity anomaly type curves; calculation of mass.

Earth's magnetic field, units of measurement, magnetic susceptibility of rocks, magnetometers, corrections, preparation of magnetic maps, magnetic anomaly type curve, analytical continuation, interpretation and application; magnetic well logging.

Conduction of electricity through rocks, electrical conductivities of metals, metallic, non-metallic and rock forming minerals, D.C. resistivity units and methods of measurement, electrode configuration for sounding and profiling, application of filter theory, interpretation of resistivity field data, application; self potential origin, classification, field measurement, interpretation of induced polarization time frequency, phase domain; IP units and methods of measurement, interpretation and application; ground-water exploration.

Origin of electromagnetic field elliptic polarization, methods of measurement for different source-receiver configuration components in EM measurements, interpretation and applications; earth's natural electromagnetic field, tellurics, magneto-tellurics; geomagnetic depth sounding principles, methods of measurement, processing of data and interpretation.

Seismic methods of prospecting: Reflection, refraction and CDP surveys; land and marine seismic sources, generation and propagation of elastic waves, velocity increasing with depth, geophones, hydrophones, recording instruments (DFS), digital formats, field layouts, seismic noises and noise profile analysis, optimum geophone grouping, noise cancellation by shot and geophone arrays, 2D and 3D seismic data acquisition and processing, CDP stacking charts, binning, filtering, dip-moveout, static and dynamic corrections, deconvolution, migration, signal processing, Fourier and Hilbert transforms, attribute analysis, bright and dim spots, seismic stratigraphy, high resolution seismics, VSP.

Principles and techniques of geophysical well-logging, SP, resistivity, induction, micro gamma ray, neutron, density, sonic, temperature, dip meter, caliper, nuclear magnetic, cement bond logging. Quantitative evaluation of formations from well logs; well hydraulics and application of geophysical methods for groundwater study; application of bore hole geophysics in ground water, mineral and oil exploration. Remote sensing techniques and application of remote sensing methods in geophysics.

IN - INSTRUMENTATION ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix Algebra, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Mean value theorems, Theorems of integral calculus, Evaluation of definite and improper integrals, Partial Derivatives, Maxima and minima, Multiple integrals, Fourier series. Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equation (linear and nonlinear), Higher order linear differential equations with constant coefficients, Method of variation of parameters, Cauchy's and Euler's equations, Initial and boundary value problems, Partial Differential Equations and variable separable method.

Complex variables: Analytic functions, Cauchy's integral theorem and integral formula, Taylor's and Laurent' series, Residue theorem, solution integrals.

Probability and Statistics: Sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Discrete and continuous distributions, Poisson, Normal and Binomial distribution, Correlation and regression analysis.

Numerical Methods: Solutions of non-linear algebraic equations, single and multi-step methods for differential equations.

Transform Theory: Fourier transform, Laplace transform, Z-transform.

INSTRUMENTATION ENGINEERING

Measurement Basics and Metrology: Static and dynamic characteristics of measurement systems. Standards and calibration. Error and uncertainty analysis, statistical analysis of data, and curve fitting. Linear and angular measurements; Measurement of straightness, flatness, roundness and roughness.

Transducers, Mechanical Measurements and Industrial Instrumentation: Transducers - elastic, resistive, inductive, capacitive, thermo-electric, piezoelectric, photoelectric, electro-mechanical, electro-chemical, and ultrasonic. Measurement of displacement, velocity (linear and rotational), acceleration, shock, vibration, force, torque, power, strain, stress, pressure, flow, temperature, humidity, viscosity, and density. energy storing elements, suspension systems and dampers.

Analog Electronics: Characteristics of diodes, BJTs, JFETs and MOSFETs; Diode circuits; Amplifiers: single and multi-stage, feedback; Frequency response; Operational amplifiers - design, characteristic, linear and non-linear applications: difference amplifiers; instrumentation amplifiers; precision rectifiers, I-to-V converters, active filters, oscillators, comparators, signal generators, wave shaping circuits.

Digital Electronics: Combinational logic circuits, minimization of Boolean functions; IC families (TTL, MOS, CMOS), arithmetic circuits, multiplexer and decoders. Sequential circuits: flip-flops, counters, shift registers. Schmitt trigger, timers, and multivibrators. Analog switches, multiplexers, S/H circuits. Analog-to-digital and digital-to-analog converters. Basics of computer organization and architecture. 8-bit microprocessor (8085), applications, memory, I/O interfacing, and microcontrollers.

Signals and Systems: Vectors and matrices; Fourier series; Fourier transforms; Ordinary differential equations. Impulse and frequency responses of first and second order systems. Laplace transform and transfer function, convolution and correlation. Amplitude and frequency modulations and demodulations. Discrete time systems, difference equations, impulse and frequency responses; Z-transforms and transfer functions; IIR and FIR filters.

Electrical and Electronic Measurements: Measurement of R, L and C; bridges and potentiometers. Measurement of voltage, current, power, power factor, and energy; Instrument transformers; Q meter, waveform analyzers. Digital volt-meters and multi-meters. Time, phase and frequency measurements; Oscilloscope. Noise and interference in instrumentation.

Control Systems & Process Control: Principles of feedback; transfer function, signal flow graphs. Stability criteria, Bode plots, root-loci, Routh and Nyquist criteria. Compensation techniques; State space analysis. System components: mechanical, hydraulic, pneumatic, electrical and electronic; Servos and synchros; Stepper motors. On-off, cascade, P, PI, PID and feed-forward controls. Controller tuning and general frequency response.

Analytical, Optical and Biomedical Instrumentation: Principles of spectrometry, UV, visible, IR mass spectrometry, X-ray methods; nuclear radiation measurements, gas, solid and semi conductor lasers and their characteristics, interferometers, basics of fibre optics, transducers in biomedical applications, cardiovascular system measurements, instrumentation for clinical laboratory.

MA - MATHEMATICS

Linear Algebra: Finite dimensional vector spaces. Linear transformations and their matrix representations, rank; systems of linear equations, eigenvalues and eigenvectors, minimal polynomial, Cayley-Hamilton theorem, diagonalisation, Hermitian, Skew-Hermitian and unitary matrices. Finite dimensional inner product spaces, self-adjoint and Normal linear operators, spectral theorem, Quadratic forms.

Complex Analysis: Analytic functions, conformal mappings, bilinear transformations, complex integration: Cauchy's integral theorem and formula, Liouville's theorem, maximum modulus principle, Taylor and Laurent's series, residue theorem and applications for evaluating real integrals.

Real Analysis: Sequences and series of functions, uniform convergence, power series, Fourier series, functions of several variables, maxima, minima, multiple integrals, line, surface and volume integrals, theorems of Green, Stokes and Gauss; metric spaces, completeness, Weierstrass approximation theorem, compactness. Lebesgue measure, measurable functions; Lebesgue integral, Fatou's lemma, dominated convergence theorem.

Ordinary Differential Equations: First order ordinary differential equations, existence and uniqueness theorems, systems of linear first order ordinary differential equations, linear ordinary differential equations of higher order with constant coefficients; linear second order ordinary differential equations with variable coefficients, method of Laplace transforms for solving ordinary differential equations, series solutions; Legendre and Bessel functions and their orthogonality, Sturm Liouville system, Greeen's functions.

Algebra: Normal subgroups and homomorphisms theorems, automorphisms. Group actions, sylow's theorems and their applications groups of order less than or equal to 20, Finite p-groups. Euclidean domains, Principal ideal domains and unique factorizations domains. Prime ideals and maximal ideals in commutative rings.

Functional Analysis: Banach spaces, Hahn-Banach theorems, open mapping and closed graph theorems, principle of uniform boundedness; Hilbert spaces, orthonormal sets, Riesz representation theorem, self-adjoint, unitary and normal linear operators on Hilbert Spaces.

