

## APPENDIX - I

## SYLLABUS for ENTRANCE EXAMINATION

## CI - 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 moment and shear force 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 and shear stresses, unsymmetrical bending, shear centre. Thin walled pressure vessels, uniform torsion, buckling of column, combined and direct bending stresses.

**Structural Analysis**

Analysis of statically determinate trusses, arches, beams, cables and frames, displacements in statically determinate structures and analysis of statically indeterminate structures by force/ energy methods, analysis by displacement methods (slope deflection method), influence lines for determinate and indeterminate structures. Basic concepts of matrix methods of structural analysis.

**Concrete Structures**

Concrete Technology- properties of concrete, basics of mix design. Concrete design-basic working stress and limit state design concepts, analysis of ultimate load capacity and design of members subjected to flexure, shear, compression and torsion by limit state methods. 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 interrelationships, permeability and seepage, effective stress principle, consolidation, compaction, shear strength.

**Foundation Engineering**

Sub-surface investigations- scope, drilling bore holes, sampling, penetration 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, negative skin friction.

## WATER RESOURCES ENGINEERING

**Fluid Mechanics and Hydraulics**

Properties of fluids, principle of conservation of mass, momentum, energy and corresponding equations,

potential flow, applications of momentum and Bernoulli's equation, laminar and turbulent flow, 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 measurements in channels, tanks and pipes. Dimensional analysis and hydraulic modeling. Kinematics of flow, velocity triangles and specific speed of pumps and turbines.

### **Hydrology**

Hydrologic cycle, rainfall, evaporation, infiltration, stage discharge relationships, unit hydrographs, flood estimation, reservoir capacity, 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 spillways. Design of weirs on permeable foundation. Types of irrigation system, irrigation methods. Water logging and drainage, sodic soils.

## **ENVIRONMENTAL ENGINEERING**

### **Water requirements**

Quality standards, basic unit processes and operations for water treatment. Drinking water standards, water requirements, basic unit operations and unit processes for surface water treatment, distribution of water. Sewage and

sewerage treatment, quantity and characteristics of wastewater. Primary, secondary and tertiary treatment of wastewater, sludge disposal, effluent discharge standards. Domestic wastewater treatment, quantity and characteristics of domestic wastewater, primary and secondary treatment. Unit operations and unit processes of domestic wastewater, sludge disposal.

### **Air Pollution**

Types of pollutants, their sources and impacts, air pollution meteorology, air pollution control, air quality standards and limits.

### **Municipal Solid Wastes**

Characteristics, generation, collection and transportation of solid wastes, engineered systems for solid waste management (reuse/ recycle, energy recovery, treatment and disposal).

### **Noise Pollution**

Impacts of noise, permissible limits of noise pollution, measurement of noise and control of noise pollution.

## **TRANSPORTATION ENGINEERING**

### **Highway Planning**

Geometric design of highways, testing and specifications of paving materials, design of flexible and rigid pavements.

### **Traffic Engineering**

Traffic characteristics, theory of traffic flow, intersection design, traffic signs and signal design, highway capacity.

## **CS - COMPUTER SCIENCE AND ENGINEERING & INFORMATION TECHNOLOGY**

### **ENGINEERING MATHEMATICS**

#### **Differential and Integral Calculus**

Limit-Continuity-Differentiability, Leibniz theorem, Mean Value Theorems, Taylor's theorem, Integrals, Improper integrals, Total Differentiation, Partial derivatives, Maxima and Minima.

#### **Probability and Statistics**

Probability, conditional probability, Baye's theorem, mean, median, mode, moments, standard deviation. Random variables, Uniform, Binomial, Poisson, normal distributions. Correlation and regression, Sampling and Tests of significance.

#### **Discrete Mathematics**

Sets, relations and functions, algebra of matrices and determinants, algebraic structures, Boolean algebra and

applications, order relations and structures, graph theory, logic and combinatorics.

#### **Numerical Methods**

Solutions to algebraic and transcendental equations (Bisection and Newton Raphsons' methods), simultaneous linear algebraic equations (Gauss elimination, Crout's, Gauss seidal and relaxation), Interpolation methods (forward, backward and central), numerical integration (Trapezoidal, Simpson's and Weddle's) eigen values and eigen vectors, Numerical solutions to ordinary (Euler, modified Euler, Runge Kutta 4th order) and partial differential (parabolic, elliptic and Hyperbolic) equations.

#### **Theory of computation**

Formal language 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.

**Mathematical physics**

Linear vector space, matrices, vector calculus; Linear differential equations; elements of complex analysis; laplace transforms, Fourier analysis, elementary ideas about tensors

**COMPUTER HARDWARE****Digital logic**

Number systems and codes-Gates-TTL-circuits-Boolean algebra and Karnaugh maps-Arithmetic logic units-Flip flops-registers and counters-Memories - Combinational and sequential logic circuits .

**Computer Architecture and organization**

Machine instructions and addressing modes, ALU and data path, Register Transfer Language, hardware and micro programmed control, memory interface, RAM, ROM I/O interface (Interrupt and DMA modes), serial communication interface, instruction pipelining, Cache, main and second memory storage-Micro processors 8085, 8086, Interfacing and memory addressing.

**Electronics**

Network analysis, semiconductor devices; bipolar transistors, FET's; Power supplies, amplifier, Oscillators; Operational amplifiers; elements of digital electronics; logic circuits.

**SOFTWARE SYSTEMS****Data structures**

Notion of abstract data types, stack, Queue, List, set, string. Tree, binary search trees, heap, graph

**Programming methodology**

C programming, program control, function, scope, binding, parameter passing, iteration and recursion, elementary concepts of object oriented, functional and logic programming, Java programming.

**Algorithms for problem solving**

Tree and graph traversal, connected components, spanning trees, shortest paths; Hashing, sorting, searching; design techniques (Greedy, dynamic programming, divide and conquer)

**Programming language processors**

Compiler, Interpreter, assembler, Linker, Loader, Macro processors; Compiler design-Lexical analysis, parsing-Top-down parsing and bottom up parsing, syntax directed translation, runtime environment, Symbol table, Code optimization, code generation.

**Operating systems**

Memory management, page faults, overlay, processor management, device management, dead lock. Processes, threads and interprocess communication, CPU scheduling, file systems, I/O systems, protection and security.

