Syllabus Of AMIE Exams: Section A (Diploma Stream)

AD 201 Fundamentals of Design and Manufacturing

AD 202 Material Science and Engineering

AD 203 Computing and Informatics

AD 204 Society and Environment

Fundamentals Of Design & Manufacturing

Group A

Engineering design process and its structure. Identification and analysis of need, product design specifications, standards of performance and constraints. Searching for design concepts; morphological analysis, brainstorming. Evaluation of design concepts for physical reliability, economic feasibility and utility.

Detailed design; design for manufacture, assembly, shipping, maintenance, use, and recyclability.

Design checks for clarity, simplicity, modularity and safety. Standardization and size ranges. Reliability and robust design. Design organisation and communication, . technical reports, drawings, presentations and models.

Concept of manufacturing; classification of manufacturing processes. Fundamentals of casting. Basic understanding of commonly used casting processes (sand casting, investment casting and permanent mould casting processes).

Fundamentals of metal forming; hot and cold working; basic understanding of primary metal forming processes (rolling, forging, extrusion and drawing processes, punching and blanking).

Group B

Fundamentals of metal cutting; tool-work interaction for production of machined surfaces. Classification of machining processes. Basic machining operations (turning, shaping, planning, drilling and milling processes).

Fundamentals of grinding and finishing; overview of unconventional machining processes; fundamentals of welding processes; introduction to primary welding and allied processes; selection of manufacturing processes. Design for manufacturability.

Need for integration-commercial, economic and technological perspective; basic tools of integration; concept of a system. introduction to information technology and its elements.

Introduction to group technology; introduction to simulation and database management systems.
Elements of integration:-eontrol1ers, sensors, robots, automated machines; AGVs, AS, RS, etc.
Product and process design- for integration; design for economic manufacturing; design for manufacturing integration.
Introduction to computer aided process planning; selection of machine tools.

Material Science & Engineering

Group A
Introduction to materials. Metal and alloys, ceramics, polymers and semi conducting materials-introduction and application as engineering materials.
Defects in solids. Point, line and surface defects. Diffusion in solids.
Phase diagrams. Mono-component and binary systems, non-equilibrium system, phase diagram and. application in crystalline and non-crystalline solids.
Mechanical properties. Tensile strength, yield strength, elastic and viscoelastic properties, creep, stress relaxation and impact. Fracture behaviour. Ductile fracture, Griffith theory, effect of heat treatment and temperature on properties of metals.
Deformation of metals. Elastic and plastic deformation, slip, twin, dislocation theory, critical resolved shear stress, deformation in polycrystalline materials; season cracking, Bachinger's effect, strengthening mechanics; work hardening recovery, crystallization and grain growth, cold and hot working.
Group B
Heat treatment. Iron-carbon system. Annealing, normalising, hardening,. critical cooling rate, hardenability, age hardening, surface hardening, tempering.
Thermal properties. High temperature materials; materials for cryogenic application, thermally insulating materials. (Specific heat, thermal conductivity, thermal expansion).
Ceramic materials and polymers. Silicon structures, polymerism . in glass, electrical properties of ceramic phases, rocks, building stones, refractories.
Polymerisation mechanism, structural properties of polymer, thermoplastics, thermosets, elastomer, resins, composites, particles and fibre reinforced composite.
Composite material including nano material.
Electronic properties. Magnetism, diamagnetism, paramagnetism, ferromagnetism, magnetic energy, zone theory of solids, zones in conductors and insulators.

Computing & Informatics

Group A

Programming languages. C including C++; Languages-declarations, expressions, control statements, arrays, functions, pointers and structures; Algorithms and flow charts. Introduction to Pascal.

Informatics. Information systems for decision making; Data management and database management technology; Office automation system-LAN, WAN, electronic mail, electronic .data interchange; client server technology; overview of TCP/IP; Information systems for business; Strategic information systems; Information resources management.

Group B

Computer basics. History, generations and classification of computers; Number systems; Boolean algebra.

Hardware. Introduction to logic gates an flip flops; components of a computer input/output devices, CPU unit and memory unit, secondary storage.

Software. System software; application software; compilers and translators

Operating systems. Introduction to operating systems; types of operating systems and their functions; popular operating systems-MS-DOS, UNIX and Windows; file. management.

Society & Environment

Group A

Societal Structures and Dynamics: An analysis of basic sociological concepts and the applications to contemporary society; social Stratification caste, class, cultural heritage, occupation, mobility and income distribution. Social tensions and their cause societal responsibilities and social institutions.

Development Processes: Parameters for development. Interrelationship between social, economic and scientific factors. Role of science and technology in development. Planning-its objective and assessment.

Technology Assessment: Historical development of science and technology Criteria for assessment of appropriate technology and technology adaptation.

Group B

Ecosystems: Natural ecosystems. Principles of eco-balance, Biosphere cycle, carbon dioxide. Causes for eco-imbalance - its effects and remedies.

Environmental Degradation: Causes for degradation - its effect. Control of air, water, soil and noise pollutions. Protection of ozone layer.

Waste Management: Agricultural, urban and industrial waste.

Sustainable Development: Definition and concept. Technology for sustainable energy and materials.

Section A (Non Diploma Stream)

AN 201 Fundamentals Of Design And Manufacturing
AN 202 Material Science And Engineering
AN 203 Computing And Informatics
AN 204 Society And Environment
AN 205 Mechanical Science
AN 206 Engineering Physics And Chemistry
AN 207 Engineering Drawing And Graphics
AN 208 Electronics And Instrumentation
AN 210 Engineering Mathematics
AN 203 Electrical Science

FUNDAMENTALS OF DESIGN AND MANUFACTURIN

Group A
Engineering design process and its structure. Identification and analysis of need, product design specifications, standards of performance and constraints.
Searching for design concepts; morphological analysis, brainstorming. Evaluation of design concepts for physical reliability, economic feasibility and utility.
Detailed design; design for manufacture, assembly, shipping, maintenance, use, and recyclability.
Design checks for clarity, simplicity, modularity and safety. Standardization and size ranges. Reliability and robust design. Design organisation and communication, . technical reports, drawings, presentations and models.
Concept of manufacturing; classification of manufacturing processes. Fundamentals of casting. Basic understanding of commonly used casting processes (sand casting, investment casting and permanent mould casting processes).
Fundamentals of metal forming; hot and cold working; basic understanding of primary metal forming processes (rolling, forging, extrusion and drawing processes, punching and blanking).

Group B
Fundamentals of metal cutting; tool-work interaction for production of machined surfaces. Classification of machining processes. Basic machining operations (turning, shaping, planning, drilling and milling processes).
Fundamentals of grinding and finishing; overview of unconventional machining processes; fundamentals of welding processes; introduction to primary welding and allied processes; selection of manufacturing processes. Design for manufacturability.
Need for integration-commercial, economic and technological perspective; basic tools of integration; concept of a system. introduction to information technology and its elements.
Introduction to group technology; introduction to simulation and database management systems.
Elements of integration:-eontrol1ers, sensors, robots, automated machines; AGVs, AS, RS, etc.
Product and process design- for integration; design for economic manufacturing; design for manufacturing integration.
Introduction to computer aided process planning; selection of machine tools.

MATERIAL SCIENCE AND ENGINEERING

Group A
Introduction to materials. Metal and alloys, ceramics, polymers and semi conducting materials-introduction and application as engineering materials.
Defects in solids. Point, line and surface defects. Diffusion in solids.
Phase diagrams. Mono-component and binary systems, non-equilibrium system, phase diagram and. application in crystalline and non-crystalline solids.
Mechanical properties. Tensile strength, yield strength, elastic and viscoelastic properties, creep, stress relaxation and impact. Fracture behaviour. Ductile fracture, Griffith theory, effect of heat treatment and temperature on properties of metals.
Deformation of metals. Elastic and plastic deformation, slip, twin, dislocation theory, critical resolved shear stress, deformation in polycrystalline materials; season cracking, Bachinger's effect, strengthening mechanics; work hardening recovery, crystallization and grain growth, cold and hot working.

Group B
Heat treatment. Iron-carbon system. Annealing, normalising, hardening,. critical cooling rate, hardenability, age hardening, surface hardening, tempering.
Thermal properties. High temperature materials; materials for cryogenic application, thermally insulating materials. (Specific heat, thermal conductivity, thermal expansion).
Ceramic materials and polymers. Silicon structures, polymerism . in glass, electrical properties of ceramic phases, rocks, building stones, refractories.
Polymerisation mechanism, structural properties of polymer, thermoplastics,

thermosets, elastomer, resins, composites, particles and fibre reinforced composite. Composite material including nano material.
Electronic properties. Magnetism, diamagnetism, paramagnetism, ferromagnetism, magnetic energy, zone theory of solids, zones in conductors and insulators.

COMPUTING AND INFORMATICS

Group A
Programming languages. C including C++; Languages-declarations, expressions, control statements, arrays, functions, pointers and structures; Algorithms and flow charts. Introduction to Pascal.
Informatics. Information systems for decision making; Data management and database management technology; Office automation system-LAN, WAN, electronic mail, electronic .data interchange; client server technology; overview of TCP/IP; Information systems for business; Strategic information systems; Information resources management.

Group B
Computer basics. History, generations and classification of computers; Number systems; Boolean algebra.
Hardware. Introduction to logic gates an flip flops; components of a computer input/output devices, CPU unit and memory unit, secondary storage.
Software. System software; application software; compilers and translators
Operating systems. Introduction to operating systems; types of operating systems and their functions, popular operating systems-MS-DOS, UNIX and Windows; file. management.

SOCIETY AND ENVIRONMENT

Group A
Societal Structures and Dynamics: An analysis of basic sociological concepts and the applications to contemporary society; social Stratification caste, class, cultural heritage, occupation, mobility and income distribution. Social tensions and their cause societal responsibilities and social institutions.
Development Processes: Parameters for development. Interrelationship between social, economic and scientific factors. Role of science and technology in development. Planning-its objective and assessment.
Technology Assessment: Historical development of science and technology Criteria for assessment of appropriate technology and technology adaptation.

Group B
Ecosystems: Natural ecosystems. Principles of eco-balance, Biosphere cycle, carbon dioxide. Causes for eco-imbalance - its effects and remedies.
Environmental Degradation: Causes for degradation - its effect. Control of air, water, soil and noise pollutions. Protection of ozone layer.
Waste Management: Agricultural, urban and industrial waste.
Sustainable Development: Definition and concept. Technology for sustainable energy and materials.

MECHANICAL SCIENCE

Group A
Mechanics of Solids: Coplanar force systems, moment, of a force, couple, equilibrium conditions, free-body diagram, laws of friction. Centroid and area moment of inertia, mass moment of inertia, principle of virtual work, screw jack.
Dynamics and Statics: Kinematics of particles, velocity, acceleration, Newton's laws, equation of motion (rectilinear), momentum impulse, work/energy, projectiles, moment of momentum, rotation and simple harmonic motion, free vibration.
Mechanics of Deformation: Stress, strain, Hooke's law, elastic constants, ultimate strength, Mohr's circle of stress, thin-walled pressure vessels. Deflection of beam-bending moment and shear force in beam/cantilevers, torsion of circular sections. ¬

Group B
Fluid Mechanics: Fluids and their properties, viscosity, compressibility, surface tension, non-Newtonian fluids, pressure at a point, . hydrostatic forces on immersed and floating bodies, type of flow, velocity and acceleration of a flow particle, hydrodynamics.
Thermodynamics: Basic concepts- properties of gases and equation of state, work, heat, heat capacity, internal energy; enthalpy. First law of thermodynamics and law of conservation of energy, basic thermodynamic processes for ideal gases. Second law of thermodynamics, Carnot cycle, entropy, various processes on T-s and H-s planes. Ideal heat. engine cycles-SI and CI engine' cycles, principle of operation of SI and CI engines.