Numerical Analysis: Numerical solution of algebraic and transcendental equations; bisection, secant method, Newton-Raphson method, fixed point iteration, interpolation: existence and error of polynomial interpolation, Lagrange, Newton, Hermite(osculatory)interpolations; numerical differentiation and integration, Trapezoidal and Simpson rules; Gaussian quadrature; (Gauss-Legendre and Gauss-Chebyshev), method of undetermined parameters, least square and orthonormal polynomial approximation; numerical solution of systems of linear equations: direct and iterative methods, (Jacobi Gauss-Seidel and SOR) with convergence; matrix eigenvalue problems: Jacobi and Given's methods, numerical solution of ordinary differential equations: initial value problems, Taylor series method, Runge-Kutta methods, predictor-corrector methods; convergence and stability.

Partial Differential Equations: Linear and quasilinear first order partial differential equations, method of characteristics; second order linear equations in two variables and their classification; Cauchy, Dirichlet and Neumann problems, Green's functions; solutions of Laplace, wave and diffusion equations in two variables Fourier series and transform methods of solutions of the above equations and applications to physical problems.

Mechanics: Forces in three dimensions, Poinsot central axis, virtual work, Lagrange's equations for holonomic systems, theory of small oscillations, Hamiltonian equations;

Topology: Basic concepts of topology, product topology, connectedness, compactness, countability and separation axioms, Urysohn's Lemma, Tietze extension theorem, metrization theorems, Tychonoff theorem on compactness of product spaces.

Probability and Statistics: Probability space, conditional probability, Bayes' theorem, independence, Random variables, joint and conditional distributions, standard probability distributions and their properties, expectation, conditional expectation, moments. Weak and strong law of large numbers, central limit theorem. Sampling distributions, UMVU estimators, sufficiency and consistency, maximum likelihood estimators. Testing of hypotheses, Neyman-Pearson tests, monotone likelihood ratio, likelihood ratio tests, standard parametric tests based on normal, X2 ,t, F-distributions. Linear regression and test for linearity of regression. Interval estimation.

Linear Programming: Linear programming problem and its formulation, convex sets their properties, graphical method, basic feasible solution, simplex method, big-M and two phase methods, infeasible and unbounded LPP's, alternate optima. Dual problem and duality theorems, dual simplex method and its application in post optimality analysis, interpretation of dual variables. Balanced and unbalanced transportation problems, unimodular property and u-v method for solving transportation problems. Hungarian method for solving assignment problems.

Calculus of Variations and Integral Equations: Variational problems with fixed boundaries; sufficient conditions for extremum, Linear integral equations of Fredholm and Volterra type, their iterative solutions. Fredholm alternative.

ME - MECHANICAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

APPLIED MECHANICS AND DESIGN

Engineering Mechanics: Equivalent force systems, free-body concepts, equations of equilibrium, trusses and frames, virtual work and minimum potential energy. Kinematics and dynamics of particles and rigid bodies, impulse and momentum (linear and angular), energy methods, central force motion.

Strength of Materials: Stress and strain, stress-strain relationship and elastic constants, Mohr's circle for plane stress and plane strain, shear force and bending moment diagrams, bending and shear stresses, deflection of beams, torsion of circular shafts, thin and thick cylinders, Euler's theory of columns, strain energy methods, thermal stresses.

Theory of Machines: Displacement, velocity and acceleration, analysis of plane mechanisms, dynamic analysis of slider-crank mechanism, planar cams and followers, gear tooth profiles, kinematics of gears, governors and flywheels, balancing of reciprocating and rotating masses.

Vibrations: Free and forced vibration of single degree freedom systems, effect of damping, vibration isolation, resonance, critical speed of rotors.

Design of Machine Elements: Design for static and dynamic loading, failure theories, fatigue strength; design of bolted, riveted and welded joints; design of shafts and keys; design of spur gears, rolling and sliding contact bearings; brakes and clutches; belt, rope and chain drives.

FLUID MECHANICS AND THERMAL SCIENCES

Fluid Mechanics: Fluid properties, fluid statics, manometry, buoyancy; control-volume analysis of mass, momentum and energy; fluid acceleration; differential equations of continuity and momentum; Bernoulli's equation; viscous flow of incompressible fluids; boundary layer; elementary turbulent flow; flow through pipes, head losses in pipes, bends etc.

Heat-Transfer: Modes of heat transfer; one dimensional heat conduction, resistance concept, electrical analogy, unsteady heat conduction, fins; dimensionless parameters in free and forced convective heat transfer, various correlations for heat transfer in flow over flat plates and through pipes; thermal boundary layer; effect of turbulence; radiative heat transfer, black and grey surfaces, shape factors, network analysis; heat exchanger performance, LMTD and NTU methods.

Thermodynamics: Zeroth, First and Second laws of thermodynamics; thermodynamic system and processes; irreversibility and availability; behaviour of ideal and real gases, properties of pure substances, calculation of work and heat in ideal processes; analysis of thermodynamic cycles related to energy conversion; Carnot, Rankine, Otto, Diesel, Brayton and vapour compression cycles.

Power Plant Engineering: Steam generators; steam power cycles; steam turbines; impulse and reaction principles, velocity diagrams, pressure and velocity compounding; reheating and reheat factor; condensers and feed heaters.

I.C. Engines: Requirements and suitability of fuels in IC engines, fuel ratings, fuel-air mixture requirements; normal combustion in SI and CI engines; engine performance calculations.

Refrigeration and air-conditioning: Refrigerant compressors, expansion devices, condensers and evaporators; properties of moist air, psychrometric chart, basic psychometric processes.

Turbomachinery: Components of gas turbines; compression processes, centrifugal and axial flow compressors; axial flow turbines, elementary theory; hydraulic turbines; Euler-turbine equation; specific speed, Pelton-wheel, Francis and Kaplan turbines; centrifugal pumps.

MANUFACTURING AND INDUSTRIAL ENGINEERING

Engineering Materials: Structure and properties of engineering materials and their applications, heat treatment.

Metal Casting: Casting processes (expendable and non-expendable) -pattern, moulds and cores, heating and pouring, solidification and cooling, gating design, design considerations, defects.

Forming Processes: Stress-strain diagrams for ductile and brittle material, Plastic deformation and yield criteria, fundamentals of hot and cold working processes, Bulk metal forming processes (forging, rolling, extrusion, drawing), sheet metal working processes (punching, blanking, bending, deep drawing, coining, spinning, load estimation using homogeneous deformation methods, defects). processing of powder metals- atomization, compaction, sintering, secondary and finishing operations. forming and shaping of plastics- extrusion, injection moulding.

Joining Processes: Physics of welding, fusion and non-fusion welding processes, brazing and soldering, adhesive bonding, design considerations in welding, weld quality defects.

Machining and Machine Tool Operations: Mechanics of machining, single and multi-point cutting tools, tool geometry and materials, tool life and wear, cutting fluids, machinability, economics of machining, non-traditional machining processes.

Metrology and Inspection: Limits, fits and tolerances, linear and angular measurements, comparators, gauge design, interferometry, form and finish measurement, measurement of screw threads, alignment and testing methods.

Tool Engineering: Principles of work holding, design of jigs and fixtures.

Computer Integrated Manufacturing: Basic concepts of CAD, CAM and their integration tools.

Manufacturing Analysis: Part-print analysis, tolerance analysis in manufacturing and assembly, time and cost analysis.

Work-Study: Method study, work measurement, time study, work sampling, job evaluation, merit rating.

Production Planning and Control: Forecasting models, aggregate production planning, master scheduling, materials requirements planning.

Inventory Control: Deterministic and probabilistic models, safety stock inventory control systems.