**System & program development methodology**

Software project phase-Life cycle of software development-steps of software development-principles of programming in any language -documentation

**Management Information systems**

Aspects of Management and Information systems- decision support and operation-support systems- systems approaches to MIS-computers and information system in business

**Databases management systems**

Data, database and DBMS-Data dictionary/directory-schema, description of database structure-forms of DBMS systems-Hierarchical, network and RDBMS-DDL, DML, stored data structure language and query language-Recent trends in database management systems-Memory management techniques used in computers, query languages (SQL), file structures (sequential files, indexing, B\* trees) Transactions and concurrency control.

**Computer networks & Data communications**

Analog Vs Digital communication, modems, techniques, multiplexers, and concentrators, serial Vs parallel communication, simplex, duplex, and half duplex communication-synchronous and asynchronous communication- Error detection/correction methods, data link control protocols, balanced and unbalanced interfaces, communication media- ISO/OSI stack, Sliding window protocol, LAN Technologies (Ethernet, Token ring, TCP/UDP, IP, Basic concepts of switches; gateways, and routers).

**CE - CHEMICAL ENGINEERING**

Laws of thermodynamics - reversible and irreversible process - concept of ideal gas and real gas - equations of states - Maxwell relations - adiabatic and isothermal compression - phase equilibrium - Gibbs phase rule - system of variable composition - van Hoff's equation - applications of Gibbs - Duhem equation.

Law of conservation of mass and energy - material balance energy balance and their applications - unit operation and unit process - psychrometry - combustion calculations.

Classification of fluids - fluid statics - basic equations of fluid flow - Bernoulli's equation - laminar flow - friction in flow through beds of solids - packed beds - fluid moving machinery - classification of pumps and its characteristics.

Introduction to particulate solids - particle separation - size reduction - motion of a particle through fluid - classification of particulate solids - centrifugal classifier - sedimentation techniques - flotation - filtration equipments - agitation and mixing of liquids.

Fourier's law of heat conduction - concept of thermal conductivity - heat transfer through fins - convective heat transfer - transfer of heat in flowing fluids - laminar and turbulent flow - heat transfer with and without phase change - types of evaporators - multiple effect evaporators.

Differential and integral method of analysis of rate data - ideal reactor design - Residence time distribution - C, E and F curves.

Basic principles of unit operation and unit process - schematic representations of unit operations - manufacture of sulfur, hydrochloric acid, cement, glass, products used in photography, ceramics and refractory, industrial gases, paints, pigments, fertilizers - fermentation process for the production of ethanol - manufacture of citric acid, antibiotics, penicillin, soaps, detergents - petroleum refining process - process for the production of petrochemical precursors - production of resins, natural and synthetic rubber.

Diffusion in liquids - development of rate equation for mass transfer - contracting devices for improving mass transfer characteristics - humidification, drying and crystallization - distillation, continuous rectification operation, absorption, liquid-liquid extraction and leaching - fundamental principles and design of the pressure, reaction vessels and related equipments in the above process.

Overview of industrial biochemical processes - industrially important microbial strains - enzymes used in industry, medicine and food - industrial production, purification and immobilization of enzymes - reactor types, characteristics and design - growth characteristics of microbial cells - free cell and immobilized cell reactors - downstream processing and effluent treatment.

**CH - CHEMISTRY****Atomic Structure**

Planck's quantum theory - wave particle duality - Heisenberg's principle - Schrodinger equation - particle in a box and hydrogen atom - VB and MO theories.

**Spectroscopy**

Rotational and vibrational spectra - harmonic unharmonic oscillator and Rigid Rotor - selection rules - fundamentals, overtones and combination bands - calculation of force constants (diatomic molecules) - Group frequencies - electronic spectroscopy - potential energy diagram - term symbols - selection rules - LS and JJ coupling - Frank Condon principle - oscillator's strength - effect of solvent's on spectrum.

**Thermodynamics**

First law of thermodynamics - second law - third law terms and their relations.

**Chemical kinetics and equilibrium**

Rate constants of chemical reactions, temperature dependence, collision and transition state theories - consecutive and parallel reactions - chemical equilibrium and response of chemical equilibrium to temperature and pressure.

**d and f block elements**

General characteristics of d and f block elements; coordination chemistry structure and isomerism, stability, theories of metal-ligand bonding (CFT and LFT), mechanisms of substitution and electron transfer reactions of coordination complexes. Electronic spectra and magnetic properties of transition metal complexes, lanthanides and actinides. 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. Bioinorganic chemistry of Na, K, Mg, Ca, Fe, Co, Zn, Cu and Mo.

### Solid State

Crystal systems and lattices, Miller planes, crystal packing, crystal defects; Bragg's Law, ionic crystals, band theory, metals and semiconductors, different structures of AX, AX<sub>2</sub>, AX<sub>3</sub> compounds, spinlals.

### Instrumental methods of analysis

Atomic absorption and emission spectroscopy including ICP-AES, UV-visible spectrophotometry, NMR, Mass, Mossbauer spectroscopy (Fe and Sn), ESR spectroscopy, chromatography including GC and HPLC and electro-analytical methods (coulometry, cyclic voltammetry, polarography - amperometry, and ion selective electrodes). Determination of structures of organic and inorganic compounds using UV-visible, IR, NMR and mass spectroscopy.

### Stereochemistry

Chirality of organic molecules with or without chiral centres. Specification of configuration in compounds having one or more stereogenic centres. Enantiotopic and diastereotopic atoms, groups and faces. Stereospecific synthesis. Conformational analysis of acyclic and cyclic compounds. Geometrical isomerism. Configurational and conformational effects on reactivity and selectivity/specificity.

### Reaction Mechanism

Electrophilic and Nucleophilic substitution informations in aliphatic and aromatic compounds various mechanisms  
- Addition and Elimination reactions various mechanisms  
- Reaction intermediates carbocations, carbanions, carbenes, nitrenes and free radicals.

### Organic synthesis

Synthesis, reactions, mechanisms and selectivity involving the following - alkenes, alkynes, arenes, alcohols, phenols, aldehydes, ketones, carboxylic acids and their derivatives, halides, nitro compounds and amines. Use of compounds of Mg, Li, Cu, B and Si in organic synthesis. Concepts in multistep synthesis - retrosynthetic analysis, disconnections, synthons, synthetic equivalents, reactivity umpolung, selectivity, protection and deprotection of functional groups.