ENGINEERING PHYSICS AND CHEMISTRY

Group A
Engineering Physics
Atomic structure, Rutherford and Bohr's models, atomic process. Proton and neutron, radioactivity and decays. Nuclear energy and reactions, nuclear reactor. Introduction to quantum physics.
Inter-atomic forces in solids, anisotropic properties. Distinction between metal and semi-metals. Semiconductor; insulator and superconductor. Dielectric materials. Types of dielectric polarisation. Piezo, pyro and ferroelectric materials and their

electrical and optical properties.
Kinetic theory of gases. Temperature and kinetic energy, ideal gas laws. Principle of statistical mechanics. Boltzman's law, Brownian movement, equiportion of energy and thermal equilibrium of radiation.
Optics. Interference, diffraction and polarisation, laser, holography, fibre optics. Crystalline and amorphous material, crystal geometry, crystal directions and planes. Space lattices. Crystal symmetry and structure. Crystal bonding. Inter-atomic forces in solids. Anisotropic properties.

Group B
Engineering Chemistry
Chemical bond. Ionic and covalent bonding; Lattice energy; Hybridisation; Resonance; Bond order; Fajan's rule; Metallic bond and intermolccular forces; Chemical kinetics.
Structure of organic molecules, nomenclature. Introduction to stereochemistry; Optical activity. Titration involving potassium permanganate, potassium dichromat. Titration involving EDTA.
Oxidation-reduction reactions. Celloid and surface chemistry; Corrosion; chromatography and ion-exchange catalysis; Crystal structure and electro-chemistry; UV-visible spectrophotometry. Chemical kinetics-simple reactions. Environmental chemistry. Pollutant analysis, e.g., CO. H2, S, NOx, SOx, oxidant.

ENGINEERING DRAWING AND GRAPHICS

Group A
Projection graphics. Objects, condition and methods of projection; Gnomonic, stereographic and orthographic projections; Coordinate systems and grid scales, scale distortion, and conditions of conformality and equivalence. Axonometric projections; Isometric; Dimetric and oblique projections; Conical equivalent and. equivalent cylindrical projections.
Spatial graphics. Basic principles of multiview drawings and Monge's projections; Points in quadrants and octants; Projections of lines and traces of lines; True relative positions of two planes and of a straight line and a plane; Method of revolution. Projections of polyhedrons, curved lines and surfaces; Contour mapping of curved surfaces; Plane sections .of polyhedrons and curved surfaces; Intersection of planes and surfaces and lines and surfaces; Development of curved surfaces. Affine correspondence and its applications.
Product graphics. Introduction to various product features; identification of functional and non-functional, surfaces; Selection of datum; Tolerancing of dimensions. Compatibility of product elements for manufacturing and assembly requirements; Sectional and auxiliary views. .
Computer graphics. Basic principles for interactive computer graphics; Systems and peripherals required; Point plotting technique; Line drawing displays; Modelling of two and three-dimensions; Display of solid objects.

Group B
Drafting principles. Manipulation and use of drafting equipments and instruments; Exercises in instrumental drawing; Introduction to drafting codes as per ISO and BIS; Technical lettering.
Drawing exercise. Drafting problems involving consideration of - stereo metric features; Toleranced dimensioning; partial views and sectioning, auxiliary sections, schematic product symbols. Drafting exercises involving (a) preparation of details, (b) aggregation for assembly, (c) exploded machine kinematics, etc.

ELECTRONICS AND INSTRUMENTATION

Group A
Electronics
Semiconductor materials, intrinsic and extrinsic semiconductors. p-n junction diodes, rectifiers-;half wave, full wave, capacitive filters, Zener diodes, their operation, characteristics and applications.
Transistors-p-n-p and n-p-n transistors, transistor as amplifier-CE, transistor characteristics, blasting and biasing stability, small signal equivalent circuits. Field effect devices-MOSFET -characteristics and applications. BJT -characteristics.
Amplifiers-Hybrid parameter equivalent circuits for common emitter configuration, current and voltage gain, . input-output impedance, frequency response_ concepts of feedback amplifiers, regenerative feedback and conditions for oscillation.
Thyristors-characteristics and applications. Triacs and GTOs.
Integrated circuits: IC devices. OP AMP applications. Analogue to, Digital Conversion (ADC), Digital to Analogue Conversion(DAC).

Group B
Instrumentation
Indicating instruments. Moving coil, moving iron, rectifier and dynamometer type meters for measurement of voltage, current, resistance and power. Integrating meters.
Electronic voltmeters-peak, r.m.s. and average reading type voltmeters. CRO-functional block diagram, operation and application.
Electronic instruments. Q-meters, distortion meters, spectrum analyzers, audio oscillators and RF signal generators, introduction to digital voltmeters; digital display devices.
Sensors and transducers. Resistive, inductive and capacitive pick ups for non electrical quantities. Analogue and digital data acquisition and transmission systems.

ENGINEERING MATHEMATICS

Group A

Calculus of functions of one variable: Successive differentiation, Leibnitz theorem, Roll's and Mean value theorems. Taylor's and Maclaurin's expansion theorems. Fundamental theorem of integral calculus. Elementary reduction formulae for integrals. Applications to length, area, volume, surface area of revolution, moments of centre of gravity. Infinite series-convergence, divergence ratio tests, etc.
Calculus of functions of several variables: Partial derivatives, gradient and directional derivatives.
Differentiation of implicit functions, exact differentials, tangents, normals, maxima; minima, saddle points. Method of Lagrange's multiplier. Multiple integrals.
Vector Calculus: Scalar and vector fields. Line and surface integrals. Gradient and divergence. Green's and Stoke's theorems and their applications
Linear Algebra: Vector spaces-linear independence and dependence of vectors, inner products, linear transformations. Matrices and determinants. Systems of linear equations¬ consistency and inconsistency. Gauss elimination, rank of a matrix, inverse of a matrix. . Eigen values and eigenvectors of a matrix, diagonalization of a matrix. .

Group B

Ordinary Differential Equations (ODEs): Formation of ODEs, definition of order, degree and solutions. ODEs of first. order; separable variables, homogeneous. and non-homogeneous .equations, exactness and integrating factors, linear equations and Bernoulli's equations {general linear ODEs of nth order, solutions of homogeneous and non-homogeneous equations, operator method, methods of undetermined coefficients and variation of parameters). Solutions of simple simultaneous ODEs. Partial differential equations and its applications. Transforms theory-Laplace, Fourier, etc.
Numerical Methods: Difference operators forward, backward, central, shift and average. operators, and relations. between them. Newton's forward and backward interpolations. Lagrange's interpolation and the error formula for interpolation. Numerical differentiation and integration. Trapezoidal rule and Simpson's one-third rule, including error formulae.
Introduction to Probability and Statistics: Basic concepts, including introduction to probability theory, Venn diagrams., central limit theorem, mean, mode and median. Properties of Beta, Poisson, Exponential and Normal distributions. Correlation and regression, Students t-distribution test, Chi-square and F tests of significance.

ELECTRICAL SCIENCE

Group A

Review of basic concepts in electrostatics and magnetostatics, Basic laws due to Ohm, Coulomb, Faraday, Ampere and Kirchhoff, Network parameters and theorems, Superposition theorem, Thevenin and Norton's Theorems, Network analysis, Steady state response of circuits to sinusoidal functions. Power and power factor. Phasor representation of sinusoidal complex impedances. Resonance. Magnetic field calculations. Magnetization curves. Magnetic circuits concepts and calculation. Hysteresis and eddy current losses. Relays.

Polyphase circuits-Three-phase supply systems. Phase sequence. Balanced three-phase circuits. Star and delta connected loads. Unbalanced three-phase circuits. Symmetrical components. Power measurement in three-phase circuits. Active and reactive power. Power factor improvement.

Group B

Elements of power distribution. d.c.2-wire, 3 wire distributions. a.c. 3-wire and 4-wire distributions. Radial and ring main distributions. Current loading and voltage profile in distributions. Comparison of copper efficiencies in different systems of distribution.

Power transformers, theory of operation, phasor diagram, equivalent circuit. Efficiency and regulation.

Principles of energy conversion; Basic concepts of rotating machines, torque and emf; d.c. machines, characteristics of series, shunt and compound motors and generators.

Basic principles of operation of synchronous and induction machines. Starting of induction motors. Regulation of synchronous generator by synchronous impedance method. Single-phase induction and commutator machines.

Section B (Mechanical Engineering)

Compulsory Subjects

IC 402 Engineering Management
MC 403 Mechanics of Solids
MC 404 Mechanics of Fluids
MC 405 Thermal Science and Engineering
MC 406 Manufacturing Technology
MC 407 Design of Machine Elements

Optional Subjects

(Any Three From Any One Group)

Group I Thermal Engineering

MC 411 Refrigeration and Air-conditioning
MC 412 Power Plant Engineering
MC 413 Non-conventional Energy Systems
MC 414 Internal Combustion Engines
MC 415 Turbo-machinery

Group II Engineering Design

MC 421 Design of Mechanical Systems
MC 422 Optimization — Theory and Applications
MC 423 Analysis and Synthesis of Mechanisms and Machines
MC 424 Design of Machine Tools
MC 425 Computer Aided Engineering Design

Group III Manufacturing Engineering

MC 431 Manufacturing Science
MC 432 Computer Aided Manufacturing
MC 433 Tool and Die Design
MC 434 Manufacturing Automation
MC 435 Production Management

Engineering Management

Group A

Management and Organisations

Management process: Definition, planning organizing, directing, controlling, coordinating, types of management.

Organisation Definition, planning, design and development, types of organizations.

Management planning and control: Classical, new classical and modern principles. General Management, scientific management, engineering, management, systems management.

Planning: Procedures, resources and constraints, objectives, goals, policies and procedures.

Control: Setting of reference or standards, appraisal or evaluation, monitoring and controlling, types of control.

Human resource planning and management, selection, recruitment, training, retraining, skill development, competence development, promotion and career development, participative management, trade unions, and collective bargaining,

Management of Physical Resources

Plant: site selection procedures, factors affecting selection. Layout-types and relative merits and demerits, Maintenance-Objectives, different types of associated decisions, strategies for effective maintenance, computer applications.

Material : Functions, objectives, planning and control including inventory models with or without storage costs, price break (excluding dynamic and probabilistic considerations). Different classes of inventory. Material Requirement Planning (MRP).

Group B

Financial management: Introduction to standard forms of financial statements, i.e., balance-sheet, profit and loss, and income statement. Fixed and current asset items. Fixed and current liability items. Linkage of two successive balance-sheets through income or profit and loss statement. Funds flow statement. Financial ratios and their implications.

Managerial economics: Concepts, theory of production, marginal productivity and cost. Introduction to theory of firm.

Quality management: Quality definition, quality planning, quality control and quality management, Total quality management, ISO 9000 systems, simple quality control techniques like control charts and acceptance sampling.

Marketing management consumer behavior, market research, product design and development pricing and promotion.

Project management: Introduction. Concept of a project, project management concepts, project simulation, cost or project and means of financing, economic evaluation criteria of the project, project implementation, project planning, scheduling and monitoring, project control (PERT, CPM techniques including crashing). Project evaluation.

Information technology and management. Role of information, management information system and decision support system, Information technology- introduction to e-business, e-commerce and integration tools like enterprise resource planning (ERP).

Mechanics Of Solids

Group A

Review of free body diagrams; Analysis of deformation unde-!" axial loading. Simple shear and pressure.

Statically determinate and indeterminate cases. Forces and moments transmitted by simple beams.

Mechanics of deformable solids, stress and strain, transformation of stress and, strain, Mohr circle diagram, equilibrium equations and compatibility conditions.

Material properties and their testing: Elastic, inelastic, plastic and viscoelastic material behaviour. Fatigue and creep. Concepts of ductility, hardness, toughness and their quantification. Tensile and impact tests.

Group B

Stress-strain-temperature relations. Generalised Hooke's law and thermal strains.

Equations of elasticity. Solutions of thin and thick cylinders and rotating disks.