Operations Research: Linear programming, simplex and duplex method, transportation, assignment, network flow models, simple queuing models, PERT and CPM

MN - MINING ENGINEERING

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

MINING ENGINEERING

Mechanics: Equivalent force systems, equations of equilibrium, two dimensional frames and trusses, free body diagrams, friction forces, particle kinematics and dynamics.

Mine Development, Geomechanics and Strata Control: Drivages for underground mine development, drilling methods and machines, explosives, blasting devices and practices, shaft sinking. Physico-mechanical properties of rocks, rock mass classification, ground control instrumentation and stress measurement techniques, theories of rock failure, ground vibrations, stress distribution around mine openings, subsidence, design of supports in roadways and workings, stability of open pits, slopes.

Mining Methods and Machinery: Surface mining - layout, development, loading, transportation and mechanization, continuous surface mining systems. Underground coal mining - bord and pillar system, longwall mining, thick seam mining methods. Underground metal mining: different stoping methods, stope mechanization, ore handling systems, mine filling. Generation and transmission of mechanical, hydraulic, and pneumatic power. Materials handling - haulages, conveyors, ropeways, face and development machinery, hoisting systems, and pumps.

Ventilation, Underground Hazards and Surface Environment: Underground atmosphere, heat load sources and thermal environment, air cooling, mechanics of air flow distribution, natural and mechanical ventilation, mine fans and their usage, auxiliary ventilation. Subsurface hazards from fires, explosions, gases, dust, and inundation, rescue apparatus and practices, safety in mines, accident analysis, noise, mine lighting. Air and water pollution: causes, dispersion, quality standards, and control.

Surveying, Mine Planning and Systems Engineering: Fundamentals of engineering surveying, Levels and levelling, Theodolite, tacheometry, triangulation, contouring, errors and adjustments, correlation, underground surveying, curves, photogrammetry, field astronomy, GPS fundamentals. Principles of planning - Sampling methods and practices, reserve estimation techniques, basics of geostatistics, optimization of facility location, cash flow concepts and mine valuation, open pit design. Work study, concepts of reliability, reliability of series and parallel systems. Linear programming, transportation and assignment problems, queueing, network analysis, inventory control.

MT - METALLURGICAL ENGINEERING

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

METALLURGICAL ENGINEERING

Thermodynamics and Rate Processes: Laws of thermodynamics, activity, equilibrium constant, applications to metallurgical systems, solutions, phase equilibria, basic kinetic laws, order of reactions, rate constants and rate limiting steps principles of electro chemistry, aqueous, corrosion and protection of metals, oxidation and high temperature corrosion - characterization and control; momentum transfer - concepts of viscosity, shell balances, Bernoulli's equation; heat transfer - conduction, convection and heat transfer coefficient relations, radiation, mass transfer - diffusion and Fick's laws.

Extractive Metallurgy: Flotation, gravity and other methods of mineral processing; agglomeration, pyro-hydro-and electro-metallurgical processes; material and energy balances; principles and processes for the extraction of non-ferrous metals - aluminium, copper, zinc, lead, magnesium, nickel, titanium and other rare metals; iron and steel making - principles, blast furnace, direct reduction processes, primary and secondary steel making, deoxidation and inclusion in steel; ingot and continuous casting; stainless steel making, design of furnaces; fuels and refractories.

Physical Metallurgy: Crystal structure and bonding characteristics of metals, alloys, ceramics and polymers; solid solutions; solidification; phase transformation and binary phase diagrams; principles of heat treatment of steels, aluminum alloys and cast irons; recovery, recrystallization and grain growth; industrially important ferrous and non-ferrous alloys; elements of X-ray and electron diffraction; principles of scanning and transmission electron microscopy; elements of ceramics, composites and electronic materials; electronic basis of thermal, optical, electrical and magnetic properties of materials.

Mechanical Metallurgy: Elements of elasticity and plasticity; defects in crystals; elements of dislocation theory - types of dislocations, slip and twinning, stress fields of dislocations, dislocation interactions and reactions, methods of seeing dislocations; strengthening mechanisms; tensile, fatigue and creep behaviour; superplasticity; fracture - Griffith theory, ductile to brittle transition, fracture toughness; failure analysis; mechanical testing - tension, compression, torsion, hardness, impact, creep, fatigue, fracture toughness and formability tests.

Manufacturing Processes: Metal casting - patterns, moulds, melting, gating, feeding and casting processes, defects and castings, hot and cold working of metals; Metal forming - fundamentals of metal forming, rolling wire drawing, extrusion, forming, sheet metal forming processes, defects in forming; Metal joining - soldering, brazing and welding, common welding processes, welding metallurgy, problems associated with welding of steels and aluminium alloys, defects in welding, powder metallurgy; NDT methods - ultrasonic, radiography, eddy current, acoustic emission and magnetic.

PH - PHYSICS

Mathematical Physics: Linear vector space, matrices; vector calculus; linear differential equations; elements of complex analysis; Laplace transforms, Fourier analysis, elementary ideas about tensors.

Classical Mechanics: Conservation laws; central forces; collisions and scattering in laboratory and centre of mass reference frames; mechanics of system of particles; rigid body dynamics; moment of inertia tensor; noninertial frames and pseudo forces; variational principle; Lagrange's and Hamilton's formalisms; equation of motion, cyclic coordinates, Poisson bracket; periodic motion, small oscillations, normal modes; wave equation and wave propagation; special theory of relativity - Lorentz transformations, relativistic kinematics, mass-energy equivalence.

Electromagnetic Theory: Laplace and Poisson equations; conductors and dielectrics; boundary value problems; Ampere's and Biot-Savart's laws; Faraday's law; Maxwell's equations; scalar and vector potentials; Coulomb and Lorentz gauges; boundary conditions at interfaces; electromagnetic waves; interference, diffraction and polarization; radiation from moving charges.

Quantum Mechanics: Physical basis of quantum mechanics; uncertainty principle; Schrodinger equation; one and three dimensional potential problems; Particle in a box, harmonic oscillator, hydrogen atom; linear vectors and operators in Hilbert space; angular momentum and spin; addition of angular momentum; time independent perturbation theory; elementary scattering theory.

Atomic and Molecular Physics: Spectra of one-and many-electron atoms; LS and jj coupling; hyperfine structure; Zeeman and Stark effects; electric dipole transitions and selection rules; X-ray spectra; rotational and vibrational spectra of diatomic molecules; electronic transition in diatomic molecules, Franck-Condon principle; Raman effect; NMR and ESR; lasers.

Thermodynamics and Statistical Physics: Laws of thermodynamics; macrostates, phase space; probability ensembles; partition function, free energy, calculation of thermodynamic quantities; classical and quantum statistics; degenerate Fermi gas; black body radiation and Planck's distribution law; Bose-Einstein condensation; first and second order phase transitions, critical point.

Solid State Physics: Elements of crystallography; diffraction methods for structure determination; bonding in solids; elastic properties of solids; defects in crystals; lattice vibrations and thermal properties of solids; free electron theory; band theory of solids; metals, semiconductors and insulators; transport properties; optical, dielectric and magnetic properties of solids; elements of superconductivity.

Nuclear and Particle Physics: Rutheford scattering; basic properties of nuclei; radioactive decay; nuclear forces; two nucleon problem; nuclear reactions; conservation laws; fission and fusion; nuclear models; particle accelerators, detectors; elementary particles; photons, baryons, mesons and leptons; Quark model.

Electronics: Network analysis; semiconductor devices; bipolar transistors; FETs; power supplies, amplifier, oscillators; operational amplifiers; elements of digital electronics; logic circuits.