### Heterocyclic compounds

Structure and reactions of furan, pyrrole, thiophene, pyridine, indole and their derivatives.

### Biomolecules

Structure, properties and reactions of mono- and disaccharides, physicochemical properties of amino acids, chemical synthesis of peptides, structural features of proteins, nucleic acids, steroids, terpenoids, carotenoids, and alkaloids.

## EE - ELECTRICAL AND ELECTRONICS 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

**Electric Circuits and Fields:** Network graph, KCL, KVL, node and mesh analysis, transient response of dc and ac networks; sinusoidal steady-state analysis, resonance, basic filter concepts, ideal current and voltage sources, Thevenin's Norton's and Superposition and Maximum Power Transfer theorems, two-port networks, three phase circuits; Gauss Theorem, electric field and potential due

to point, line, plane and spherical charge distributions; Ampere's and Biot-Savart's laws; inductance; dielectrics; capacitance.

**Signals and Systems:** Representation of continuous and discrete-time signals; shifting and scaling operations; linear, time-invariant and causal systems; Fourier series representation of continuous periodic signals; sampling theorem; Fourier, Laplace and Z transforms.

**Electrical Machines:** Single phase transformer - equivalent circuit, phasor diagram, tests, regulation and efficiency; three phase transformers - connections, parallel operation; auto-transformer; energy conversion principles; DC machines - types, windings, generator characteristics, armature reaction and commutation, starting and speed control of motors; three phase induction motors - principles, types, performance characteristics, starting and speed control; single phase induction motors; synchronous machines - performance, regulation and parallel operation of generators, motor starting, characteristics and applications; servo and stepper motors.

**Power Systems:** Basic power generation concepts; transmission line models and performance; cable performance, insulation; corona and radio interference; distribution systems; per-unit quantities; bus impedance and admittance matrices; load flow; voltage control; power factor correction; economic operation; symmetrical components; fault analysis; principles of over-current, differential and distance protection; solid state relays and digital protection; circuit breakers; system stability

concepts, swing curves and equal area criterion; HVDC transmission and FACTS concepts.

**Control Systems:** Principles of feedback; transfer function; block diagrams; steady-state errors; Routh and Niquist techniques; Bode plots; root loci; lag, lead and lead-lag compensation; state space model; state transition matrix, controllability and observability.

**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-meters; oscilloscopes; potentiometric recorders; error analysis.

**Analog and Digital Electronics:** Characteristics of diodes, BJT, FET; 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; multi-vibrators; sample and hold circuits; A/D and D/A converters; 8-bit microprocessor basics, architecture, programming and interfacing.

**Power Electronics and Drives:** Semiconductor power 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.

## **EI - 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's 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

**Basics of Circuits and Measurement Systems:** Kirchoff's laws, mesh and nodal Analysis. Circuit theorems. One-port and two-port Network Functions. Static and dynamic characteristics of Measurement Systems. Error and uncertainty analysis. Statistical analysis of data and curve fitting.

**Transducers, Mechanical Measurement and Industrial Instrumentation:** Resistive, Capacitive, Inductive and piezoelectric transducers and their signal conditioning. Measurement of displacement, velocity and acceleration (translational and rotational), force, torque, vibration and shock. Measurement of pressure, flow, temperature and liquid level. Measurement of pH, conductivity, viscosity and humidity.

**Analog Electronics:** Characteristics of diode, BJT, JFET and MOSFET. Diode circuits. Transistors at low and high frequencies, Amplifiers, single and multi-stage. Feedback amplifiers. Operational amplifiers, characteristics and circuit configurations. Instrumentation amplifier. Precision rectifier. V-to-I and I-to-V converter. Op-Amp based active filters. Oscillators and signal generators.

**Digital Electronics:** Combinational logic circuits, minimization of Boolean functions. IC families, TTL, MOS and CMOS. Arithmetic circuits. Comparators, Schmitt trigger, timers and mono-stable multi-vibrator. Sequential circuits, flip-flops, counters, shift registers. Multiplexer, S/H circuit. Analog-to-Digital and Digital-to-Analog converters. Basics of number system. Microprocessor applications, memory and input-output interfacing. Microcontrollers.

**Signals, Systems and Communications:** Periodic and aperiodic signals. Impulse response, transfer function and frequency response of first- and second order systems.

Convolution, correlation and characteristics of linear time invariant systems. Discrete time system, impulse and frequency response. Pulse transfer function. IIR and FIR filters. Amplitude and frequency modulation and demodulation. Sampling theorem, pulse code modulation. Frequency and time division multiplexing. Amplitude shift keying, frequency shift keying and pulse shift keying for digital modulation.

**Electrical and Electronic Measurements:** Bridges and potentiometers, measurement of R, L and C. Measurements of voltage, current, power, power factor and energy. A.C & D.C current probes. Extension of instrument ranges. Q-meter and waveform analyzer. Digital voltmeter and multimeter. Time, phase and frequency measurements. Cathode ray oscilloscope. Serial and parallel communication. Shielding and grounding.

**Control Systems and Process Control:** Feedback principles. Signal flow graphs. Transient Response, steady-state-errors. Routh and Nyquist criteria. Bode plot, root loci. Time delay systems. Phase and gain margin. State space representation of systems. Mechanical, hydraulic and pneumatic system components. Synchro pair, servo and step motors. On-off, cascade, P, P-I, P-I-D, feed forward and derivative controller, Fuzzy controllers.

**Analytical, Optical and Biomedical Instrumentation:** Mass spectrometry. UV, visible and IR spectrometry. X-ray and nuclear radiation measurements.

Optical sources and detectors, LED, laser, photo-diode, photo-resistor and their characteristics. Interferometers, applications in metrology. Basics of fiber optics. Biomedical instruments, EEG, ECG and EMG. Clinical measurements. Ultrasonic transducers and Ultrasonography. Principles of Computer Assisted Tomography.

## 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.

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

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

**NETWORK****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, fourier series, linear constant coefficient differential and difference equations; time domain analysis of simple RLC circuits. Laplace and Z transforms: frequency domain analysis of RLC circuits, convolution, 2-port network parameters, driving point and transfer functions, state equation for networks.