Stresses in beams. Torsion of circular shafts and thin walled sections. Deflection of helical springs.

Yield criteria, energy methods, basic elasticity equations.

Mechanics Of Fluids

Group A

Properties and classifications of fluids. Fluids statics, buoyancy.

Scalar and vector fields, Reynolds transport theorem.

Continuity and momentum equations, momentum theorem, Bernoulli’s equation and their applications.

Constitutive relation for a Newtonian fluid. Navier Stokes equations, exact solutions for flow between parallel plates, rotating cylinders, Couette flow and Poiseuille flow.

Application of viscous flows through pipes, Correlation of friction factor.

Laminar boundary layer, boundary layer equations Blasius solution over a flat plate, wall shear stress. boundary layer thickness, boundary layer control.

Group B

Separation; momentum integral method.

Turbulent flow; mixing length models; Skin friction coefficient in a turbulent boundary layer.

Compressibility flow; Nozzles and diffusers; Shocks; Effect of friction and heat transfer.

Potential flows.

Experimental methods for flow and velocity measurements.

Thermal Science & Engineering

Group A

System, property, work and heat interactions, zeroth law, first law of thermodynamics, application of first law to closed systems and flow processes.

Thermodynamic properties of fluids.

Second law of thermodynamics, Carnot cycle, temperature scale, Clausius inequality, entropy increase, availability.

Thermodynamic property relations. Clapeyron's equation.

Power and refrigeration cycles. Operating principles and essential components of vapour power cycles. IC engines and gas turbines.

Thermodynamics of mixtures, psychrometry.

Group B

Conduction: One-dimensional steady and unsteady state problems, fins, multidimensional problems.

Convection: External flows, boundary layer flow on heated flat plate.

Thermally and hydro-dynamically fully developed 10w through a pipe, turbulence flow, Dittus Boelter's and Sieder state correlation.

Natural convection, condensation and boiling. Heat exchangers, LMTD and e-NTU method. Radiation: Fundamental concepts, black body radiation, surface emission, surface properties, Kirchoff's law, view factor, black body radiation exchange.

Manufacturing Technology

Group A

Introduction. Manufacturing cycle. Manufacturing processes and their selection. Engineering materials and their selection.

Casting: Patterns, gating system design, riser design, product design, defects, inspection techniques. Other casting processes: investment casting, die casting, centrifugal casting and continuous casting. Basic design considerations in casting.

Metal forming: Plastic deformation, hot and cold working. Forming operations-rolling, extrusion, drawing processes, sheet metal operations, load estimations for homogeneous deformation. Sheet metal die design. High velocity forming processes.

Heat treatment processes.

Processing of plastics: Extrusion, injection moulding, blow moulding, rational moulding, thermo-forming and compression moulding. Basic design considerations, rapid prototyping, stereo lithography technique.

Powder metallurgy processing: Production of metal powders, compaction and sintering processes. .

Group B

Metal cutting: Tool .materials, tool geometry and nomenclature in ASA, ORS and NRS, cutting fluids, single and multipoint cutting operations, production of gears and screw threads, grinding and finishing processes, specification of grinding wheels.

Machine tools: Primary and secondary dnves, guideway and slideways, structure. Introduction to NC, CNC and DNC machining.

New machining methods: Process capabilities and limitations of AJM, USM, WJM, ECM, ECG, EDM, EBM and LBM processes.

Joining processes: Fusion welding processes, heat affected zone, testing of welded joints, solid state welding processes, brazing and soldering. Basic design considerations in welding. Process selection. Adhesive bonding. Mechanical fastening processes.

Design of Machine Elements

Group A

Mechanical systems and elements, overall design considerations, safety, ecological and societal considerations in design. Codes for design-Bureau of Indian Standards (BIS)-codes, design data handbook. Load, stress and critical sections in machine parts.

Materials, stress-strain curves of ductile and brittle materials, cast iron, steel, non-ferrous alloys and plastics, hardness and surface properties of materials, material

strength, factor of safety and allowable stress. Review of axial, bending, shear and torsional loading on machine components, combined loading, two- and three dimensional Mohr's circle. Stresses in curved beams, thick and thin shells under pressure.

Deflection and stability, beam deflection and column buckling. Euler's formula and Johnson's formula. Failures theories-maximum normal stress theory, maximum shear stress theory, and maximum distortion energy theory. Application to components made of brittle and ductile materials, stress concentration factor.

Cyclic loading and fatigue failures: Reverse bending, axial and torsion loadings, effect of stress concentration, fatigue life prediction-Miner's rule, effect of surface treatments (shot-peening, surface hardening) on fatigue life of components.

Design of threaded fasteners and power screws, thread forms and threaded fastener types and materials, power screws, bolt tightening and initial tension, static and group of bolts.

Rivets and welding: Loading, bending, direct shear, axial and bending.

Group B

Design of springs: Spring materials, helical compression and extension springs, design for fatigue, loading, leaf sprints. Design of sliding bearings, bearing materials, fluid viscosity, hydrodynamic lubrication, Petroff's equation, Raimondi and Boyd chart. Heat dissipation.

Rolling elements bearings: Types, catalogue information (Timken and SKF bearings), bearing life radial and thrust loads. Selection of bearings. Spur, helical and worm gears, gear tooth profile, gear geometry, module, contact ratio, gear train, gear tooth bending strength, gear tooth surface fatigue analysis, gear material.

Design of shafts, keys, pins and splines, shaft couplings. Cotter and pin joints, pipe joints, gaskets, seal and packing, cylinder joints, flanged joints.

Clutches and brakes: Single and multiple plate clutch, constant wear and constant pressure theories for plate clutches, materials, shoe drum brakes, internal and external shoe brakes.

Power transmission elements: Belts and chain drives, design of flat and V-belts.

REFRIGEREATION AND AIRCONDITIONING

Group A

Introduction to refrigeration and air-conditioning, methods of refrigeration-conventional and non-conventional, unit of refrigeration, COP and refrigeration efficiency.

Air refrigeration. Carnot. Bell Coleman, Brayton cycles, simple and bootstrap aircraft refrigeration systems.

Mechanical refrigeration. Carnot vapour refrigeration compression cycle, simple vapour compression cycle. Effect of sub-cooling and superheating on cycle performance, actual vapour compression cycle, multistage and cascade refrigeration, industrial refrigeration systems.

Vapour absorption refrigeration: Working principle, COP comparison between vapour absorption and vapour compression refrigeration systems, actual ammonia

vapour refrigeration systems. Lithium bromide water absorption system, electrolux refrigeration system.

Group B

Steam jet refrigeration system: Principle and applications, performance, actual steam jet refrigeration. Vortex and pulse tube refrigeration, theory and operation.

Thermoelectric refrigeration: Thermoelectric elements, working principle and COP refrigerants, desirable properties of refrigerants, primary and secondary refrigerants, various refrigerants and their properties, alternatives to the chloro fluorocarbons.

Air-conditioning: Psychrometry, psychrometry chart and various psychometric processes, comfort and industrial airconditioning, effective temperature and comfort chart, unitary and central airconditioning systems.

Cooling and heating load calculations, design conditions, sensible and latent heat loads, sensible heat ratio, structural, electrical, infiltration and ventilation heat gains, occupancy heat gains, apparatus dew point, bypass and contact factors.

POWER PLANT ENGINEERING

Group A

Thermal power stations. Main components and working of power stations, thermodynamics cycles, fuel handling, combustion and combustion equipment, problem of ash disposal, circulating water schemes and supply of make up water. Choice of pressure of steam generation and steam temperature, selection of appropriate vacuum economiser, air pre-heater, feedwater heaters and dust collection. Characteristics of turbo alternators, steam power plant, heat balance and efficiency.

Boilers and steam generation, general classification, fire tube and water tube boilers, natural circulation and forced circulation boilers, high pressure, high temperature boilers, supercritical pressure boilers, boiler mounting and accessories, feed pumps, economisers, superheaters, air preheaters; boiler furnaces, heat generation rates, water walls.

Gas fired and fuel fired oil furnaces, pulverised fuel fired furnaces, burners for gas fired, fuel oil-fired and pulverised fuel fired furnaces, grate fired furnaces for solid

fuels, feedwater pumps and pipings, boiler settings, estimation of air quantity requirement and draught systems, ID and FD fans.

Diesel power plants: Diesel engine performance and operation, plant layout, log sheets, selections of engine size.

Gas turbine plants: Plant layout, methods of improving output and performance fuel and fuel systems, methods of testing, open and closed cycle plants, operating characteristics-Group B

Group B

Combined working of power plants: Advantages of combined working of different types of power plants, need for co-ordination of types of power plants in power systems, base load stations and peak load stations.

Hydroelectric plants: Penstocks, water turbines, specific speed, turbine governors, hydroplant auxiliaries, plant layout, automatic and remote control of hydroplants, pumped projects, cost of hydroelectric project.

Nuclear power plants: Elements of nuclear power plants, nuclear reactor fuel moderators, coolants, control.

Major electrical equipment in power plants: Generator and exciters, power and unit transformers, circuit breakers, protective equipment, control board equipment, elements of instrumentation.

Power station auxiliaries. Alternate power sources. Solar power, geothermal, tidal and wind power.

NON CONVENTIONAL ENERGY SYSTEMS

Group A

Introduction to non-conventional sources—Solar, bio-gas, wind, tidal, geothermal.

Basic bio-conversion mechanism; source of waste; simple digester; composition and calorific values of bio-gas.

Wind and tidal energy generation: Special characteristics; Turbine parameters and optimum operation; Electrical power generation from wind/tidal energy.

Energy from the sun: Techniques of collection; Storage and utilisation; Types of solar collectors; Selective surfaces; Solar thermal processes; Heating; Cooling; Drying; Power generation, etc.

Group B

Direct energy conversion methods: Photoelectric, thermoelectric, thermionic, MHD (magneto-hydrodynamics) and electro-chemical devices; Solar cells.

Photo voltaic; Amorphous semiconductors; Limitations of photovoltaics efficiency; Fuel cells; Peak load demands; Developments in fuel cells and applications.

Ocean thermal energy conversion; Geothermal energy-hot springs and steam injection; Power plant based on OTEC and geothermal springs.

Fusion energy: Control through fusion of hydrogen and helium. Energy release rates-present status and problems. Future possibilities.

Integrated energy packages using solar, biomass, wind, etc. Comparative study of non-conventional energy sources; Cost considerations and economics.

INTERNAL COMBUSTION ENGINES

Group A

Classification of engines according to fuels, cycle of operation and number of strokes, construction details, value arrangements, application of IC engines, review of air standard cycles, deviation of actual cycles from fuel-air cycles, various influencing factors.

Review of fuels for IC engines with particular reference to velocity, ignition quality and knock rating, variable compression ratio engines.

Air-fuel ratios and mixture requirements of SI engines, stoichiometric fuel air ratio, lean and rich mixture operation, optimum conditions, carburetors-principle, types and venturi, fuel orifice sizes, charge stratification and distribution.

Fuel-air requirement in CI engines. Methods of fuel oil distribution and injection. Types of injector systems in SI and CI engines. Flame front and normal combustion. Detonation in SI and knocking CI engines. Factors influencing detonation and knock. Comparative analysis. Ignition systems in SI and CI engines.

Group B

Engine friction and lubrication: Effect of engine variables, total engine friction, requirements of lubricants and lubricating systems.

Cooling systems: Gas temperature variation, heat transfer rates, piston and cylinder temperature, heat rejected to coolant, air and water cooling systems and components.

Two-stroke engines: Special features, scavenging systems.

Supercharging: Objects, effects on engine performance, supercharging limits, methods of supercharging with special .emphasis on turbochargers.

Engine testing and performance: Various performance parameters and their measurements.

Air pollution from engine exhaust, its measurement and control, principle constituents of engine, emission methods of control, modification of conventional engines, dual fuel and multifuel engines, stratified charged engines, sterlings engines, Wankel rotary combustion engine.