PI - PRODUCTION AND INDUSTRIAL ENGINEERING

ENGINEERING MATHEMATICS

Linear Algebra: Matrix algebra, Systems of linear equations, Eigen values and eigenvectors.

Calculus: Functions of single variable, Limit, continuity and differentiability, Mean value theorems, Evaluation of definite and improper integrals, Partial derivatives, Total derivative, Maxima and minima, Gradient, Divergence and Curl, Vector identities, Directional derivatives, Line, Surface and Volume integrals, Stokes, Gauss and Green's theorems.

Differential equations: First order equations (linear and nonlinear), Higher order linear differential equations with constant coefficients, Cauchy's and Euler's equations, Initial and boundary value problems, Laplace transforms, Solutions of one dimensional heat and wave equations and Laplace equation.

Complex variables: Analytic functions, Cauchy's integral theorem, Taylor and Laurent series.

Probability and Statistics: Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Random variables, Poisson, Normal and Binomial distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations Integration by trapezoidal and Simpson's rule, single and multi-step methods for differential equations.

GENERAL ENGINEERING:

Engineering Materials: Structure and properties of engineering materials and their applications; effect of strain, strain rate and temperature on mechanical properties of metals and alloys; heat treatment of metals and alloys.

Applied Mechanics: Engineering mechanics - equivalent force systems, free body concepts, equations of equilibrium, virtual work and minimum potential energy; strength of materials-stress, strain and their relationship, Mohr's circle, deflection of beams, bending and shear stress, Euler's theory of columns.

Theory of Machines and Design: Analysis of planar mechanisms, plane cams and followers; governers and fly wheels; design of elements-failure theories; design of bolted, riveted and welded joints; design of shafts, keys, belt drives, brakes and clutches.

Thermal Engineering: Fluid machines - fluid statics, Bernoulli's equation, flow through pipes, equations of continuity and momentum; Thermodynamics - zeroth, First and Second laws of thermodynamics, thermodynamic system and processes, calculation of work and heat for systems and control volumes; Heat transfer - fundamentals of conduction, convection and radiation.

PRODUCTION ENGINEERING

Metal Casting: Casting processes; patterns-materials; allowances; moulds and cores - materials, making and testing; melting and founding of cast iron, steels and nonferrous metals and alloys; solidification; design of casting, gating and risering; casting defects and inspection.

Metal working: Stress-strain in elastic and plastic deformation; deformation mechanisms; hot and cold working-forging, rolling, extrusion, wire and tube drawing; sheet metal working; analysis of rolling, forging, extrusion and wire /rod drawing; metal working defects, high energy rate forming processes-explosive, magnetic, electro and electrohydraulic.

Metal Joining Processes: Welding processes - gas shielded metal arc, TIG, MIG, submerged arc, electroslag, thermit, resistance, pressure and forge welding; thermal cutting; other joining processes - soldering, brazing, braze welding; welding codes, welding symbols, design of welded joints, defects and inspection; introduction to modern welding processes - friction, ultrasonic, explosive, electron beam, laser and plasma.

Machining and Machine Tool Operations: Machining processes-turning, drilling, boring, milling, shaping, planing, sawing, gear cutting, thread production, broaching, grinding, lapping, honing super finishing; mechanics of cutting- Merchant's analysis, geometry of cutting tools, cutting forces, power requirements; selection of process parameters; tool materials, tool wear and tool life, cutting fluids, machinability; nontraditional machining processes and hybrid processes- EDM, CHM, ECM, USM, LBM, EBM, AJM, PAM AND WJM; economics of machining.

Metrology and Inspection: Limits and fits, linear and angular measurements by mechanical and optical methods, comparators; design of limit gauges; interferometry; measurement of straightness, flatness, roundness, squareness and symmetry; surface finish measurement; inspection of screw threads and gears; alignment testing.

Powder Metallurgy and Processing of Plastics: Production of powders, compaction, sintering; Polymers and composites; injection, compression and blow molding, extrusion, calendaring and thermoforming; molding of composites.

Tool Engineering: Work-holding-location and clamping; principles and methods; design of jigs and fixtures; design of press working tools, forging dies.

Manufacturing Analysis: Sources of errors in manufacturing; process capability; part-print analysis; tolerance analysis in manufacturing and assembly; process planning; parameter selection and comparison of production alternatives; time and cost analysis; Issues in choosing manufacturing technologies and strategies.

Computer Integrated Manufacturing: Basic concepts of CAD, CAM, CAPP, group technology, NC, CNC, DNC, FMS, Robotics and CIM.

INDUSTRIAL ENGINEERING

Product Design and Development: Principles of good product design, component and tolerance design; efficiency, quality and cost considerations; product life cycle; standardization, simplification, diversification, value analysis, concurrent engineering.

Engineering Economy and Costing: Financial statements; elementary cost accounting, methods of depreciation; break-even analysis, techniques for evaluation of capital investments.

Work System Design: Taylor's scientific management, Gilbreths's contributions; productivity concepts and measurements; method study, micro-motion study, principles of motion economy; human factors engineering, ergonomics; work measurement - time study, PMTS, work sampling; job evaluation, merit rating, wage administration, incentive systems; business process reengineering.

Logistics and Facility Design: Facility location factors, evaluation of alternatives, types of plant layout, evaluation; computer aided layout; assembly line balancing; material handling systems; supply chain management.

Production Planning and Inventory Control: Inventory Function costs, classifications - deterministic and probabilistic models; quantity discount; safety stock; inventory control system; Forecasting techniques - causal and time series models, moving average, exponential smoothing; trend and seasonality; aggregate production planning; master scheduling; bill of materials and material requirement planning; order control and flow control, routing, scheduling and priority dispatching; JIT; Kanban PULL systems; bottleneck scheduling and theory of constraints.

Operation Research: Linear programming - problem formulation, simplex method, duality and sensitivity analysis; transportation; assignment; network flow models, constrained optimization and Lagrange multipliers; simple queuing models; dynamic programming; simulation; PERT and CPM, time-cost trade-off, resource leveling.

Quality Control: Taguchi method; design of experiments; quality costs, statistical quality assurance, process control charts, acceptance sampling, zero defects; quality circles, total quality management.

Reliability and Maintenance: Reliability, availability and maintainability; probabilistic failure and repair times; system reliability; preventive maintenance and replacement, TPM.

Management Information System: Value of information; information storage and retrieval system - database and data structures; interactive systems; knowledge based systems.

Intellectual Property System: Definition of intellectual property, importance of IPR; TRIPS, and its implications, WIPO and Global IP structure, and IPS in India; patent, copyright, industrial design and trademark; meanings, rules and procedures, terms, infringements and remedies.

PY - PHARMACEUTICAL SCIENCES

Natural Products: Pharmacognosy & Phytochemistry - Chemistry, tests, isolation, characterization and estimation of phytopharmaceuticals belonging to the group of Alkaloids, Glycosides, Terpenoids, Steroids, Bioflavanoids, Purines, Guggul lipids. Pharmacognosy of crude drugs which contain the above constituents. Standardisation of raw materials and herbal products. WHO guide lines. Quantitative microscopy including modern techniques used for evaluation. Biotechnological principles and techniques for plant development Tissue culture.

Pharmacology: General pharmacological principles including Toxicology. Drug interaction. Pharmacology of drugs acting on Central nervous system, Cardiovascular system, Autonomic nervous system, Gastro intestinal system and Respiratory system. Pharmacology of Autocoids, Hormones, Chemotherapeutic agents including anticancer drugs. Bioassays. Immuno Pharmacology.