**ANALOG CIRCUITS**

Characteristics and equivalent circuits (large and small signal) of diodes, BJT, JFETs and MOSFET 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. Comparators, timers, multivibrators. Sample and hold circuits, ADCs and DACs. Semiconductor memories. Microprocessor (8085): architecture, programming, memory and I/O interfacing

**CONTROL SYSTEMS**

Basic control system components; block diagrammatic description, reduction of block diagrams, properties of systems: linearity, time-invariance, stability, causality. Open loop and closed loop (feedback) systems. Special properties of linear time-invariance (LTI) systems-transfer function, impulse response, poles, zeros, their significance 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 system 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 compensations, elements of proportional-integral-Derivative (PID) control. State variable representation and solution of state equation for LTI systems.

**COMMUNICATION SYSTEMS**

Fourier analysis of signals - amplitude, phase and power spectrum, auto-correlation and cross-correlation and their Fourier transforms. Signal transmission through linear time-invariant (LTI) systems, impulse response and frequency response, group delay phase delay. Analog modulation systems-amplitude and angle modulation and demodulation systems, spectral analysis of these operations, superheterodyne receivers, elements of hardware realizations of analog communication systems. Basic sampling theorems. 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). Multiplexing - time division and frequency division. Additive Gaussian noise; characterization using correlation, probability density function (PDF), power spectral density (PSD). Signal-to-noise ratio (SNR) calculations for amplitude modulation (AM) and frequency modulation (FM) for low noise conditions.

**ELECTROMAGNETICS**

Elements of vector calculus: gradient, divergence and curl; Gauss and Stokes theorems, Maxwell's equation: 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. Wave guides: modes in rectangular waveguides; boundary conditions; cut-off frequencies; dispersion relations. Antennas; Dipole antennas; antenna arrays; radiation pattern; reciprocity theorem, antenna gain.



## LS - LIFE SCIENCES

**Biophysics**

Levels of structures in Biological macromolecules. basic strategies in biophysics. Forces that determine protein and nucleic acid structure, Prediction of proteins structure nucleic acids, Properties of lipid bilayers, Biochemical Kinetics studies, unimolecular reactions, methods of determining macromolecular structures inclusive of the spectroscopic techniques like UV-vis absorption, IR absorption, circular dichroism fluorescence NMR and X-ray and neutron diffraction techniques.

**Biochemistry**

Structure and properties, Amino acids, peptides, proteins and conjugated proteins, protein hydration, coagulation, denaturation - gelation, protein-protein interactions, cytosolic and membrane properties, purines, pyrimidines, nucleosides, nucleotides, polynucleotides, Ribonucleic acids and deoxyribonucleic acids, TCA cycle, glycolysis, pentose phosphate pathway, Embden Meyerhof pathway, urea cycle, metabolic regulation, respiratory chain, TP cycle, energy rich compounds, integrated metabolism, Carbohydrates - linear and branched carbohydrates, N containing carbohydrates, cell wall carbohydrates, metabolism of carbohydrates, Fats and oils-structure and properties of saturated and unsaturated fatty acids, glycerolipids, phospholipids, sphingolipids, glycolipids, steroids, Vitamins and minerals-types, structure and functional properties of vitamins, utility of essential minerals sources and trace elements.

**Biotechnology**

Importance and economics of downstream processing in biotechnology process-problems and requirements of bioproduct purification, process design criteria, primary separation and recovery process, membrane based separations, precipitation methods, different types of purification and chromatographic techniques.

Types of reactors - ideal reactors, integral method of analysis for reactions, simultaneous, consecutive and combined reactions, models for non-ideal flow.

Industrial biotechnology - isolation, preservation and improvement of industrial microbes for overproduction of primary and secondary metabolites, economics of modern industrial processes, fermentation processes and biological waste treatment processes.

Introduction to bioinformatics - sequence databases, search and their use, sequence alignment, ultrasonic trees,

parsimony, phylogenetic alignment, connection between multiple alignment and tree construction, DNA mapping and sequencing, sequence assembly and gene prediction, molecular predictions with DNA strings.

**Cell Structure and Function of the Organelles**

Eukaryotic and Prokaryotic cells, cell division, mitosis & meiosis cell cycle and molecules that control cell cycle, endocytosis and Exocytosis. Ultrastructure of cellular organelles, viz. Mitochondria, ER, Golgi, Chloroplast, plasma membrane, centriole, nuclear and membrane bound receptors, Signal Transduction, Techniques of propagation of prokaryotic and Eukaryotic cells, Autocrine, Paracrine and Endocrine models of action, Cell line, generation of cell lines.

**Molecular Biology**

Structure of DNA and histone molecules, Replication of eukaryotic chromosomes, nucleoid the complex replication apparatus, process of transcription and, Structure of tRNA, mRNA, rRNA, Deciphering of the genetic code, Translation, Mutation. General principles of cloning.

**Recombinant DNA**

Genetic elements that control gene expression, method of creating recombinant DNA molecules creating transgenic animals, plants microbes, safety guidelines of creating recombinant DNA research, restriction enzymes and mapping of DNA, plasmid and phage and other vectors. Construction of genomic and cDNA libraries, methods of nucleic acid. Patents and methods of application of patents, legal implications bioremediation.

**Environmental Sciences**

Ecosystems, energy flow, ecological succession, pollution. Conventional and Non conventional sources of energy. Bio-geo chemical cycles. Biodiversity and wild life conservation. Social issues and the environment.

**Genetics**

Classical genetics, Mendel's genetics, crossing over, linkage, Chromosome maps, chromosomal theory of heredity, cytoplasmic inheritance, Sex determination, sex linked inheritance, microbial genetics, population genetics, polyploidy, pedigree analysis, eugenics, mutation.

**Microbiology**

Basic concepts of Microbiology, classification, morphology, anatomy, physiology of bacteria, viruses, fungi, parasite.

Microbes of various plant and animal diseases. Industrial microbiology, Microbial biotechnology, Microbial diversity and ecology.

### Immunology

Basic concepts of immunology, types of immunity, biotechnological applications; organs of immune response, Innate and adaptive immunity, clonal selection theory, hypersensitivity, hybridoma technology, vaccine development, epitope mapping and immunomics,

immunological tolerance and transplantation biotechnology.

### Plant Sciences

Taxonomy and systematic botany, Plant structure and development, morphology and anatomy, embryogenesis of mono and dicots. Phytohormones, respiration, nutrition, transpiration. Photosynthesis, C<sub>3</sub> and C<sub>4</sub>, & CAM plants, photoperiodism, concepts of ecosystems and energy flow in biosphere.