TURBOMACHINERY

Group A

Positive displacement and turbo machines. Basic principles of rotodynamic machines. Efficiency of turbo machines.

Flow through nozzles and blade passages: Steady flow through nozzles, isentropic flow; Effect of friction in flow passages; Converging-diverging nozzles; Flow of wet steam through nozzles; Diffusers.

Steam and gas turbines. Pressure and velocity compounding; Velocity diagrams; Degree of reaction; Utilisation factor; Reaction blanding; Analysis of flow through turbo machines; Energy equation; Momentum equation.

Fluid dynamic consideration: Theoretically obtainable work head; Profile losses. Clearance and leakage losses. Windage losses. Partial admission losses. Flow deviation, Diffuser performance. Design of blade passages. Cavitation in turbo machines.

Group B

Centrifugal compressors: Description and operation, energy transfer and relations, losses, adiabatic efficiency, effect of compressibility, performance characteristics, pressure coefficient, slip factor, surging, surge lines and stall line.

Axial compressor: Introduction, stage characteristics, blade efficiency, design coefficients, blade loading, cascade characteristics, three-dimensional flow considerations, supersonic axial flow compressor, performance characteristics.

Wind turbines: Power, energy and torque of wind turbines, coefficient of performance, energy production and capacity factor, turbine shaft power, torque at variable speeds.

Hydraulic turbomachines: Hydraulic turbines (Pelton wheel and Kaplan turbines), centrifugal and axial flow pumps, characteristics of hydraulic turbomachines.

Fans: Classification, fan laws.

Power transmitting turbomachines: Hydraulic coupling; Torque converters.

DESIGN OF MECHANICAL SYSTEMS

Group A

The essential inputs to a design engineer. Stages in design. Creative and evolutionary design. Problem formulation. Preliminary design and analysis.

Conceptual design: Alternative designs, feasibility analysis and design space, best design constraints, system integration, rational design.

Design process and design cycle. Design morphology.

Design data bases and design standards.

Selection of materials and processes. Accuracy, surface finish, tolerances, statistical nature of loads, part dimensions. Probabilistic design, factor of safety.

Detailed design of simple systems involving pressure vessels, fasteners, pins and welds.

Group B

Optimal design of machine elements and systems. Minimum weight and minimum cost design rigidity and strength.

Reliability of systems, failure rate and component life, MTBF, reliability considerations in design.

Static and dynamic analysis of engineering systems involving shafts, linkages, couplers, transmission devices, toothed elements, etc.

OPTIMIZATION - THEORY AND APPLICATIONS

Group A

Introduction to optimisation: Historical development. Engineering applications. Statement of an optimisation problem, classification and formulation of optimisation problems, optimisation techniques.

Classical optimisation methods: Single variable optimisation, multivariable optimisation with and without constraints.

Linear programming: Standard form of a linear programming problem (LPP), geometry of LPPs, related theorems, linear simultaneous equations, pivotal reduction, simplex method, revised simplex method, duality, decomposition, transportation and assignment problems.

Nonlinear programming (unconstrained): Uni-modal function, exhaustive search, bi-section and golden section methods, interpolation methods, random search methods, univariate method, gradient of a function, conjugate gradient, quasi-Newton and variable metric methods.

Group B

Nonlinear programming (constrained): Complex method* cutting plane method, method of feasible directions, transformation techniques, penalty function methods, convergence checks.

Geometric programming: Introduction to geometric programming, polynomial, unconstrained and constrained problems.

Dynamic programming: Introduction to dynamic programming, multistage decision processes, computational procedures, calculus and tabular methods.

ANALYSIS AND SYNTHESIS OF MECHANISMS AND MACHINES

Group A

Mechanisms and machines, kinematic pair, elements, chains and inversions, degree of freedom, movability, Grubler's criterion, four-link mechanisms,. Grashof's criteria.

Kinematic analysis, instantaneous centres, Kennedy theorem, velocity analysis using velocity difference and instantaneous centres, acceleration analysis, velocity and acceleration images.

Kinematic synthesis, graphical method using inversion and overlay, three-point synthesis problems, motion, path and function generation. Freudenstein's method of three point synthesis of four link mechanisms.

Dynamic force analysis of four-bar and slider crank mechanisms, turning moment and flywheel analysis.

Types of governors, characteristics of centrifugal governors, stability control of speed hunting of governors.

Group B

Balancing of rotating masses: Two balancing masses in two planes for complete dynamic balance. Determination of balancing masses, balancing of rotors, balancing of internal combustion engines, balancing of multicylinder inline engines, V-twin cylinder, multi-row W-engine and radial engine. Lanchester technique for balancing internal combustion engines with rotating eccentric weights.

Types of cam followers, selection of motion, displacement diagrams, cam profile determination.

Gears and gear trains, fundamental law of gearing, involute tooth profile, undercutting and interference. Minimum number of teeth, types of gears, simple, compound and epicyclic gear trains.

DESIGN OF MACHINE TOOLS

Group A

Conceptualisation of mechanical systems for prescribed scheme; Layout of machine tool elements; Introduction to machine tool drives and mechanisms; General principles of machine tool design.

Design of drive systems; Regulation of speed and feed; Kinematic structure of machine tool gear box; Hydraulic, mechanical and electrical speed regulation.

Design of machine tool structures: Material selection; Welded vs. cast structure; Static and dynamic stiffness; Choice of element sections and their design.

Group B

Analysis of spindles, bearings, slides and guides.

Control systems for machine tools.

Dynamics of machine tools: Machine tools as a closed loop system. Dynamic stability. Forced vibration and chatter in machine tools.

Concept of modular design; Concepts of aesthetic and ergonomics applied to machine tools; Acceptance tests and standardisation of machine tools.

COMPUTER AIDED ENGINEERING DESIGN

Group A

Computer aided design of engineering systems. Applications in modelling, analysis, design and manufacturing.

Computer graphics, raster graphics and interactiveness, pixels and graphic display in computers, windows and view-ports, lines and circles, graphic data storage and manipulation, hardware display, input and output devices.

Geometric transformations-two, three-dimensional and homogeneous transformations, rotation, translation, mirror, perspective, projections, etc.

Computer aided drafting. Introduction to Auto CAD-use of menus and icons, two-dimensional drawings using auto CAD lines, circles, tangents, simple machine drawings, dimensioning, blocks and layers, editing and adding text to a drawing.

Advanced auto CAD-three-dimensional drawings. Curves, surfaces and solid models, customizing. Auto CAD, auto LISP.

Group B

Design of curves—PC, Beizer and B-spline curves, normal, tangent, curvature and torsion of curves. Blending of two curves.

Design of surfaces, tangent and normal planes. Curvature and twist, surface patches—PC, Baizer and B-spline, ruled and developable surfaces, swept and revolved surfaces.

Solid modeling—wire frame, constructive solid geometry (CSG) and boundary representation (B-rep); parametric instancing. Cell decomposition, spatial occupancy enumeration, generalized sweep.

Mass property calculations—curve length, surface area, volume, centroid, mass, moment, etc.

Finite element analysis: Fundamentals of finite element analysis; discretization, mesh generation, pre and post processing and simple applications.

MANUFACTURING SCIENCE

Group A

Deformation of metals, stress-strain curves, temperature and strain rate effects, ductility and toughness, plane-strain deformation, mechanism of plastic deformation, control of material properties—alloying and heat treatment.

Sand casting: Pattern materials and allowances, moulding materials, properties ol moulding sand, effects of moulding ingredients on mould properties, estimation of pouring time, mechanism of solidification, rate of solidification in an insulating mould, riser design and placement, residual stresses.

Elements of plasticity—yield criteria and flow rule, plastic instability. Analysis of forming processes—forging, rolling, extrusion, wire and strip drawing, using slab method, deep drawing, blanking and piercing. Lubrication and friction in metal forming.

Group B

Metal cutting: Mechanics of orthogonal cutting, chip formation in turning, shaping, planning, milling and drilling, evaluation of surface roughness in machining, heat generation, estimation of average tool temperature, tool wear mechanism and tool life testing, variables affecting tool life machining economics—estimation of cost and optimum cutting conditions.

Metal grinding: Basic mechanics of grinding process, forces and specific energy, grinding temperature—heat sources and estimation of average temperature, wheel wear mechanism, estimation of surface roughness.

Non-conventional machining: Classification of processes, mechanism of material removal and effects of process parameters in AJM, USM, ECM, EDM, LBM, EBM and PAM.

Welding and allied processes: Bonding process in welding, principles of solid-state welding, fusion welding, soldering and brazing, effects of process parameters, metallurgy of welding stress distribution and heat affected zone.

COMPUTER AIDED MANUFACTURING

Group A

Basic definitions of manufacturing systems: Definitions, design, planning and control.

Part design and CAD: Engineering design, design drafting and its interpretation, inspection and measurement. A brief history of CAD, CAD hardware and software. Fundamentals of geometric modeling. CAD data exchange.

Process engineering: Experience-based planning, process capability analysis, basic machining and other manufacturing process calculations, process optimisation.

Hard automation: Introduction to automated manufacturing, fixed automated manufacturing systems, workpiece handling hardware for automation and economics of automation.

Programmable logic controllers: Function of controllers, control devices, programmable logic controllers.

Data communication and local area networks in manufacturing: Fundamentals of data communication and local area networks.

Group B

Fundamentals of numerical control: Historical developments and principles of NC, classification of NC, NC part programming, manual and computer-assisted part programming.

Introduction to industrial robots: Power sources, actuators and transducers. Robot applications. Economic considerations of robotic systems.

Group technology: Introduction, coding and classification, benefits of group technology.

Process planning: Introduction, manual process planning, computer aided process planning, variant and generative approaches, simple examples.

TOOL AND DIE DESIGN

Group A

Influence of tools and dies on quality, productivity and environment, tool design methods and procedures, tool making practices, tooling materials and treatment.

Jigs and fixtures: Basic principles of locating and clamping, development of fixture using locating, clamping, indexing tool setting elements, force analysis, standardisation of elements, illustrative examples of machining, welding, assembly and inspection fixtures.

Design of cutting tools and special tools (form cutters and broachers), tooling for CNC, introduction to modular fixtures and tools.

Group B

Die design: Design of sheet metal blanking, piercing, bending and deep drawing dies. Progressive die design.

Mould design. Introduction to die casting and injection mould design. General mould construction. Design of ejection, feed and cooling systems. Parting surface design. Side cores and side cavities. Product design for die casting and injection molding.

Cost estimation and cost benefit analysis.

MANUFACTURING AUTOMATION

Group A

Definition of automation, reasons for automating, pros and cons of automation.

Fundamentals of manufacturing and automation: Manufacturing operations and automation strategies, production economics.

High volume production systems: Detroit type automation, analysis of automated flow lines, assembly and line balancing, automated assembly systems.

Numerical control production systems: CNC, DNC and adaptive control.

Group B

Industrial robots: Robotics technology, robot applications.

Material handling and storage: Automated materials handling, automated storage and retrieval systems.

Flexible manufacturing systems (FMS): FMS workstations, material handling and storage systems, computer control systems, planning the FMS, analysis methods for FMS, applications and benefits.

Automated inspection and testing: Inspection and testing, statistical quality control, automated inspection principles and methods, sensor technologies for automated inspection, coordinate measuring machines, other contact inspection methods, machine vision and other optical inspection methods, and non-contact inspection methods.

PRODUCTION MANAGEMENT

Group A

Introduction. Concept of management, concept of a system, production system, production functions.

Organisation fundamentals. Guidelines for good practice, organisation structures, organisation charts, span of control, number of levels, number of executives, management functions.

Production economics: Kinds of costs, evaluation of capital investments. Capital budgeting, break-even analysis, make or buy decisions, evaluation of alternatives, discounted cash flow, equivalent comparison methods, depreciation.