Medicinal Chemistry: Structure, nomenclature, classification, synthesis, SAR and metabolism of the following category of drugs which are official in Indian Pharmacopoeia and British Pharmacopoeia Hypnotics and Sedatives, Analgesics, NSAIDS, Neuroleptics, Antidepressants, Anxiolytics, Anticonvulsants, Antihistaminics, Local anaesthetics, Cardio Vascular drugs - Antianginal agents Vasodilators, Adrenergic & cholinergic drugs, Cardiotonic agents, Diuretics, Antihypertensive drugs, Hypoglycemic agents, Antilipedmic agents, Coagulants, Anticoagulants, Antiplatelet agents. Chemotherapeutic agents - Antibiotics, Antibacterials, Sulphadrugs. Antiproliozoal drugs, Antiviral, Antitubercular, Antimalarial, Anticancer, Antiamoebic drugs. Diagnostic agents. Preparation and storage and uses of official Radiopharmaceuticals. Vitamins and Hormones.

Pharmaceutics: Development, manufacturing standards, labeling, packing as per the pharmacopoeal requirements, Storage of different dosage forms and new drug delivery systems. Biopharmaceutics and Pharmacokinetics and their importance in formulation. Formulation and preparation of cosmetics - lipstick, shampoo, creams, nail preparations and dentifrices. Pharmaceutical calculations.

Pharmaceutical Jurisprudence: Legal aspects of manufacture, storage, sale of drugs. D and C act and rules. Pharmacy act.

Pharmaceutical Analysis: Principles, instrumentation and applications of the following. Absorption spectroscopy (UV, visible & IR), Fluorimetry, Flame photometry, Potentiometry, Conductometry and Plarography. Pharmacopoeial assays. Principles of NMR, ESR, Mass spectroscopy, X-ray diffraction analysis and different chromatographic methods.

Biochemistry and Clinical Pharmacy: Biochemical role of hormones, Vitamins, Enzymes, Nucleic acids. Bioenergetics. General principles of immunology. Immunological techniques. Adverse drug interaction.

Microbiology: Principles and methods of microbiological assays of the Pharmacopoeia. Methods of preparation of official sera and vaccines. Serological and diagnostic tests. Applications of microorganisms in Bio Conversions and in Pharmaceutical industry.

TF - TEXTILE ENGINEERING AND FIBRE SCIENCE

ENGINEERING MATHEMATICS:

Linear Algebra: Matrices and Determinants, Systems of linear equations, Eigen values and eigen vectors.

Calculus: Limit, continuity and differentiability; Partial Derivatives; Maxima and minima; Sequences and series; Test for convergence; Fourier series.

Vector Calculus: Gradient; Divergence and Curl; Line; surface and volume integrals; Stokes, Gauss and Green's theorems.

Diferential Equations: Linear and non-linear first order ODEs; Higher order linear ODEs with constant coefficients; Cauchy's and Euler's equations; Laplace transforms; PDEs - Laplace, heat and wave equations.

Probability and Statistics: Mean, median, mode and standard deviation; Random variables; Poisson, normal and binomial distributions; Correlation and regression analysis.

Numerical Methods: Solutions of linear and non-linear algebraic equations; integration of trapezoidal and Simpson's rule; single and multi-step methods for differential equations.

TEXTILE ENGINEERING & FIBRE SCIENCE

Textile Fibres: Classification of textile fibres according to their nature and origin; general characteristics of textile fibres-their chemical and physical structures and their properties; essential characteristics of fibre forming polymers; uses of natural and man-made fibres; physical and chemical methods of fibre and blend identification and blend analysis.

Melt Spinning processes with special reference to polyamide and polyester fibres; wet and dry spinning of viscose and acrylic fibres; post spinning operations-drawing, heat setting, texturing- false twist and air-jet, tow-to-top conversion. Methods of investigating fibre structure e.g. X-ray diffraction, birefringence, optical and electron microscopy, I.R. absorption, thermal methods; structure and morphology and principal natural and man-made fibres, mechanical properties of fibres, moisture sorption in fibres; fibre structure and property correlation.

Textile Testing: Sampling techniques, sample size and sampling errors; measurement of fibre length, fineness, crimp, strength and reflectance; measurement of cotton fibre maturity ad trash content; HVI and AFIS for fibre testing. Measurement of yarn count, twist and hairiness; tensile testing of fibres, yarn and fabrics; evenness testing of slivers, rovings and yarns; testing equipment for measurement test methods of fabric properties like thickness, compressibility, air permeability, drape, crease recovery, tear strength bursting strength and abrasion resistance. Correlation analysis, significance tests and analysis of variance; frequency distributions and control charts.

Yarn Manufacture and Yarn Structure: Modern methods of opening, cleaning and blending of fibrous materials; the technology of carding with particular reference to modern developments; causes of irregularity introduced by drafting, the development of modern drafting systems; principles and techniques of preparing material for combing; recent development in combers; functions and synchronization of various mechanisms concerned with roving production; forces acting on yarn and traveller, ring and traveller designs; causes of end breakages; properties of doubles yarns; new methods of yarn production such as rotor spinning, air jet spinning and friction spinning.

Yarn diameter; specific volume, packing coefficient; twist-strength relationship; fibre orientation in yarn; fibre migration.

Fabric Manufacture and Fabric Structure: Principles of cheese and cone winding processes and machines; random and precision winding; package faults and their remedies; yarn clearers and tensioners; different systems of yarn splicing; features of modern cone winding machines; different types of warping creels; features of modern beam and sectional warping machines; different sizing systems, sizing of spun and filament yarns, modern sizing machines; principles of pirn winding processes and machines; primary and secondary motions of loom, effect of their settings and timings on fabric formation, fabric appearance and weaving performance; dobby and jacquard shedding; mechanics of weft insertion with shuttle; warp and weft stop motions, warp protection, weft replenishment; functional principles of weft insertion systems of shuttleless weaving machines, principles of multiphase and circular looms. Principles of weft and warp knitting; basic weft and warp knitted structures; classification, production and areas of application of nonwoven fabrics.

Basic woven fabric constructions and their derivatives; crepe, cord, terry, gauze, lino and double cloth constructions.

Peirce's equations for fabric geometry; thickness, cover and maximum sett of woven fabrics

Textile Chemical Processing: Preparatory processes for natural-and and their blends; mercerization of cotton; machines for yarn and fabric mercerization.

Dyeing and printing of natural- and synthetic- fibre fabrics and their blends with different dye classes; dyeing and printing machines; styles of printing; fastness properties of dyed and printed textile materials.

Finishing of textile materials, wash and wear, durable press, soil release, water repellent, flame retardant and antistatic finishes; shrink-resistance finish for wool; heat setting of synthetic-fibre fabrics, finishing machines; energy efficient processes; pollution control.

XE - ENGINERING SCIENCES

The syllabi of the sections of this paper are as follows:

SECTION A. ENGINEERING MATHEMATICS (Compulsory)

Linear Algebra : Determinates, algebra of matrices, rank, inverse, system of linear equations, symmetric, skew-symmetric and orthogonal matrices. Hermitian, skew-hermitian and unitary matrices. eigenvalues and eigenvectors, diagonalisation of matrices, Cayley-Hamiltonian, quadratic forms.

Calculus : Functions of single variables, limit, continuity and differentiability, Mean value theorems, Intermediate forms and L'Hospital rule, Maxima and minima, Taylor's series, Fundamental and mean value-theorems of integral calculus. Evaluation of definite and improper integrals, Beta and Gamma functions, Functions of two variables, limit, continuity, partial derivatives, Euler's theorem for homogeneous functions, total derivatives, maxima and minima, Lagrange method of multipliers, double and triple integrals and their applications, sequence and series, tests for convergence, power series, Fourier Series, Fourier integrals.

Complex variable: Analytic functions, Cauchy's integral theorem and integral formula without proof. Taylor's and Laurent' series, Residue theorem (without proof) with application to the evaluation of real integarls.