## ME - MECHANICAL ENGINEERING

### Engineering Mathematics

Geometry Equations of straight line, common normal between straight lines in space; Equations of circles, ellipse, etc.; Parametric representation.

### 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,

### 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.

### Control Theory

Open and closed loop systems; Laplace transforms; Transfer function; Block Diagram analysis; Concepts of stability; Input signals and system response; Nyquist stability criterion; Bode plot.

### Probability and Statistics

Definitions of probability and sampling theorems, Conditional probability, Mean, median, mode and standard deviation, Permutations and combinations, Random variables, Poisson, Normal and Binomial distributions. Properties of normal curve; Statistical quality control

## APPLIED MECHANICS AND DESIGN

### Engineering Mechanics

Free body diagrams and equilibrium; trusses and frames; virtual work; kinematics and dynamics of particles and of rigid bodies in plane motion, including impulse and momentum (linear and angular) and energy formulations; impact.

### Strength of Materials

Stress and strain, stress-strain relationship and elastic constants, Mohr's circle for plane stress and plane strain, thin cylinders; shear force and bending moment diagrams; bending and shear stresses; deflection of beams; thermal stresses.

### Theory of Machines

Displacement, velocity and acceleration analysis of plane mechanisms; dynamic analysis of slider-crank mechanism; flywheels.

### Vibrations

Free and forced vibration of single degree of freedom systems; effect of damping; vibration isolation; resonance, critical speeds of shafts.

### Technical drafting

Engineering drawing practice; Indian standards for technical drawing. Machine Elements Basic concepts of machine elements and their design; Stress concentration factor; Fatigue Strength and S-N curve; failure theories. FLUID MECHANICS AND THERMAL SCIENCES

### Fluid Mechanics

Fluid properties; viscous flow of incompressible fluids; fluid statics, manometry, buoyancy; control-volume analysis of mass, momentum and energy; fluid acceleration;

differential equations of continuity and momentum; Bernoulli's equation; flow through pipes, head losses in pipes, bends etc.

### Heat-Transfer

Modes of heat transfer; one dimensional heat conduction, fins; dimensionless parameters in free and forced convective heat transfer, radiative heat transfer, black and grey surfaces, shape factors; heat exchanger performance, LMTD and NTU methods.

### Thermodynamics

Zeroth, First and Second laws of thermodynamics; thermodynamic system and processes; Carnot cycle. 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.

### Applications

#### Power Engineering

Steam Tables, Rankine, Brayton cycles with regeneration and reheat. I.C. Engines air-standard Otto, Diesel cycles. Sterling cycle.

#### Refrigeration and air-conditioning

Vapour refrigeration cycle, heat pumps, gas refrigeration, Reverse Brayton cycle; moist air psychrometric chart, basic psychrometric processes.

#### Turbo machinery

Pelton-wheel, Francis and Kaplan turbines, impulse and reaction principles, velocity diagrams.

## MANUFACTURING AND INDUSTRIAL ENGINEERING

### Engineering Materials

Structure and properties of engineering materials, heat treatment, stress-strain diagrams for engineering materials.

### Metal Casting

Design of patterns, moulds and cores; solidification and cooling; riser and gating design, design considerations.

### Forming

Load estimation for bulk (forging, rolling, extrusion, drawing) and sheet (shearing, deep drawing, bending) metal forming processes; principles of powder metallurgy

### Joining

Physics of welding, brazing and soldering; adhesive bonding;

### Machining and Machine Tool Operations

Mechanics of machining, single and multi-point cutting tools, tool geometry and materials, tool life and wear; economics of machining; principles of non-traditional machining processes; principles of work holding, principles of design of jigs and fixtures.

### Metrology and Inspection

Limits, fits and tolerances; linear and angular measurements; comparators; gauge design; interferometry; form and finish measurement; alignment and testing methods; tolerance analysis in manufacturing and assembly.

### Production Planning and Control

Forecasting models, aggregate production planning, scheduling, materials requirement 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.

## SOME CURRENT TRENDS IN DESIGN AND MANUFACTURING

### Mechatronics System Design

Pneumatic and hydraulic systems; Eletro-pneumatic and electro-hydraulic systems; Pneumatic, hydraulic and electric motors and actutators; Concepts of microcontrollers, Feedback devices; Point-to-point, continuous-path and servo control; Types of CNC machines and robots. Programmable logic controllers; CNC and robot programming. Some current developments in modern machine tools, robotics, mechatronics; Basic topics related to micro-electro mechanical systems (MEMS).

### Computer Integrated Manufacturing

Basic concepts of CAD/CAM and their integration tools. Exchange of product design and manufacturing data; CNC and robot programming methods. CAD/CAM Software and Virtual Product Development; Rapid Manufacturing

Technologies; Concepts of Machine vision and Jigless manufacturing;

### Computer Aided Engineering

Finite Element Methods; Computational Fluid Dynamics; Mechanical Systems Simulation; Tools for conventional mechanisms and MEMS design.

## PM - PHARMACY

### Medicinal Chemistry

Structure, nomenclature, classification, synthesis, SAR and mechanism of action of the following categories of drugs, which are official in Indian pharmacopoeia and British pharmacopoeia. Introduction to drug design. Stereochemistry of drug molecules. Analgesics - NSAIDS, Antidepressants, Anxiolytics, Neuroleptics, Hypnotics and sedative. Anticonvulsants, Antihistaminics, Local anaesthetics, Antianginal agents, Cardiotonic agent, Diuretic, Cardiovascular drugs, Anticoagulants, Coagulants, Antihypertensive drugs - Adrenergic and Cholinergic drugs Cardiotonic agents, Antihypertipidemic agents, Hypoglycemic agents, Antiplatelet agent, Chemotherapeutic agents, Antibiotics, Antibacterials, Antiprotozoal drugs, Sulphonamides, Antimalarial, Antiviral, Antitubercular, Antimoebic drugs, Anticancer drugs, Diagnostic agents. Preparation and storage, and uses of official radio pharmaceuticals, Vitamines and Harmones, Eicosonoids and applications.