Aggregate planning. Planning time horizons, inputs to aggregate planning systems, single and multistage aggregate planning systems, decision processes for aggregate planning—graphical method, linear decision rule, and linear programming method-Demand management. Time span for forecasts, forecasting system, forecasting methods-time series, casual and predictive forecasting methods, selection of a forecasting method.

Group B

Scheduling. Scheduling process scheduling for a multistage production system, sequencing production operations, Johnson's rule.

Facilities management. Plant location—factors influencing plant location, cost factors, plant location decision process, selection of a location for new facilities, evaluation of alternative regions and sub-regions. Plant layout-objectives, decision process, types of layouts, comparison of layouts. Line balancing and sequence analysis concepts. Materials handling-devices for materials handling, basic considerations in the selection of materials handling system.

Human factor engineering: Methods analysis and works measurement, methods study, process analysis, operation process chart, operator process chart, motion study, principles of motion economy, motion analysis. Time study-types of studies, procedure for job time study, physical environment.

Quality management: Three aspects of quality, functional responsibility for quality in a manufacturing system, economics of quality assurance, quality control, QC decision variables, process control, control charts, acceptance sampling, single, double and sequential sampling plans, concept of total quality control (TQC).

Maintenance management: Maintenance functions, concept of reliability engineering, reliability improvement, preventive maintenance, preventive maintenance policy, repair policy, replacement decisions, queuing theory and its applications in maintenance.

Introduction to PERT/CPM.

Section B

(Civil Engineering)

Compulsory Subjects

IC 402 Engineering Management
CV 403 Civil Engineering Materials and Construction Practices
CV 404 Geo-technical and Foundation Engineering
CV 405 Water Resources Systems
CV 406 Principles of Geo-informatics
CV 407 Analysis and Design of Structures

Optional Subjects

(Any three from any one Group)

Group I Structural Engineering

CV 411 Advanced Structural Analysis
CV 412 Design of RCC and Pre-stressed Concrete Structures
CV 413 Design of Steel Structures
CV 414 Structural Dynamics
CV 415 Seismic Design of Structures

Group II Environmental Engineering

CV 421 Principles of Environmental Engineering
CV 422 Environmental Engineering — Processes and Management
CV 423 Air Pollution and Its Control
CV 424 Design of Water and Wastewater Treatment Systems
CV 425 Waste Management and Environmental Impact Assessment

Group III Infrastructure and Urban Development

CV 431 Transportation Engineering
CV 432 Traffic and Transportation Systems
CV 433 Town Planning and Urban Development
CV 434 Design of Water and Wastewater Treatment Systems
CV 435 Construction Management Systems

Engineering Management

Group A

Management and Organisations

Management process: Definition, planning organizing, directing, controlling, coordinating, types of management.

Organisation Definition, planning, design and development, types of organizations.

Management planning and control: Classical, new classical and modern principles. General Management, scientific management, engineering, management, systems management.

Planning: Procedures, resources and constraints, objectives, goals, policies and procedures.

Control: Setting of reference or standards, appraisal or evaluation, monitoring and controlling, types of control.

Human resource planning and management, selection, recruitment, training, retraining, skill development, competence development, promotion and career development, participative management, trade unions, and collective bargaining,

Management of Physical Resources

Plant: site selection procedures, factors affecting selection. Layout-types and relative merits and demerits, Maintenance-Objectives, different types of associated decisions, strategies for effective maintenance, computer applications.

Material : Functions, objectives, planning and control including inventory models with or without storage costs, price break (excluding dynamic and probabilistic considerations). Different classes of inventory. Material Requirement Planning (MRP).

Group B

Financial management: Introduction to standard forms of financial statements, ie., balance-sheet, profit and loss, and income statement. Fixed and current asset items. Fixed and current liability items. Linkage of two successive balance-sheets through income or profit and loss statement. Funds flow statement. Financial ratios and their implications.

Managerial economics: Concepts, theory of production, marginal productivity and cost. Introduction to theory of firm.

Quality management: Quality definition, quality planning, quality control and quality management, Total quality management, ISO 9000 systems, simple quality control techniques like control charts and acceptance sampling.

Marketing management consumer behavior, market research, product design and development pricing and promotion.

Project management: Introduction. Concept of a project, project management concepts, project simulation, cost or project and means of financing, economic evaluation criteria of the project, project implementation, project planning, scheduling and monitoring, project control (PERT, CPM techniques including crashing). Project evaluation.

Information technology and management. Role of information, management information system and decision support system, Information technology-introduction to e-business, e-commerce and integration tools like enterprise resource planning (ERP).

CIVIL ENGINEERING MATERIALS & CONSTRUCTION PRACTICES

Group A

Introduction to civil engineering materials-stone, timber, cement, steel, plastics, concrete. Engineering properties of materials-density, strength (compressive, tensile, flexural, shear, etc.), modulus of elasticity, fatigue, limit, creep, shrinkage, relaxation, permeability, fire resistance. Materials and environment-effect of environment on materials. Classification of environment-temperature, humidity, rain, fire.

Steel: Manufacture, rolled sections, properties, classifications.

Cement: Manufacture-wet and dry processes, constituents and constitution, properties-setting, strength, durability, classification-high early strength, low alkali, rapid hardening.

Concrete: Constituents-coarse and fine aggregates, cement, water. Mineral admixtures-fly ash, blast furnace, slag, silica fume. Chemical admixtures-air entraining, set retarding and accelerating, super plasticising. Fresh concrete-workability, air content, segregation. Hardened concrete-strength, hardness, modulus of elasticity, modulus of rupture. Special concretes-fibre, reinforced, shortcrete, underwater, high strength. Deterioration and durability-reinforcement, corrosion, carbonation, alkali aggregate reaction.

Group B

Bricks: Manufacture, classification. Other materials. Standardization and standards-need to have standards and some common international standards. Relevant Indian standards (commonly used standards to be listed with brief description). Quality control. Non-destructive testing and evaluation.

Construction practices: Standards relevant to quality control at site. Safety issues. Quantities and estimation. Tender document. Contracts-unit rate, lumpsum, turnkey. Project management-CPM, PERT, bar charts, pie diagrams, escalation, depreciation.

GEOTECHNICAL AND FOUNDATION ENGINEERING

Group A

Introduction to soil mechanic, examples of geotechnical engineering applications. Description of assemblage and individual particles, classification, etc. Soil types.

Geostatic stresses, stresses due to applied loads, stress point, stress paths, principle of effective stress. Soil-water systems, capillarity, flow through soils. Darcy's law, tests to determine the coefficient of permeability in the lab and in situ, one-dimensional flow, total elevation and pressure heads, piping/quicksand condition.

Two-dimensional flow, seepage, continuity condition, methods of solution, confined and unconfined flows, flow nets, etc. Tests for strength and stress strain relations, stress paths.

One-dimensional compression test, compressibility parameters, maximum past consolidation pressure, OCR, phenomenon of consolidation, Terzaghi theory, coefficients of consolidation and secondary compression (creep), consolidation under construction loading, vertical drains, radial flow consolidation, etc.

Strength and triaxial testing, Mohr-Coulomb strength criterion, drained, consolidated, undrained and undrained tests, strength of sands loose and dense) and fine grained (NC and OC) soils, partially saturated soils, volume changes (dilation and contraction) due to shear stresses.

Group B

Characterization of ground, site investigations, methods of drilling/boring, sampling and in situ tests SPT, CPT, plate load test and its limitations, groundwater levels, etc.

Bearing capacity of foundations, general, local and punching shear modes, theories, corrections for different conditions, ultimate and allowable pressures, methods based on in situ tests.

Settlement of foundations, one- two- and three dimensional approaches, immediate consolidation and creep settlements, stress path method, methods based on III Situ tests, etc.

Choice of type of foundations, shallow/deep, isolated, combined, strap, trapezoidal or mat foundations, contact pressure, distribution, basics of footing design. Ground improvement methods, preloading, vertical drains, vibrocompaction, stone columns, heavy tamping, etc.

Earth pressure theories, Coulomb and Rankine theories, effect of, layering, water level, etc. Retaining walls, types-gravity, cantilever, counterfort, reinforced. earth, ete. Design methods, checking for stability.

WATER RESOURCES SYSTEMS

Group A

Introduction to Water Resources Systems. Elements of a water system, concept of a system, systems analysis techniques, issues in systems approach, advantages and limitations of systems approach, challenges in water sector.

Acquisition and Processing of Water Resources Data. Types of data, design of hydromet networks, data validation, acquisition and processing of precipitation and other meteorological data, acquisition and processing of stream flow data, water quality and other data, water resource information system.

Emerging Techniques for Data Acquisition and Systems Modelling Remote sensing, geographic information systems.

Statistical Techniques for Data Analysis. Random variable, cumulative distribution function, probability distribution function, distribution characteristics. Normal distribution, Extreme value type I distribution, Gamma distribution, Pearson type HI distribution, Discrete probability distributions, method of moments for continuous and discrete systems, problems of parameter estimation, hypothesis testing; t-test, Chi-square distribution, linear regression, correlation analysis. Frequency analysis; Frequency factor method, time-series analysis, auto regression and moving average models.

Systems Analysis Techniques. Optimization, Kuhn-Tucker conditions. Linear programming: Standard form, graphical solution, simplex method, duality, piecewise linearization, simulation.

Group B

Economic Considerations. Basic principles of project economics, demand utility of water, project economics and evaluation, discounting techniques, benefit-cost ratio method, present worth and rate-of-return and annual cost methods, project-feasibility and optimality.

Environmental and Social Considerations. Water in environment, environmental impact of water resources projects, environmental impact of reservoirs, environmental problems in command areas, environmental impact assessment, sustainable development. Social impacts.

Water Resources Planning. Stages in water resources planning, data collection and processing, estimation of future water demands, preliminary planning, institutional set-up, public involvement, formulation and screening of alternatives, models for water resources planning, sensitivity analysis.

Reservoir Sizing. Need for reservoirs, classification of reservoirs, water uses, reservoir planning, estimation of water yield, hydro-power generation, reservoir

losses, water balance of a reservoir, storage requirement for conservation purpose. Mass curve method, sequent peak algorithm, flood control storage capacity, reservoir routing.

Principles Of Geoinformatics

Group A

Introduction to surveying: Objectives, classification of surveys, Indian topographic series, map reading.

Linear measurements: Distance measurements with chain and tapes, corrections to measured length, field survey by chains/tapes.

Compass surveying: True and magnetic bearings, local attraction, fore and back bearing, various types of compasses and applications, detail plotting, adjustment of compass traverse using graphical approach.

Levelling: Concepts of Geold, ellipsoid, MSL and level surface, methods of levelling, determination of height, booking of levelling operation, types of levels, sensitivity. of the bubble, trigonometric levelling, curvature and refraction effects.

Contouring: Guidelines for preparation of contour m;1ps, methods of contouring.

Plane Tabling (PT): Accessories in PT, methods of PT, re-section method , preparation of map.

Theodolites: Measurements of horizontal and vertical angles, differences in Vernier and microplic theodolites, methods of recording angles.

Errors and adjustments: Accuracy and precision, propagation of variance/covariance and adjustment of errors using observation equation and condition equation approach (matrix based solution).

Tacheometric surveys: Principle and basic system, subtense bar, various types of tachometers, plotting with tacheometers.

Curves: Classification, elements of simple circular, compound, reverse, transition, vertical curves, setting of curves.

Group B

Triangulation: Purpose of triangulation and trilateration, classification, strength of figure, well conditioned triangle, triangulation figures, reconnaissance and station selection, intervisibility of stations, signal and towers, base lining, computation and adjustment in triangulation, satellite station.

EDM: Principles and applications, instruments: Geodimeter, Tellurometer, Distomat, etc.

Digital Theodolites/Total Station/GPS: Principles and applications.

Introduction to photogrammetry: Comparison of serial photographs and topographic maps, definition of basic terms, perspective of near-vertical photograph, scale and

coordinates from photographs, stereoscopy, parallel bar measurements, determination of heights, principle of radial line triangulation, assumption, limitations and errors.