Vector Calculus: Gradient, divergence and curl, vector identities, directional derivatives, line, surface and volume integrals, Stokes, Gauss and Green's theorems (without proofs) with applications.

Ordinary Differential Equations: First order equation (linear and nonlinear), higher order linear differential equations with constant coefficients, method of variation of paramaters, Cauchy's and Euler's equations, initial and boundary value problems, power series solutions, Legendre polynomials and Bessel's functions of the first kind.

Partial Differential Equations: Variables separable method, solutions of one dimensional heat, wave and Laplace equations.

Probability and Statistics: Definitions of probability and simple theorems, conditional probability, mean, mode and standard deviation, random variables, discrete and continuous distributions, Poisson, normal and Binomial distribution, correlation and regression

Numerical Methods: L-U decomposition for systems of linear equations,Newton-Raphson method, numerical integration(trapezoidal and Simpson's rule), numerical methods for first order differential equation (Euler method)

SECTION B. COMPUTATIONAL SCIENCE

Numerical Methods: Truncation errors, round off errors and their propagation; Interpolation; Lagrange, Newton's forward, backward and divided difference formulas, least square curve fitting, solution of non-linear equations of one variables using bisection, false position, secant and Newton Raphson methods; Rate of convergence of these methods, general iterative methods. Simple and multiple roots of polynomials. Solutions of system of linear algebraic equations using Gauss elimination methods, Jacobi and Gauss-Seidel iterative methods and their rate of convergence; ill conditioned and well conditioned system. eigen values and eigen vectors using power methods. Numerical integration using trapezoidal, Simpson's rule and other quadrature formulas. Numerical Differentiation. Solution of boundary value problems. Solution of initial value problems of ordinary differential equations using Euler's method, predictor corrector and Runge Kutta method.

Programming : Elementary concepts and terminology of a computer system and system software, Fortran77 and C programming.

Fortran : Program organization, arithmetic statements, transfer of control, Do loops, subscripted variables, functions and subroutines.

C language : Basic data types and declarations, flow of control- iterative statement, conditional statement, unconditional branching, arrays, functions and procedures.

SECTION C. ELECTRICAL SCIENCES

Electric Circuits: Ideal voltage and current sources; RLC circuits, steady state and transient analysis of DC circuits, network theorems; alternating currents and voltages, single-phase AC circuits, resonance; three-phase circuits.

Magnetic circuits: Mmf and flux, and their relationship with voltage and current; transformer, equivalent circuit of a practical transformer, three-phase transformer connections.

Electrical machines: Principle of operation, characteristics, efficiency and regulation of DC and synchronous machines; equivalent circuit and performance of three-phase and single-phase induction motors.

Electronic Circuits: Characteristics of p-n junction diodes, zener diodes, bipolar junction transistors (BJT) and junction field effect transistors (JFET); MOSFET's structure, characteristics, and operations; rectifiers, filters, and regulated power supplies; biasing circuits, different configurations of transistor amplifiers, class A, B and C of power amplifiers; linear applications of operational amplifiers; oscillators; tuned and phase shift types.

Digital circuits: Number systems, Boolean algebra; logic gates, combinational circuits, flip-flops (RS, JK, D and T) counters.

Measuring instruments: Moving coil, moving iron, and dynamometer type instruments; shunts, instrument transformers, cathode ray oscilloscopes; D/A and A/D converters.

SECTION D. FLUID MECHANICS

Fluid Properties: Relation between stress and strain rate for Newtonian fluids

Hydrostatics, buoyancy, manometry

Concept of local and convective accelerations; control volume analysis for mass, momentum and energy conservation.

Differential equations of continuity and momentum (Euler's equation of motion); concept of fluid rotation, stream function, potential function; Bernoulli's equation and its applications.

Qualitative ideas of boundary layers and its separation; streamlined and bluff bodies; drag and lift forces.

Fully-developed pipe flow; laminar and turbulent flows; friction factor; Darcy Weisbach relation; Moody's friction chart; losses in pipe fittings; flow measurements using venturimeter and orifice plates.

Dimensional analysis; similitude and concept of dynamic similarity; importance of dimensionless numbers in model studies.

SECTION E. MATERIALS SCIENCE

Atomic structure and bonding in materials: metals, ceramics and polymers.

Structure of materials: Crystal systems, unit cells and space lattice; determination of structures of simple crystals by X-ray diffraction; Miller indices for planes and directions. Packing geometry in metallic, ionic and covalent solids.

Concept of amorphous, single and polycrystalline structures and their effects on properties of materials.

Imperfections in crystalline solids and their role in influencing various properties.

Fick´s laws of diffusion and applications of diffusion in sintering, doping of semiconductors and surface hardening of metals.

Alloys: solid solution and solubility limit. Binary phase diagram, intermediate phases and intermetallic compounds; iron-iron carbide phase diagram. Phase transformation in steels. Cold and hot working of metals, recovery, recrystallization and grain growth.

Properties and applications of ferrous and nonferrous alloys.

Structure, properties, processing and applications of traditional and advanced ceramics.

Polymers: classification, polymerization, structure and properties, additives for polymer products, processing and application.

Composites: properties and application of various composites.

Corrosion and environmental degradation of materials (metals, ceramics and polymers).

Mechanical properties of materials: Stress-strain diagrams of metallic, ceramic and polymeric materials, modulus of elasticity, yield strength, plastic deformation and toughness, tensile strength and elongation at break; viscoelasticity, hardness, impact strength. ductile and brittle fracture. creep and fatigue properties of materials.

Heat capacity, thermal conductivity, thermal expansion of materials.

Concept of energy band diagram for materials; conductors, semiconductors and insulators in terms of energy bands. Electrical conductivity, effect of temperature on conductivity in materials, intrinsic and extrinsic semiconductors, dielectric properties of materials.

Refraction, reflection, absorption and transmission of electromagnetic radiation in solids.

Origin of magnetism in metallic and ceramic materials, paramagnetism, diamagnetism, antiferromagnetism, ferromagnetism, ferrimagnetism in materials and magnetic hysteresis.

Advanced materials: Smart materials exhibiting ferroelectric, piezoelectric, optoelectronic, semiconducting behaviour; lasers and optical fibers; photoconductivity and superconductivity in materials.

SECTION F. SOLID MECHANICS

Equivalent force systems; free-body diagrams; equilibrium equations; analysis of determinate and indeterminate trusses and frames; friction.

Simple relative motion of particles; force as function of position, time and speed; force acting on a body in motion; laws of motion; law of conservation of energy; law of conservation of momentum

Stresses and strains; principal stresses and strains; Mohr's circle; generalized Hooke's Law; equilibrium equations; compatibility conditions; yield criteria.

Axial, shear and bending moment diagrams; axial, shear and bending stresses; deflection (for symmetric bending); torsion in circular shafts; thin cylinders; energy methods (Castigliano's Theorems); Euler buckling.

SECTION G. THERMODYNAMICS

Basic Concepts: Continuum, macroscopic approach, thermodynamic system (closed and open or control volume); thermodynamic properties and equilibrium; state of a system, state diagram, path and process; different modes of work; Zeroth law of thermodynamics; concept of temperature; heat.

First Law of Thermodynamics: Energy, enthalpy, specific heats, first law applied to systems and control volumes, steady and unsteady flow analysis.

Second Law of Thermodynamics: Kelvin-Planck and Clausius statements, reversible and irreversible processes, Carnot theorems, thermodynamic temperature scale, Clausius inequality and concept of entropy, principle of increase of entropy; availability and irreversibility.

Properties of Pure Substances: Thermodynamic properties of pure substances in solid, liquid and vapour phases, P-V-T behaviour of simple compressible substances, phase rule, thermodynamic property tables and charts, ideal and real gases, equations of state, compressibility chart.