### Natural Products

Pharmacognosy and Phytochemistry, Chemical tests for identification, chemistry, isolation, characterizations and estimation of phytopharmaceuticals belonging to the groups of terpenoids, steroids, Bioflavanoids, Purines, Alkaloids, Guggul lipids, Glycosides. Pharmacognosy of crude drugs that contain the above constituents. Standardization of raw materials and Herbal products, WHO guideline quantitative microscopy including modern techniques used for evaluation, Biotechnological principles and techniques for plant development, tissue culture.

### Pharmaceutics

Formulation and preparation of cosmetics - lipstick, shampoo, nail preparation, creams, and dentifries, quality control of tablets, capsules, liquid dosage forms, parenteral preparations of ointment and creams, suppositories, and controlled release product, Quality control of containers, closers, caps, and secondary packing materila like paper

### Automotive Engineering

Development in Bio-fuels, other alternative fuels and hydrogen as future fuel; Emission standards; Electronic injection systems; Passenger comfort and safety devices; Indian auto industry and Automotive vehicles in Indian market.

and board for pharmaceuticals, safety and legislation for cosmetic products, pharmaceutical calculations, Development, Manufacturing standards, Quality control limits, labeling, as per the pharmacopoeical requirement. Storage of different dosage forms and new drug delivery systems, Biopharmaceutics and pharmacokinetics and their importance in formulations.

### Microbiology

Principles and methods microbiological assays as per pharmacopocia, methods of preparations of official sera and vaccines, Serological and diagnostics tests, Enzymes immuno assay, concept and methodology, Sterility testing - methodology and interpretation, Applications of microorganisms in Bioconversions and in pharmaceutical industry.

### Clinical Pharmacy

Adverse drug reaction, Drug - Drug intraction, and Drug - Food interactions, Medication History, interview and patient conuseling. Therapeutic drug monitoring, Dosage regimen in pregenancy and lactation, pediatrics and Geriatrices, Renal and Hepatic impairment.

### Pharmaceutical Analysis

Principles, Instrumentation and applications of the following, Absorption spectroscopy UV visible, IR, Flame photometry, Potentiometry, Fluorimetry, conductometry and Polarography, Pharmacopocial assays. Principles of NMR, ESR, Mass spectroscopy, X-ray diffraction,optical Rotatory dispersion, statistical analysis and different chromatographic methods, Quality control of Radio pharmaceuticlas and Radio Chemical methods in analysis.

### Pharmaceutical Jurisprudence

Pharmaceutical Ethics, Pharmacy Acts, Drugs and Cosmetics Acts and rules with respect to manufacture, sales and storages.

### Bio-chemistry

Metabolism of Carbohydrates, lipids, proteins, methods to determine, kidney and liver function, Lipid profiles,



General principles of immunology, immunological, Biochemical role of Hormones, Vitamines, Enzymes, Nucleic acids, Bio energetics.

### Pharmacology

Pharmacology of Autocoids, Hormones, Hormone antagonists, Chemotherapeutic agents including

Anticancer drugs, Bioassays, Immuno Pharmacology, General Pharmacological Principles including toxicology, Drug interaction. Pharmacology of drug acting on central nervous systems, cardiovascular systems, Autonomic nervous systems, Gastro intestinal systems and Respiratory systems, Drug acting on the renal systems, Drug acting on the blood and blood forming organs.

## PH - PHYSICS

### Mathematical Physics

Fourier series - Fourier transform - properties - convolution theorem - Application to solve differential equations - Laplace's transform - properties - application to ordinary and partial differential equations - Cayley Hamilton Theorem - Eigen value problems

### Classical Mechanics

Orthogonal transformations - Eulerian angles - Rotating frames of reference and coriolis force. Mechanics of rigid bodies Angular momentum and kinetic energy - Moment of inertia tensor - Euler's equations of motion - Torque - free motion - motion of a symmetrical top under gravity.

### Electro Magnetic Theory

Faraday's laws of induction - Maxwell's displacement current - Maxwell's equations - vector and scalar potentials - Gauge invariance - wave equation and plane wave solutions - Coulomb and Lorentz Gauges - energy and momentum of the field - Poynting's theorem.

### Quantum Mechanics

Justification of Schroedinger equation - the Schroedinger equation - probabilities and normalization - Applications - particle in a box - simple harmonic oscillator - time dependence - steps and barriers.

### Statistical Mechanics

Equation of state - gas degeneracy - Bose-Einstein condensation - thermal properties of Bose-Einstein gas - liquid Helium - Tisza's two fluid model - Landau's theory of liquid Helium II - Black body radiation - phonons - Einstein and Debye models for lattice specific heat.

### Experimental Design

Measurement of fundamental constants  $e$ ,  $h$ ,  $c$  - Measurement of High & Low Resistances,  $L$  and  $C$  - Detection of X-rays, Gamma rays, charged particles,

neutrons etc - Ionization chamber - proportional counter - GM counter - Scintillation detectors - Solid State detectors - Emission and Absorption Spectroscopy - IR spectroscopy - Measurement of Magnetic field - Hall effect, magnetoresistance - X-ray and neutron Diffraction - Vacuum Techniques - basic idea of conductance, pumping speed etc - Pumps - Mechanical Pump - Diffusion pump - Gauges Thermocouple - Penning - Pirani - Hot Cathode - Low Temperature Cooling a sample over a range upto 4 K and measurement of temperature.

Measurement of Energy and Time using electronic signals from the detectors and associated instrumentation Signal processing, A/D conversion & multichannel analyzers

### Lasers

Ruby laser - Nd - YAG laser - colour centre lasers -- Helium - Neon laser - Carbondioxide laser - excimer lasers - liquid dye laser - semiconductor lasers - Homojunction laser - Heterojunction laser - Quantum well laser.

### Nonlinear Fiber Optics

Introduction - Second harmonic generation (SHG) - optical mixing - phase matching - Third harmonic generation (THG) - parametric generation of light - Optical parametric oscillator - self-focussing of light.

### Solid State Physics

Types of lattices - Miller indices - Simple crystal structures - Crystal diffraction - Bragg's law - Reciprocal Lattice (BCC, FCC) - Brillouin zone - Structure factor - Atomic form factor - Cohesive energy of ionic crystals - Madelung constant - Types of crystal binding.

### Materials Science

Phase diagram - phase rule - single component system - binary phase diagram - microstructural changes during cooling - Lever rule - Magnesia - Alumina system - Copper - Zinc system - Iron - Carbon system - Applications of phase diagram.