Introduction to remote sensing: Remote sensing system, data-acquisition and processing, EMR and spectrum, atmospheric windows, Interaction mechanisms, multi-concept, sensors and platforms. Interpolation of aerial photographs and satellite imagery and their interaction.

Analysis And Design Of Structures

Group A

Analysis

Stability and determinacy of structures.

Review of shear force and bending moment diagrams in beams and frames.

Plane trusses.: Method of joints and method of sections. Deflection of trusses (virtual work method). Deflection of beams and frames.

Method of virtual work by Castigliano's theorem.

Moment-area method and conjugate beam method. Influence line diagrams and moving loads. Three-hinged arches and cables.

Analysis of statically indeterminate structures. Force and stiffness method of analysis.

Plane truss using method of consistent deformation. Beams and frames.

Method of consistent deformation, three-moment equation, slope-deflection equations, moment distribution method, Kani's method.

Group B

Design

Introduction.

Structural fasteners (rivets, welds, bolts).

Design of tension members.

Design of compression members.

Design of beams (rolled section, build-up sections). Design of bolted (eccentric) connections.

Design of welded plate girder.

Design of industrial buildings (gantry girder, roof trusses etc).

Design of beam-columns and column bases. Design of RCC beams, columns, slabs and footings by working stress method of design.

ADVANCED STRUCTURAL ANALYSIS

Group A

Matrix analysis, displacement and force method: Computers and structural analysis; brief discussion on analysis procedures with introduction to displacement and force methods; basic structural system and mathematical model; coordinate systems, joint displacement and joint loads; statically determinate and indeterminate structures; kinematically determinate and indeterminate structures.

Member end load matrix: Member deformation matrix; influence coefficients; global flexibility matrix; global stiffness matrix; local member flexibility and stiffness matrices; plane frame members; space frame members.

Flexibility analysis of statically determinate structures; computer program for flexibility analysis; flexibility analysis of statically indeterminate structures; computer program for flexibility analysis for statically indeterminate structures.

Stiffness analysis method; computer program for stiffness analysis of kinematically determinate systems; stiffness analysis of kinematically determinate plain frame; stiffness analysis of kinematically indeterminate systems; assembly process for obtaining global stiffness matrix from member stiffness matrices for plane truss, space truss, plane frame and space frame.

Group B

Stress analysis and failure criteria. Analysis of stress and strain—principal stresses and Strains, deviatoric stress and strain, stress and strain invariants; compatibility conditions; and equilibrium equations. Failure criteria stress-strain relations for anisotropic and isotropic elastic materials; yield (failure) criteria.

Stress concern ration. Fatigue failure.

Plates and shells; thin plate bending theory, thin plate bending solutions; membrane theory of shells; bending theory—circular cylindrical shells.

DESIGN OF RCC AND PRESTRESSED CONCRETE STRUCTURES

Group A

Introduction to working stress and limit states/design. Working stress design of rectangular beams.

Working stress design of T-beams. Design of tension members and compression members.

Limit states, design of beams.

Design of two-way slabs, design of circular slabs, and design of flat slabs.

Design of miscellaneous structures—staircase, curved beam, lintel, etc.

Group B

Limit state, design of columns. Design of members under combined bending and direct stresses.

Design of footings and design of bridges.

Design of liquid retaining structures.

Design of prestressed concrete structures. Design of masonry structures.

DESIGN OF STEEL STRUCTURES

Group A

Industrial buildings: Loads, classification and types of buildings, braced and unbraced buildings.

Steel towers: Transmission line towers; microwave towers; guyed towers.

Group B

Multistoried buildings: Analysis, types of loads, and design.

Other miscellaneous topics: Steel bridges; pressure vessels; water tanks, chimneys, etc.

STRUCTURAL DYNAMICS

Group A

Single degree of freedom systems: Equations oF motion. Free vibrations, damping. Response to harmonic excitation. Response to general dynamic loading. Duhamel's integral. Numerical methods.

Response spectrum: Concept. Deformation, pseudo-velocity and pseudo-acceleration response spectra. Analysis of SDOF systems using response spectrum. Difference between response spectrum and design spectrum.

Group B

Multi degree of freedom systems: Equations of motion. Free vibrations, natural frequencies and modes. Free vibration analysis for classically damped systems. Damped matrix. Rayleigh damping. Modal analysis. Earthquake analysis of linear systems by response spectrum method.

Continuous systems: Equations of motion. Natural frequencies and modes. Modal orthogonality. Earthquake response spectrum analysis.

SEISMIC DESIGN OF STRUCTURES

Group A

Characteristics of earthquake: Earthquake terminology. Magnitude. Intensity. Measurement of ground motion. Frequency-magnitude relationship. Liquefaction.

Strong ground motion: Acceleration time histories. Peak parameters (peak ground acceleration/velocity/ displacement). Response spectrum. Site effects.

Earthquake analysis of structures: Idealisation on structures. Response spectrum analysis. Equivalent force concepts. Torsionally coupled systems.

Group B

Concepts of earthquake-resistant design: Objectives. Ductility, ductility reduction factor, over strength, response reduction factor. Design response spectrum. Lateral stiffness. Building configuration. Base isolation. Concept of structural control.

Building codes: Performance of buildings in past earthquakes. Historical perspective on code development-Indian code (IS 1893) provisions for buildings.

Detailing of reinforced concrete and masonry buildings: Provisions of IS 13920, IS 4326, IS 13827. Retrofitting and strengthening of buildings (IS 13935).

Other structures: Introduction to concept of seismic design for bridges and liquid retaining tanks.

PRINCIPLES OF ENVIRONMENTAL ENGINEERING

Group A

Environmental engineering: Introduction and scope. Ecology and environment—definitions and interactions, anthropogenic effects.

Pollution and environmental quality: Air and water quality parameters, variation of water quality in the hydrogeologic cycle, beneficial uses of water, water ity criteria and standards for various beneficial uses, air quality criteria, ambient air standards.

Pollutants: Definition, significance, measurement (both air and water).

Wastes: Solid, liquid and gaseous, and their sources and characteristics.

Water and wastewater quality estimation: Population forecast, water demand for various purposes, variation in quantity of water and wastewater.

Overview and elements of water supply scheme.

Group B

Water/wastewater quality enhancement: Unit operations and processes, physico-chemical vs. biological methods, solid-liquid separation, grit removal, screening,

commutation, mixing, equalization, coagulation, flocculation, filtration, disinfection, aeration and gas transfer, precipitation, softening, adsorption and ion exchange.

Surface and groundwater treatment: Sequencing of unit operations and processes, plant layout, hydraulic considerations-Rural water supply and sanitation.

Wastewater collection system and water distribution system: Review of analysis, design and appurtenances.

ENVIRONMENTAL ENGINEERING - PROCESS & MANAGEMENT

Group A

Introduction: Review of environmental engineering.

Biological processes for water and wastewater quality enhancement. Microbiological aspects, classification of bioprocesses, aerobic and anaerobic processes, dispersed and immobilized growth systems, reactor analysis, unit operations and processes, aerobic dispersed growth systems—activated sludge process and its modifications, aerobic immobilized growth systems-trickling filters, rotating biological contactors, anaerobic processes-conventional, stationary and mobile, fixed film, sludge blanket, ponds and lagoons, septic tanks.

Overview and elements of wastewater disposal scheme: Primary, secondary and tertiary treatment, sequencing of unit operations and processes, plant layout, hydraulic considerations.

Disposal of wastes: Liquid—inland waters, on land, ocean; disposal standards—effluent and stream, gaseous-atmospheric dispersion, meteorological and stack factors, emission standards.

Group B

Air pollution control; Stack height estimation, particulate removal mechanisms and processes, reduction of gaseous pollutants—adsorption, absorption, neutralization, incineration.

Solid waste management: Collection, classification, reduction—quantity and hazard potential, composting, land filling, incineration, ground water pollution.

Noise pollution and hazardous waste management: Definition, measurement, control measures.

Environmental impact and auditing: Environmental impact and assessment—statements and methodologies, environmental laws—special constitutional provisions, role of federal and state governments and NGOs in monitoring and control of environmental pollution and resources, environmental auditing.

AIR POLLUTION AND ITS CONTROL

Group A

Introduction: History of air pollution, air pollution systems, concepts of air quality, air quality criteria and standards, atmospheric chemistry and philosophy of air pollution control.

Air Pollution sources: Stationary—industrial, domestic, non-point Mobile: Petrol and diesel-driven vehicles.

Assessment of air pollution: Preparation of emission inventory, emission factors, pollution loads.

Effects of air pollution: Human health, vegetation and property.

Air quality surveillance: Design of air quality monitoring network.

Meteorology: Physics of atmosphere—sun atmosphere, heat balance, wind speed, direction, ventilation, mixing height, stability, class.

Group B

Transport and dispersion of pollutants: Turbulence, advection, diffusion equation, Gaussian model and its variation, plume rise, fate process and migration pathways, dry and wet deposition.

Engineering control: Setting chambers, inertial devices, bagfihers, dry and wet scrubbers, mobile source control, two- and three-way catalytic converters.

Source sampling and monitoring: Isokinetic sampling. Air pollution legislations, international treaties, emission standards. Global and regional air pollution issues.

DESIGN OF WATER AND WASTE WATER TREATMENT SYSTEMS

Group A

Environmental engineering: Introduction and scope.

Design consideration.

Environment quality and pollution: Water quality and its parameters; variation of water quality in hydrogeologic cycle, beneficial uses of water, water quality criteria and ambient water standards.

Water quality and health.

Consideration in water supply scheme.

Water and wastewater quantity estimation: Population forecast; water demand for various purposes, variation in quantity of water and wastewater.

Design of grit removal, equalisation, coagulation— flocculation, filtration, disinfection; aeration and gas transfer, and distribution system.

Group B

Wastewater characterisation, wastewater quality parameters, BOD, COD, various types of solids, physicochemical, biological methods, solid-liquid separation, grit removal, screening, commutation, mixing equalization.

Design of activated sludge process, trickling filters, oxidation ponds, oxidation ditch.

Water quality modelling: DO-BOD Streeter-Phelphs equation.

Wastewater collection system: Analysis, design and appurtenances.

WASTE MANAGEMENT AND ENVIRONMENT IMPACT ASSESSMENT

Group A

Sources and types of wastes. Solid, liquid and gaseous wastes from various industries. Water use in industry, industrial water quality requirements.

Control and removal of specific pollutants in industrial wastewater, e.g., oil and grease, cyanide, fluoride, toxic organics, heavy metals, radioactivity, etc. Solid and hazardous wastes—definitions, concept and management aspects.

Recent trends in industrial waste management, cradle to grave concept, life cycle analysis, clean technologies. Case studies of various industries.

Environment audit, accounts audit, relevant methodologies, regulations. Introduction to ISO and ISO 14000.

Environmental management, problems and strategies. Review of political, ecological and remedial actions.

Group B

Multi disciplinary environmental strategies, the management dimensions. Environmental impact Assessment (EIA)—an overview.

Definitions and concepts of sustainable development.

Initial environmental examination, environmental appraisal, environmental audit- Environmental impact factors and areas of consideration, measurement of environment impact, scope and methodologies of EIA. Case studies stressing physical aspects of EIA.

TRANSPORTATION ENGINEERING

Group A

Components of transportation.

Vehicle and driver characteristics.

Resistance to vehicles and power requirements; Perception-Reaction time of drivers; Visual acquity of drivers; Driver comfort.

Pavement materials; Aggregates; Bitumen; Concrete.

Pavement design; Flexible pavements; Rigid pavements.

Railway track and structures; Design of formation, sleeper density, rail joints, long welded rails; Properties of sleeper material, ballast, points and crossing, railway signalling, interlocking of signals and points.

Geometric design; Horizontal alignment; Vertical i alignment; Sight distance.