Thermodynamic Relations: T-ds relations, Maxwell equations, Joule-Thomson coefficient, coefficient of volume expansion, adiabatic and isothermal compressibilities, Clapeyron equation.

Ideal Gas Mixtures: Dalton's and Amagat's laws, calculations of properties, air-water vapour mixtures.

XL - LIFE SCIENCES

The syllabi of the Sections of this paper are as follows:

SECTION H. CHEMISTRY (Compulsory)

Atomic structure and periodicity: Quantum chemistry; Planck's quantum theory, wave particle duality, uncertainty principle, quantum mechanical model of hydrogen atom; electronic configuration of atoms; periodic table and periodic properties; ionization energy, election affinity, electronegativity, atomic size.

Structure and bonding: Ionic and covalent bonding M.O. and V.B. approaches for diatomic molecules, VSEPR theory and shape of molecules, hybridisation, resonance, dipole moment, structure parameters such as bond length, bond angle and bond energy, hydrogen bonding, van der Waals interactions. Ionic solids; ionic radii, lattice energy (Born-Haber Cycle).

s.p. and d Block Elements: Oxides, halides and hydrides of alkali and alkaline earth metals, B, Al, S, N, P and S, silicones, general characteristics of 3d elements, coordination complexes: valence bond and crystal field theory, color, geometry and magnetic properties.

Chemical Equilibria: Colligative properties of solutions, ionic equilibria in solution, solubility product, common ion effect, hydrolysis of salts, pH, buffer and their applications in chemical analysis.

Electrochemistry: Conductance, Kohlrausch law, Half Cell potentials, emf, Nernst equation, galvanic cells, thermodynamic aspects and their applications.

Reaction Kinetics: Rate constant, order of reaction, molecularity, activation energy, zero, first and second order kinetics, equilibrium constants (Kc, Kp and Kx) for homogeneous reactions, catalysis and elementary enzyme reactions.

Thermodynamics: First law, reversible and irreversible processes, internal energy, enthalpy, Kirchoff's equation, heat of reaction, Hess law, heat of formation, Second law, entropy, free energy, and work function. Gibbs-Helmholtz equation, Clausius-Clapeyron equation, free energy change and equilibrium constant, Troutons rule, Third law of thermodynamics.

Mechanistic Basis of Organic Reactions: Elementary treatment of SN1, SN2, E1 and E2 reactions, Hoffmann and Saytzeff rules, Addition reactions, Markonikoff rule and Kharash effect, Diels-Alder reaction, aromatic electrophilic substitution, orientation effect as exemplified by various functional groups.

Structure-Reactivity Correlations: Acids and bases, electronic and steric effects, optical and geometrical isomerism, tautomerism, concept of aromaticity

SECTION I. BIOCHEMISTRY

Organization of life. Importance of water. Cell structure and organelles. Structure and function of biomolecules: Carbohydrates, Lipids, Proteins and Nucleic acids. Biochemical separation techniques. Spectroscopic methods; UV-visible and fluorescence. Protein structure, folding and function: Myoglobin, Hemoglobin, Lysozyme, ribonuclease A, Carboxypeptidase and Chymotrypsin. Enzyme kinetics and regulation, Coenzymes.

Metabolism and bioenergitics. Generation and utilization of ATP. Photosynthesis. Major metabolic pathways and their regulation. Biological membranes. Transport across membranes. Signal transduction; hormones and neurotransmitters.

DNA replication, transcription and translation. Biochemical regulation of gene expression. Recombinant DNA technology and applications. Genomics and Proteomics.

The immune system. Active and passive immunity. Complement system. Antobody structure, function and diversity. Cells of the immune system: T, B and macrophages. T and B cell activation. Major histocompatibilty complex. T cell receptor. Immunological techniques: Immunodiffusion, immunoelectrophoresis, RIA and ELISA.

SECTION J. BIOTECHNOLOGY

Recombinant DNA technology for the production of therapeutic proteins. Micro array technology. Heterologous protein expression systems in bacteria, yeast etc.

Architecture of plant genome; plant tissue culture techniques; methods of gene transfer into plant cells; manipulation of phenotypic traits in plants; plant cell fermentations and production of secondary metabolites using suspension/ immobilized cell culture; methods for plant micro propagation; crop improvement and development of transgenic plants. Expression of animal proteins in plants.

Animal cell metabolism and regulation; cell cycle; primary cell culture; nutritional requirements for animal cell culture; techniques for the mass culture of animal cell lines; production of vaccines; growth hormones and interferons using animal cell culture; cytokines-production and therapeutic uses; hybridoma technology; vectors for gene transfer and expression in animal cells. Transgenic animals and molecular pharming.

Microbial production of industrial enzymes; methods for immobilization of enzymes; kinetics of soluble and immobilized enzymes; application of soluble and immobilized enzymes; enzyme-based sensors.

Microbial growth kinetics; batch, fed batch and continuous culture of microbial cells; media for industrial fermentations; sterilization of air and media; design features and operation of stirred tank, air-lift and fluidized bed reactors; aeration and agitation in aerobic fermentations; recovery and purification of fermentation products- filtration, centrifugation, cell disintegration, solvent extraction and chromatographic separations; industrial fermentations for the production of ethanol, citric acid, lysine, penicillin and other biomolecules; simple calculations based on material and energy balance of fermentation processes; application of microbes in the management of domestic and industrial wastes.

SECTION K. BOTANY

Anatomy: Roots, stem and leaves of land plants, meristems, vascular system, their ontogeny, structure and functions. Plant cell structure, organisation, organelles, cytoskeleton, cell wall and membranes.

Development: Cell cycle, cell division, senescence, hormonal regulation of growth; life cycle of an angiosperm, pollination, fertilization, embryogenesis, seed formation, seed storage proteins, seed dormancy and germination. Concept of cellular totipotency, organogenesis and somatic embryogenesis, somaclonal variation, embryo culture, in vitro fertilization.

Physiology and Biochemistry: Plant water relations, transport of minerals and solutes, N2 metabolism, proteins and nucleic acid, respiration, photophysiology, photosynthesis, photorespiration; biosynthesis, mechanism of action and physiological effects of plant growth regulators.

Genetics: Principles of Mendelian inheritance, linkage, recombination and genetic mapping; extrachromosomal inheritance; eukaryotic genome organization (chromatin structure) and regulation of gene expression, gene mutation, chromosome aberrations (numerical and structural), transposons.

Plant Breeding: Principles, methods - selection, hybridization, heterosis; male sterility, self and inter-specific incompatibility; haploidy; somatic cell hybridization; molecular marker-assisted selection; gene transfer methods viz. direct and vector-mediated, transgenic plants and their applications in agriculture.

Economic Botany: Economically important plants - cereals, pulses, plants yielding fiber, timber, sugar, beverages, oils, rubber, dyes, gums, drugs and narcotics - a general account.

Systematics: Systems of classification (non-phylogenetic vs. phylogenetic - outline), plant groups, molecular systematics.

Plant Pathology: Nature and classification of plant diseases, diseases of important crops caused by fungi, bacteria and viruses, and their control measures, mechanism(s) of pathogenesis and resistance, molecular detection of pathogens; plant-microbe beneficial interactions.

Ecology and Plant Geography: Ecosystems - types, dynamics, degradation, ecological succession; food chains; vegetation types of the world; pollution and global warming; speciation and extinction, conservation strategies, cryopreservation.

SECTION L. MICROBIOLOGY

Historical perspective - Discovery of the microbial world; Controversy over spontaneous generation; Role of microorganisms in transformation of organic matter and in the causation of diseases.