## MA- MATHEMATICS

**Linear Algebra:** Finite dimensional vector spaces; Linear transformations and their matrix representations, rank; systems of linear equations, eigen values and eigen vectors, minimal polynomial, Cayley-Hamilton Theorem, diagonalisation, Hermitian, Skew-Hermitian and unitary matrices; Finite dimensional inner product spaces, Gram-Schmidt orthonormalization process, self-adjoint operators.

**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; Riemann integration, 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.

**Algebra:** Normal subgroups and homomorphism theorems, automorphisms; Group actions, Sylow's theorems and their applications; Euclidean domains, Principle ideal domains and unique factorization domains. Prime ideals and maximal ideals in commutative rings; Fields, finite fields.

**Functional Analysis:** Banach spaces, Hahn-Banach extension theorem, open mapping and closed graph theorems, principle of uniform boundedness; Hilbert spaces, orthonormal bases, Riesz representation theorem, bounded linear operators.

**Numerical Analysis:** Numerical solution of algebraic and transcendental equations: bisection, secant method, Newton-Raphson method, fixed point iteration; interpolation: error of polynomial interpolation, Lagrange,

Newton interpolations; numerical differentiation; numerical integration: Trapezoidal and Simpson rules, Gauss Legendre quadrature, method of undetermined parameters; least square polynomial approximation; numerical solution of systems of linear equations: direct methods (Gauss elimination, LU decomposition); iterative methods (Jacobi and Gauss-Seidel); matrix eigenvalue problems: power method, numerical solution of ordinary differential equations: initial value problems: Taylor series methods, Euler's method, Runge-Kutta methods.

**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; solutions of Laplace, wave and diffusion equations in two variables; Fourier series and Fourier transform and Laplace transform methods of solutions for the above equations.

**Mechanics:** Virtual work, Lagrange's equations for holonomic systems, Hamiltonian equations.

**Topology:** Basic concepts of topology, product topology, connectedness, compactness, countability and separation axioms, Urysohn's Lemma.

**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, maximum likelihood estimators, Testing of hypotheses, standard parametric tests based on normal,  $\chi^2$ ,  $t$ ,  $F$  - distributions; Linear regression; Interval estimation.

**Linear programming:** Linear programming problem and its formulation, convex sets and 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; Balanced and unbalanced transportation problems,  $u$ - $v$  method for solving transportation problems; Hungarian method for solving assignment problems.

**Calculus of Variation and Integral Equations:** Variation problems with fixed boundaries; sufficient conditions for extremum, linear integral equations of Fredholm and Volterra type, their iterative solutions.

**MB - Research Aptitude & Quantitative Ability**

(for research candidates only)

**Verbal Comprehension**

This section aims to test the candidate's comprehension of and interpretative abilities in English as a language of business. Given the potential manager's decision-making roles, this section seeks to examine the candidate's felicity with common forms of English expression, grammar and usage in business that would enable him/her to extract essential information from a variety of data, and arrive at an informed decision. Regular analysis of business articles and non-fiction prose, besides a firm grasp of communicative English grammar would be helpful in preparing for this section.

**Logical Reasoning**

This section consists of analytical reasoning, argument analysis, and analysis of explanation questions

**Quantitative Ability**

Basic Mathematics (Numbers; Operations; HCF and LCM; Fractions, Decimals and Percentages; Ratio and Proportion; Roots and Power; Progressions; Elementary Geometry and Mensuration; Introductory Set Theory), Linear Algebra (Equations and Inequalities; Matrices; Determinants; Simultaneous equations and solutions; Elementary Linear Programming; Elementary differential

calculus involving functions of one variable; Elementary integral calculus), and Probability and Statistics

(Types of Data; Frequency Distributions; Measures of Central Tendency and Dispersion; Probability Concepts: Basic Outcomes, Events, Sample Spaces; Probability Calculations: Counting Rules using Permutations and Combinations, Unions and Intersections, Complementary Events, Mutually Exclusive Events, Conditional Probability and Independent Events; Correlation and Simple Linear Regression) for their use in business applications such as Partnership and Shareholding;

Present Worth and Discounts; Depreciation; Demand and Supply; Cost and Revenue, and common applications such as Banking Transactions; Inventories; Mixtures; Time and Work; Time and Distance; Pipes and Tanks; Estimation of time, distance, area, volume, effort, etc.

**Data Interpretation**

Assess the ability of the examinee to make valid interpretations from a given data set. The section also assesses the ability of the examinee to understand data in different representative forms such as simple tables, histograms, pie charts, graphs, scatter diagrams, etc. Although involved calculations are not expected, simple data manipulations would be required.

**GG - GEOLOGY AND GEOPHYSICS**

(for research candidates only)

**Common to Geology and Geophysics**

Earth and Planetary system, size, shape, internal structure and composition of the earth; atmosphere and greenhouse effect; isostasy; elements of seismology; physical properties of the interior of the earth; continents and continental processes; physical oceanography; geomagnetism and paleomagnetism, continental drift, plate tectonics.

Weathering; soil formation; action of river, wind, glacier and ocean; earthquakes, volcanism and orogeny. Basic structural geology, mineralogy and petrology. Geological time scale and geochronology; stratigraphic principles; major stratigraphic divisions of India. Engineering properties of rocks and soils. Ground water geology. Geological and geographical distribution of ore, coal and petroleum resources of India.

Introduction to remote sensing. Physical basis and applications of gravity, magnetic, electrical, electromagnetic, seismic and radiometric prospecting for oil, mineral and ground water; introductory well logging.

**Geology**

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

Igneous rocks - classification, forms and textures, magmatic differentiation; phase diagrams and trace elements as monitors of magma evolutionary processes; mantle melting models and derivation and primary magmas. Metamorphism; controlling factors, metamorphic facies, grade and basic types; metamorphism of pelitic, mafic and impure carbonate rocks; Igneous and metamorphic provinces of India; structure and petrology of sedimentary rocks; sedimentary processes and environments, sedimentary facies, basin analysis; association of igneous, sedimentary and metamorphic rocks with tectonic setting.

Stress, strain and material response; brittle and ductile deformation; 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; basement cover relationship.

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.

Ore mineralogy and optical properties of ore minerals; ore forming processes vis-a-vis ore-rock association (magmatic, hydrothermal, sedimentary and metamorphogenic ores); ores and metamorphism; fluid inclusions as an ore genetic tool; prospecting and exploration of economic minerals; sampling, ore reserve estimation, geostatistics, mining methods. Coal and petroleum geology; origin and distribution of mineral and fuel deposits in India; marine geology and ocean resources; ore dressing and mineral economics.