Group B

Airport planning and design; Regional -planning; Airport site selection; Airport capacity; Airport design; Runway orientation; Basic runway length and its corrections; Taxiway system; Aircraft parking; Terminal building.

Public transportation, different alternatives and their usefulness.

Traffic flow fundamentals, traffic stream variables, relation between traffic stream variables.

Traffic studies: Traffic volume studies, speed studies, Origin and destination studies, traffic flow characteristics, traffic capacity study, parking study, accident studies.

Capacity and level of service analysis; Level of service analysis, capacity of various traffic facilities like highways, freeways, signalized intersections.

TRAFFIC AND TRANSPORTATION SYSTEMS

Group A

Traffic engineering—introduction. Traffic Characteristics

— Road user characteristics

— Vehicular characteristics Traffic Studies

— Use of speed, journey time, and daily studies

— Method of measuring spot speeds.

— Methods for measurement of running speed and journey speed
— Vehicle volume counts
— Origin-destination studies
— Parking studies
— Statistical analysis for traffic studies Traffic Controls
— Traffic signs
— Traffic markings :— Traffic signals
— Traffic signs
— Traffic markings :— Traffic signals
— Design of traffic signals
— Types of traffic signals & traffic signal system Traffic Safety
— Road accidents—causes and prevention
— Traffic management measures and their influence on accident prevention

Traffic Regulations

— Basic principles of regulations
— Regulation of speed and vehicles
— General rules concerning traffic
— Parking regulations
— Enforcement of regulations.

Group B

Urban Transportation: Introduction

— Objectives and policies
— Urban transport problems
— Urban transport systems in India
— Issues (safety, congestion, pollution, land-use policy)
— Urban transport planning process Travel Demand Forecasting Models
— Trip generation
— Trip distribution
— Traffic assignment
— Model

Land Use and Transport Planning

— Lane use transport models

— Land use as an instrument of diffusing congestion
— Hierarchy of planning

Public Transport—Needs, modes and systems

— Model split and trip characteristics
— Road based systems
— Rail based systems
— Innovative transit systems
— Automation technology
— Intelligent vehicle highway systems (IVHS)
— Bus and railway stations

Economic Evaluation of Transportation Plans

— Costs and benefits of transport project
— Time horizon in economic evaluation
— Basic principles in economic evaluation Methods of economic evaluation.

TOWN PLANNING AND URBAN DEVELOPMENT

Group A

Planning thoughts through ages—early settlements-Roman, Greek, Medieval, Renaissance and industrial towns—urbanisation and settlement structure.

Garden City concept of E Howard, Geddesian trend and valley section green belts. Planning of new towns, evolution of planning concepts in India. Levels of planning surveys for urban and regional planning. Contents of master plan, regional plan, structure plan, detailed development plan. Basic principles in planning different land uses.

Group B

Planning, legislation and administration, review of planning legislation and Acts relating to urban and regional planning. Building by-laws, planning agencies and their functions. Fiscal policies and resource management in the context of urban development. 73rd and 741'1 CAA and its implication to planning.

Slum clearance, urban renewal, conservation, rehabilitation and redevelopment. Decentralisation policies. Review of various urban development schemes and projects.

CONSTRUCTION MANAGEMENT

Group A

Introduction to construction management. Construction industry and its practices. Problems of construction industry. Management problems in construction. Methodology of system design and techniques in construction. Elements of engineering economies. Probability and statistics. Allocation models, coordination and inventory model. Queuing model. Uncertainty principles. Simulation.

Engineering economics in construction management. Time value of money, interest tables and rates of payment and return. Depreciation of capital assets. Evaluation of feasibility. Public project analysis and evaluation. Case study modules.

Use of elementary statistics and probability theory. Statistical approach, probability distributions, expected value analysis, parameter estimation, statistical inference, quality control using statistical tools, regression and correlation analysis. Case study modules.

Allocation models in construction. Transportation model and its solution. Assignment model. Sequencing. Case study modules.

Group B

CPM and PERT network in construction: Applications in the field of construction, planning of scheduling phase and control phase, optimisation studies, case study modules.

Inventory management. Inventory costs, lead and economic order quantity, inventory models, ABC analysis, inventory management.

Queuing models and applications in construction technology. Queues and queuing theory, models of queues, case study modules.

Construction projects management. Organisational aspects of sectors such as housing, institutional and commercial, industrial and heavy engineering. Contracts-theory and practice. Human resources development and construction industry.

Section B

(Electrical Engineering)

Compulsory Subjects

IC 402 Engineering Management
EL 403 Power Systems
EL 404 Circuit and Field Theory
EL 405 Electrical Machines
EL 406 Measurements and Control
EL 407 Design of Electrical Systems

Optional Subjects

(Any Three From Any One Group)

Group I Power Systems

EL 411 Energy Systems
EL 412 Power Electronics
EL 413 High Voltage Engineering and Power Apparatus
EL 414 Power System Performance
EL 415 Micro-processors and Micro-controllers

Group II Electrical Machines and Drives

EL 421 Advanced Aspects of Electrical Machines
EL 422 Power Electronics
EL 423 Electrical Drives
EL 424 Electrical Power Utilization
EL 425 Micro-processors and Micro-controllers

Group III Control and Instrumentation

EL 431 Control Theory
EL 432 Power Electronics
EL 433 Process Control Systems
EL 434 Instrumentation Systems
EL 435 Micro-processors and Micro-controllers

Engineering Management

Group A

Management and Organisations

Management process: Definition, planning organizing, directing, controlling, coordinating, types of management.

Organisation Definition, planning, design and development, types of organizations.

Management planning and control: Classical, new classical and modern principles. General Management, scientific management, engineering, management, systems management.

Planning: Procedures, resources and constraints, objectives, goals, policies and procedures.

Control: Setting of reference or standards, appraisal or evaluation, monitoring and controlling, types of control.

Human resource planning and management, selection, recruitment, training, retraining, skill development, competence development, promotion and career development, participative management, trade unions, and collective bargaining,

Management of Physical Resources

Plant: site selection procedures, factors affecting selection. Layout-types and relative merits and demerits, Maintenance-Objectives, different types of associated decisions, strategies for effective maintenance, computer applications.

Material : Functions, objectives, planning and control including inventory models with or without storage costs, price break (excluding dynamic and probabilistic considerations). Different classes of inventory. Material Requirement Planning (MRP).

Group B

Financial management: Introduction to standard forms of financial statements, i.e., balance-sheet, profit and loss, and income statement. Fixed and current asset items. Fixed and current liability items. Linkage of two successive balance-sheets

through income or profit and loss statement. Funds flow statement. Financial ratios and their implications.

Managerial economics: Concepts, theory of production, marginal productivity and cost. Introduction to theory of firm.

Quality management: Quality definition, quality planning, quality control and quality management, Total quality management, ISO 9000 systems, simple quality control techniques like control charts and acceptance sampling.

Marketing management consumer behavior, market research, product design and development pricing and promotion.

Project management: Introduction. Concept of a project, project management concepts, project simulation, cost or project and means of financing, economic evaluation criteria of the project, project implementation, project planning, scheduling and monitoring, project control (PERT, CPM techniques including crashing). Project evaluation.

Information technology and management. Role of information, management information system and decision support system, Information technology-introduction to e-business, e-commerce and integration tools like enterprise resource planning (ERP).

Power Systems

Group A

Generation of electrical power: Conventional and non-conventional methods. Typical layout of thermal and hydro power stations-main and auxiliary equipment.

Load management: Base and peak loads. Load curves. Definitions of load factor, diversity factor, demand factor. Capacity planning. Load forecasting. Capital and running costs for different types of plants. Different electricity tariffs-flat rate, two part and TOD tariff.

Generator excitation systems: Speed and excitation control of generators. Load sharing of generators in a system.

Stability of power system: Definitions of transient and steady state stability. Swing equation and its solution by step-by-step method. Equal area criterion for transient stability.

Group B

Transmission of electrical power: Overhead and underground transmission line configurations. Materials for transmission line conductors and insulators. Power station and sub-station switchyard and layouts. ACSR conductors, bundled conductors. Overhead line poles, towers and cross arms.' Single and double circuit lines.

Untransposed and transposed 3-phase transmission lines. Overhead, line sag calculation. Effect of wind pressure and ice loading on transmission lines.

Transmission line parameters: Resistance, inductance and capacitance calculations. Skin and proximity effects. Corona and radio interference of EHV lines. Voltage distribution in suspension insulators. String efficiency. Different types of cables. Capacitance of cables. Intersheath grading.

Performance of short transmission lines: Line loss, efficiency and regulation of line. Zero regulation condition of power transmission.

Performance of medium transmission lines: Nominal T and ^ representation. Regulation and efficiency of medium lines.

Performance of long transmission lines: Equivalent T and ^ representations. Propagation constant and characteristic impedance of a long line. Ferranti effect. urge impedance loading. Infinite line. Wavelength of line. Determination of A, B, C, D constants of transmission lines.

Transmission line charts: Power factor and power angle of a transmission line. Power angle diagram of an interconnector. Use of shunt and series capacitor in a transmission line.

Circuit & Field Theory

Group A

Circuit Theory

Graph of a network. Concept of tree, loop current and node pair voltage. Tie set and tie set matrices-cut set and cut set matrices. Solution of equilibrium equations on loop and node basis. Application of Laplace transforms for solving transient equations of electrical circuits. initial and final value theorems. Unit step, impulse and ramp inputs. Laplace transform for shifted and singular functions. The. convolution integral. Fourier series and its applications. Exponential form of the Fourier series. Relation between frequency spectra and. Laplace transform of the Fourier series. The concept of complex frequency, transform impedance and admittance; series and parallel. combinations.

Network theorems: Thevenin, Norton, Reciprocity, Superposition and Telegen. Terminals and ports. Driving point and transfer impedances. S-plane representation: Poles and zeros. Time domain behaviour from pole and zero plots. Procedure for finding network functions for general two-port network. Radian frequency and sinusoidal network functions in terms of poles and zeros. Resonance, Q-factor and bandwidth. Asymptotic change of magnitude with frequency in terms of poles and zeros. The symmetrical lattice..

Group B

Field Theory

Vectors and vector calculus. Gradient, divergence and curl of a vector. Gauss, Stokes and Helmholtz theorems.

Electrostatics: Potential and electric field intensity. Conducting boundaries, Coaxial spheres and cylinders. Laplace's and Poisson's equations. Electrostatic energy. Uniqueness theorem. Method of images; dipoles. Dielectric polarisation, electric flux density, permittivity. Boundary conditions. Stationary currents. Ohm's law; E.M.F. conservation of charge. Resistance of arbitrary shaped conductors. Boundary conditions and refraction, current flow lines. Numerical solutions of Laplace's equation by the method of iterations.

Magneto static : Magnetic field intensity and flux density. Vector potential. Magnetic dipole. Divergence of B. Ampere's law of force. Ampere's circuital law. Differential equation for vector potential. Magnetic polarisation and permeability. Boundary conditions for and H.

Time varying fields: Faraday's law. Dynamically and statically induced E.M.F's. Inductance and stored energy. Hysteresis loss, Maxwell's equations. Displacement current. Deviation of generalised wave equations from v1axwell's equations for the magnetic vector potential. specialization to Eddy current or diffusion equations and non dissipative wave equations.

Plane wave propagation and eddy current phenomenon as solutions of the above relevant equations. Reflection and refraction of plane waves at the plane boundary of electromagnetic media.

Electrical Machines

Group A

D.C. machines: Parallel operations of D.c. generators. Speed control of D.c. motors. Testing of D.c. motors.

Transformers: Construction of 3-phase transformers. Vector groupings. Connections of 3-phase transformers Star, delta, zig-zag, Scott and Vee connections. Grounding transformers. On load tap changing arrangement of transformers. .

Synchronous machines: Regulation of synchronous generators. Salient pole synchronous machines. Direct and quadrature axis reactances. Synchronisation of 3-phase generators.