Methods in microbiology - Pure culture techniques; Theory and practice of sterilization; Principles of microbial nutrition; Construction of culture media; Enrichment culture techniques for isolation of chemoautotrophs, chemoheterotrophs and photosynthetic microorganisms.

Microbial evolution, systematics and taxonomy - Evolution of earth and earliest life forms; Primitive organisms and their metabolic strategies; New approaches to bacterial taxonomic classification including ribotyping; Nomenclature.

Microbial diversity - Bacteria, archea and their broad classification; Eukaryotic microbes, yeast, fungi, slime mold and protozoa; Viruses and their classification.

Microbial growth -The definition of growth, mathematical expression of growth, growth curve, measurement of growth and growth yields; Synchronous growth; Continuous culture.

Nutrition and metabolism - Overview of metabolism; Microbial nutrition; Energy classes of microorganisms; Culture media; Energetics, modes of ATP generation; ATP generation by heterotrophs; Fermentation; Glycolysis; Respiration; The citric acid cycle; Electron transport systems; Alternate modes of energy generation; Pathways (anabolism) in the biosynthesis of amino acids, purines, pyrimidines and fatty acids.

Metabolic diversity among microorganisms - Photosynthesis in microorganisms; Role of chlorophylls, carotenoids and phycobilins; Calvin cycle; Chemolithotrophy; Hydrogen- iron- nitrite-oxidizing bacteria; Nitrate and sulfate reduction; Methanogenesis and acetogenesis.

Prokaryotic cells: structure-function - Cells walls of eubacteria (peptidoglycan) and related molecules; Outer-membrane of gram-negative bacteria; Cell wall and cell membrane synthesis; Flagella and motility; Cell inclusions like endospores, gas vesicles.

Microbial diseases and host parasite relationships - Normal microflora of skin; Oral cavity; Gastrointestinal tract; Entry of pathogens into the host; Infectious disease transmission; Respiratory infections caused by bacteria and viruses; Tuberculosis; Sexually transmitted diseases including AIDS; Diseases transmitted by animals (Rabies, plague), insects and ticks (rikettsias, Lyme disease, malaria); Food and water borne diseases; Public health and water quality; Pahtogenic fungi; Emerging and resurgent infectious diseases.

Chemotherapy/Antibiotics - Antimicrobial agents; Sulfa drugs; Antibiotics; Pencillins and cephalosporins; Broad-spectrum antibiotics; Antibiotics from prokaryotes; Antifungal antibiotics; Mode of action; Resistance to antibiotics.

Microbial genetics - Genes, mutation and mutagenesis - UV and chemical mutagnes; Types of mutations; Ames test for mutagenesis; Methods of genetic analysis. Bacterial genetic system - Transformation; Conjugation; Transduction; Recombination; Plasmids and Transposons; Bacterial genetic map with reference to E. coli. Viruses and their genetic system - Phage ? and its life cycle; RNA phages; RNA viruses; Retroviruses; Genetic systems of yeast and Neurospora; Extrachromosomal inheritance and mitochondrial genetics; Basic concept of genomics.

SECTION M. ZOOLOGY

Animal world: Animal diversity, distribution, systematic and classification of animals, the phylogenetic relationship.

Evolution: Origin of life, history of life on earth, evolutionary theories, natural selection, adaptation, speciation.

Genetics: Principles of inheritance, molecular basis of heredity, the genetic material, transmission of genetic material, mutations, cytoplasmic inheritance.

Biochemistry and Molecular Biology: Nucleic acids, proteins and other biological macromolecules. Replication, transcription and translation, regulation of gene expression, organization of genome, Kreb's cycle, glycolysis, enzyme catalysis, hormones and their action.

Cell Biology: Structure of cell, cellular organelles and their structure and function, cell cycle, cell division, cellular differentiation, chromosome and chromatin structure. Eukaryotic gene organisation and expression.

Animal Anatomy and Physiology: Comparative physiology, the respiratory system, circulatory system, digestive system, the nervous system, the excretory system, the endocrine system, the reproductive system, the skeletal system, osmoregulation.

Parasitology and Immunology: Nature of parasite, host-parasite relation, protozoan and helminthic parasites, the immune response, cellular and humoral immune response, evolution of the immune system.

Development Biology: Embryonic development, cellular differentiation, organogenesis, metamorphosis, genetic basis of development.

Ecology: The ecosystem, habitats the food chain, population dynamics, species diversity, zoogeography, biogeochemical cycles, conservation biology.

Animal Behaviour: Types of behaviours, courtship, mating and territoriality, instinct, learning and memory, social behaviour across the animal taxa, communication, pheromones, evolution of animal behaviour.

IT - INFORMATION TECHNOLOGY

ENGINEERING MATHEMATICS

Mathematical Logic: Propositional Logic; First Order Logic.

Probability: Conditional Probability; Mean, Median, Mode and Standard Deviation; Random Variables; Distributions; uniform, normal, exponential, Poisson, Binomial.

Set Theory & Algebra: Sets; Relations; Functions; Groups; Partial Orders; Lattice; Boolean Algebra.

Combinatorics: Permutations; Combinations; Counting; Summation; generating functions; recurrence relations; asymptotics.

Graph Theory: Connectivity; spanning trees; Cut vertices & edges; covering; matching; independent sets; Colouring; Planarity; Isomorphism.

Linear Algebra: Algebra of matrices, determinants, systems of linear equations, Eigen values and Eigen vectors.

Numerical Methods: LU decomposition for systems of linear equations; numerical solutions of non linear algebraic equations by Secant, Bisection and Newton-Raphson Methods; Numerical integration by trapezoidal and Simpson's rules.

Calculus: Limit, Continuity & differentiability, Mean value Theorems, Theorems of integral calculus, evaluation of definite & improper integrals, Partial derivatives, Total derivatives, maxima & minima.

FORMAL LANGUAGES AND AUTOMATA

Regular Languages: finite automata, regular expressions, regular grammar.

Context free languages: push down automata, context free grammars

COMPUTER HARDWARE

Digital Logic: Logic functions, minimization, design and synthesis of combinatorial and sequential circuits, number representation and computer arithmetic (fixed and floating point)

Computer organization: Machine instructions and addressing modes, ALU and data path, hardwired and microprogrammed control, memory interface, I/O interface (interrupt and DMA mode), serial communication interface, instruction pipelining, cache, main and secondary storage

SOFTWARE SYSTEMS

Data structures and Algorithms: the notion of abstract data types, stack, queue, list, set, string, tree, binary search tree, heap, graph, tree and graph traversals, connected components, spanning trees, shortest paths, hashing, sorting, searching, design techniques (greedy, dynamic, divide and conquer), asymptotic analysis (best, worst, average cases) of time and space, upper and lower bounds, intractability

Programming Methodology: C programming, program control (iteration, recursion, functions), scope, binding, parameter passing, elementary concepts of object oriented programming

Operating Systems (in the context of Unix): classical concepts (concurrency, synchronization, deadlock), processes, threads and interprocess communication, CPU scheduling, memory management, file systems, I/O systems, protection and security

Information Systems and Software Engineering: information gathering, requirement and feasibility analysis, data flow diagrams, process specifications, input/output design, process life cycle, planning and managing the project, design, coding, testing, implementation, maintenance.

Databases: relational model, database design, integrity constraints, normal forms, query languages (SQL), file structures (sequential, indexed), b-trees, transaction and concurrency control

Data Communication: data encoding and transmission, data link control, multiplexing, packet switching, LAN architecture, LAN systems (Ethernet, token ring), Network devices: switches, gateways, routers

Networks: ISO/OSI stack, sliding window protocols, routing protocols, TCP/UDP, application layer protocols & systems (http, smtp, dns, ftp), network security

Web technologies: three tier web based architecture; JSP, ASP, J2EE, .NET systems; html, XML
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