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

Engineering properties of rocks and soils; rocks as construction materials; role of geology in the construction of engineering structures including dams, tunnels and excavation sites; natural hazards. Ground water geology - exploration, well hydraulics and water quality. Basic principles of remote sensing - energy sources and radiation principles, atmospheric absorption, interaction of energy with earth's surface, air-photo interpretation, multispectral remote sensing in visible, infrared, thermal IR and microwave regions, digital processing of satellite images. GIS - basic concepts, raster and vector mode operation.

### **Geophysics**

The earth as a planet; different motions of the earth; gravity field of the earth, Clairaut's theorem, size and shape of earth; geochronology; seismology and interior of the earth; variation of density, velocity, pressure, temperature, electrical and magnetic properties of the earth; earthquakes-causes and measurements, magnitude and intensity, focal mechanisms, earthquake quantification, source

characteristics, seismotectonics and seismic hazards; digital seismographs, geomagnetic field, paleomagnetism; oceanic and continental lithosphere; plate tectonics; heat flow; upper and lower atmospheric phenomena.

Scalar and vector potential fields; Laplace, Maxwell and Helmholtz equations for solution of different types of boundary value problems in Cartesian, cylindrical and spherical polar coordinates; Green's theorem; Image theory; integral equations in potential theory; Eikonal equation and Ray theory. Basic concepts of forward and inverse problems of geophysics, Ill-posedness of inverse problems.

'G' and 'g' units of measurement, absolute and relative gravity measurements; Land, airborne, shipborne and bore-hole gravity surveys; various corrections in gravity data reduction - free air, Bouguer and isostatic anomalies; density estimates of rocks; regional and residual gravity separation; principle of equivalent stratum; upward and downward continuation; wavelength filtering; preparation and analysis of gravity maps; gravity anomalies and their interpretation - anomalies due to geometrical and irregular shaped bodies, depth rules, calculation of mass.

Earth's magnetic field - elements, origin and units of measurement, magnetic susceptibility of rocks and measurements, magnetometers, Land, airborne and marine magnetic surveys, corrections, preparation of magnetic maps, upward and downward continuation, magnetic anomalies-geometrical shaped bodies, depth estimates, Image processing concepts in processing of magnetic anomaly maps; Interpretation of processed magnetic anomaly data.

Conduction of electricity through rocks, electrical conductivities of metals, non-metals, rock forming minerals and different rocks, concepts of D.C. resistivity measurement, various electrode configurations for resistivity sounding and profiling, application of filter theory, Type-curves over multi-layered structures, Dar-Zarrouck parameters, reduction of layers, coefficient of anisotropy, interpretation of resistivity field data, equivalence and suppression, self potential and its origin, field measurement, Induced polarization, time and frequency domain IP measurements; interpretation and applications of IP, ground-water exploration, environmental and engineering applications.

Basic concept of EM induction, Origin of electromagnetic field, elliptic polarization, methods of measurement for different source-receiver configuration, components in EM measurements. Skin-depth, interpretation and



applications; earth's natural electromagnetic field, tellurics, magneto-tellurics; geomagnetic depth sounding principles, electromagnetic profiling, methods of measurement, processing of data and interpretation. Geological applications including groundwater, mining and hydrocarbon exploration.

Seismic methods of prospecting; Elastic properties of earth materials; Reflection, refraction and CDP surveys; land and marine seismic sources, generation and propagation of elastic waves, velocity - depth models, 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, processing and interpretation; CDP stacking charts, binning, filtering, dip-moveout, static and dynamic corrections, Digital seismic data processing, seismic deconvolution and migration methods, attribute analysis, bright and dim spots, seismic stratigraphy, high resolution seismics, VSP, AVO. Reservoir geophysics.

Geophysical signal processing, sampling theorem, aliasing, Nyquist frequency, Fourier series, periodic waveform, Fourier and Hilbert transform, Z-transform and wavelet transform;

power spectrum, delta function, auto correlation, cross correlation, convolution, deconvolution, principles of digital filters, windows, poles and zeros.

Principles and techniques of geophysical well-logging. SP, resistivity, induction, gamma ray, neutron, density, sonic, temperature, dip meter, caliper, nuclear magnetic, cement bond logging, micro-logs. 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.

Radioactive methods of prospecting and assaying of minerals (radioactive and non radioactive) deposits, half-life, decay constant, radioactive equilibrium, G M counter, scintillation detector, semiconductor devices, application of radiometric for exploration and radioactive waste disposal.

Geophysical inverse problems; non-uniqueness and stability of solutions; quasi-linear and non-linear methods including Tikhonov's regularization method, Backus-Gilbert method, simulated annealing, genetic algorithms and artificial neural network

## MC - Master of Computer Application (MCA)

### English

Sentence correction and comprehension

### Logical Reasoning

Questions on comprehension of a logical situation and questions based on the facts given in the passage.

### Mathematics

**Algebra:** Indices, variation, arithmetic progression, geometric progression, harmonic progression, quadratic equations, permutation, combination, binomial theorem, logarithms, exponential series, logarithmic series.

**Trigonometry:** Sine and cosine of sum and difference of angles, sum and difference of sine and cosine, multiple angles, submultiple angle, general solution of trigonometric equation, properties of triangles, solution of triangles.

**Analytic geometry (Two-dimensional):** Rectangular Cartesian coordinates, distance between points, section ratio, straight line, circle, ellipse, parabola, hyperbola, tangent, normal.

**Calculus:** Function, limit, continuity, differentiation, chain rule, differentiation of implicit functions, parametric functions, application of differentiation, integration, integration by substitution, by parts, by partial fractions, definite integrals, application of definite integral.

**Set Theory:** Concept of set, set operations, cardinality, Cartesian product.

**Matrices & Determinants:** Addition, subtraction, multiplication and inverse of matrices, evaluation of determinant of order up to four.

**Vector Algebra:** Position vector, addition, subtraction, scalar multiplication, scalar product, vector product.

### Statistics and probability

Frequency distribution, mean, median, mode, range, mean deviation, standard deviation, coefficient of variation, correlation, regression, probability, conditional probability, Baye's theorem, binomial, Poisson, normal distribution.