Starting of synchronous motors. V-curves for synchronous motors. Synchronous condensers. Load and torque angles of synchronous machines.

Group B

Three-phase induction motors: Torque-slip characteristics. Starting maximum and pull out torques. Circle diagram of induction motors. Starters for induction motor. Speed control of induction motor. Testing of induction motor.

Single-phase A.C. motors: Working principle and performance of split phase shaded pole and capacitor , motors. Series motor, repulsion motor.

Servo motors: D.C. and A.C.

Measurement And Control

Group A

Measurements

Units and standards. Measurement of electric quantities such as voltage, current and power and power factor at various frequencies.

High and low value resistance measurement. A.C. potentiometer. A.C. bridges: Owen, Anderson al Schering. Magnetic measurements: Flux, permeability a. B H loop.

High voltage measurements: D.C, A.c. and impulse. Frequency and time interval measurement.

Group B

Control

Open loop and closed loop control systems. Concept of linear and nonlinear systems. Transfer functions a block diagrams. Signal flow graph.

State variables: State equations. Matrix representation of state equations. Relationship between state equations and transfer functions.

Time response: Transient analysis of feedback systems - First and second order systems. Steady state error and error coefficients.

Frequency response: Polar plots, Bode plots, logarithmic vs. phase plots.

Stability: Concept and determination of absolute stability. Routh's criterion. Nyquist criterion. Rela1 stability. Determination of gain and phase margin from Nyquist and Bode plots.

Root locus: Definitions. Construction of root loci. Root contours, S plane analysis of systems.

Control system components: D.C. and A.C. tachogenerator, synchros, D.C. and A.C. preamplifier Servo potentiometers and gyroscopes.

Design Of Electrical Systems

Group A

Design of load boxes and rheostats.

DC machine design: Main dimensions, output equation, choice of number of poles, choice of type of winding, design of commutator and brush gear, design of field poles and field windings.

Armature windings: Basic principles and classification of armature windings, single layer and double layer windings, simple and multiple windings. Different types of AC windings, commutator windings, AC winding factors. Armature reaction in AC machines, causes and elimination of harmonies. Skin effect and eddy current losses in armature conductors. Design of different types of motor starters, field regulators.

Group B

Transformer design: Single-phase and three-phase main dimensions, core and winding design, magnetizing current, losses, reactance of windings, tank design.

Induction motor design: Three-phase-main dimensions. Stator and rotor windings. Calculation of no load and pull out currents. Torque and speed calculations.

Distribution design: Fixing location of distribution transformer. Plotting of load curves and determination of maximum demand. Design of distributors and feeders. Design of domestic wiring.

ENERGY SYSTEMS

Group A

Sources of conventional energy. Fossil fuels—solid fossil fuel—coal and lignite, formation, physical properties and chemical properties. Combustion equations. Coal analyses—proximate and ultimate, determination of air/fuel ratio for coal-fired boilers.

Liquid and gaseous fossil fuels: Petroleum and natural gas. Physical and chemical properties. Combustion equations. Manufactured and byproduct gases composition, heating value, use. Air/fuel ratio for liquid and gaseous fuel boilers.

Cogeneration and combined cycle generation. Fiuidised bed combustion. Nuclear fission reactions: Fuel isotope energy release in fission. Fertile isotopes.

Converter and breeder reactors. Nuclear fusion-fusion reactions. Energy release in fusion. Advantages and disadvantages of nuclear fusion.

Hydro energy; Run of the river and pumped storage systems. Energy and power equations. Available water head. Impulse and reaction type hydro turbines.

Environmental effects of conventional energy conversion. Energy conservation and energy audit.

Group B

Different forms of non-conventional energy sources: Solar, wind, geothermal, ocean, biogas, etc.

Two types of non-conventional energy conversion processes: a) Direct conversion to electrical energy, viz, photovoltaic, fuel cells, etc.; b) Primary conversion to non-electrical energy viz. solar-thermal, wind-turbine, ocean-thermal, tidal, etc.

Solar: Terrestrial solar radiation, solar-thermal conversion, techniques of collection, storage and utilization, types of solar collectors, selective surfaces, thermal processes, power generation, etc.

Photoelectric effect, solar cells, crystalline and amorphous semiconductors as solar cell materials, equivalent circuit and efficiency considerations.

Wind: Principles of wind power, wind-turbine operation, state characteristics, small machines, large machines.

Geothermal and ocean: Origin and types of geothermal energy, vapour dominated systems, liquid dominated systems, flashed-steam type.

Ocean temperature differences, open cycle, closed cycle, ocean-waves, energy and power from wave, tides, simple single pool tidal system.

Biogas: Biogas conversion mechanisms, source of waste, simple digester, composition and calorific value of biogas.

Chemical: Principles of electrochemical cell operation, fuel cells, different components of fuel cells, hydrogen-oxygen fuel cells, hydro-carbon fuel cells, Faraday's law of electrolysis and thermodynamics of electrochemical energy conversion, ideal cell voltage, ideal cell efficiency, practical limitations.

Comparative study of conventional and non-conventional energy conversion as regards efficiency, economics and environmental effects.

POWER ELECTRONICS

Group A

Devices

Power diodes, uncontrolled rectification and power loss during transients. Bipolar junction transistor. Power MOSFET, IGBT, GTO and LASCR, UJT, UJT oscillator, its design and frequency stability.

Driver circuit, pulse transformer and opto coupler. Thyristor, 2-transistor analogy, triggering circuits, dv/dt and di/dt protections, snubber circuit and its design.

Cooling and head sinks. Natural and forced commutations. DC choppers, step-down and step-up operations, thyristor choppers and switching mode regulators.

Group B

Applications

BI-2, M-2, B-6 and M-6 half/full controlled circuits with R and R-L loads. Principle of phase control, circuits for control and UPS. I-O and 3-0 cycloconverter and harmonic reduction.

Inverters: Series inverter, domestic inverter, PWM inverter, auxiliary commutated thyristor inverters, complementary commutated thyristor inverters, current-source inverters, 12-pulse converters and hvdc link.

D.C. drives: one-phase semiconverter/full-converter drives, 3-phase semiconverter/full/dual-converter drives, 2/4-quadrant chopper drives.

Induction motor drives, V/f control and closed-loop control.

HIGH VOLTAGE ENGINEERING AND POWER APPARATUS

Group A

Breakdown phenomena: Breakdown of gaseous medium, mechanism of charge multiplication, secondary emission, Townsend theory, Streamer theory, Paschens law, corona, effect of polarity of voltage on corona and breakdown process.

Breakdown of solid: Intrinsic breakdown, thermal breakdown, electro-mechanical breakdown, streamer breakdown.

Breakdown of liquid: Breakdown of commercial liquid, cavitation theory, bubble theory, suspended particle theory.

Insulating materials: Properties of traditional insulating materials, SF^, vacuum, air, insulating oils, ceramics, epoxy resins, PVC, PTFF, PMMC, fibre glass, polyethylene.

Insulation resistance. Tacking index. Electrical and mechanical properties of insulators used in transmission line. Different types of line insulators. String efficiency, bushings, general design approach of bushing.

Cables: Different types of cables. Paper insulated cables, XLPE cables, gas-filled cables, technology and principles. Generation of travelling waves in transmission lines, reflection and transmission constants.

Power system grounding: Solid grounding, resistance grounding, reactance grounding, grounding through earthing transformer, resonant grounding.

Group B

Voltage surges: Lightning phenomena, lightning induced overvoltage, direct stroke, indirect stroke-Protection of power stations and sub-stations and transmission line against direct strokes.

Protection of electrical apparatus against travelling waves. Lightning arrestors—expulsion type, valve type, magnetic blow-out type and metal oxide type.

Insulation co-ordination: Determination of the line insulation, basic impulse level and insulation level of substation equipment. Selection of lightning arrester. Establishment of impulse withstand level. Overvoltage due to switching. Reduction of switching overvoltage.

Generation of high voltage and current in high voltage laboratory. Generation of high AC, DC and impulse voltage. Generation of high impulse current, impulse generator, testing transformer, source resonant circuit.

Non-destructive testing of- materials and electrical apparatus. Measurement of DC resistivity, measurement of dielectric constant and loss factors, partial discharge measurement.

Preventive testing of insulation: High voltage testing of insulators, bushings, cables and transformers. High voltage testing of surge diverters.

POWER SYSTEM PERFORMANCE

Group A

An overview of modern power system: Layout of typical power system—generating station, substation, transformer, transmission line, distribution, load. Symbols and circuit representation of various components of the system. Single line diagram.

Per unit method of calculation: Base quantities and per unit values, modification of per unit values- due to change of base, equivalent circuit of transformer on per unit basis, choice of base quantities for power system analysis, advantages of per unit method of calculation, per unit impedance diagram of a power system.

Symmetrical components: Transformation of voltage, current and impedance to symmetrical component system, complex power in terms of transformed voltage and currents, positive, negative and zero sequence impedances of different power system components; equivalent circuits in terms of symmetrical component quantities, advantage of symmetrical component representation.

Fault studies: Symmetrical three-phase fault calculation, fault MVA and circuit breaker capacity, current limiting reactor, their placement and usefulness.

Unsymmetrical faults, classification, analysis of L-G, L-L and L-L-G fault using symmetrical components, equivalent circuit for representation of different kinds of faults, calculation of fault current and post-fault voltages. Arcing ground, its consequences and remedy.

Load flow study: The basic load flow problem and its importance, classification of system bus bars, formulation of load flow equations using bus admittance matrix, tteiative solution of load flow equations by Gauss-Seidel method, acceleration for convergence.

Economic load despatch: Generation cost, incremental cost, optimal loading of generators on a common bus bar, transmission loss formula, incremental transmission loss, generation scheduling taking care of transmission loss.

Group B

High voltage d.c. transmission: Historical review, merits and limitations of d.c. transmission, kinds of d.c. links, constitution of d.c. links, terminal equipment transformer, converter, choke and filter; gate control and operation of three-phase thyristor bridge as rectifier and inverter, relationship between input and output voltage and current in the bridge convener, active and reactive power; control of current and-voltage in a d.c. link, back-to-back connection and its usefulness.

Power system control: Automatic load frequency and voltage control, speed governor, load sharing among synchronous generators, exciter, brushless excitation system.

Power system stability: Transient power output of a synchronous machine, effect of voltage regulator and governor on enhancement of transient stability. The swing equations in multi-machine system, numerical method of solution of swing equations and assessment of transient stability.

Power system protection: Electromagnetic relays,

construction and operating principle of attracted armature, induction disc and induction cup type relay, inverse time lag relay, plug setting and time setting arrangement.

Overvoltage, overcurrent, earth fault and neutral displacement protection. Primary and backup protection, co-ordination of overcurrent relays in radial feeder protection, directional overcurrent relay, ring main and parallel feeder protection.

Distance protection for transmission lines, three zone protection, tripping circuit, impedance setting for earth fault and phase fault types relays. Errors in distance measurement, arcing fault, power swing, directional, reactance, mho, ohm and quadrilateral characteristics.

Differential protection schemes for generator and transformer, other protections of generator and transformer.

Pilot wire relays for feeders and cables, carrier relays-blocking and inter-tripping schemes, carrier equipment, carrier phase comparison.

MICROPROCESSOR AND MICROCONTROLLERS

Group A

Microprocessor architecture and microcomputer systems, memory systems, input and output devices. Number systems—binary, hexadecimal and BCD numbers, 2s complement and arithmetic operations.

8085 microprocessor architecture. Memory interfacing-address decoding techniques, memory read and write operations. Memory map. Interfacing I/O devices-Memory-mapped I/O and I/O mapped I/O. Polled and interrupt modes of data transfer. 8085 interrupts, direct memory access. Introduction to 16-bit microprocessor using 8086 as an example. Concept of debugger and MASM/TASM for PC assembly language programming.

Peripheral devices. 8255 programmable peripheral interface, 8253 programmable counter timer, serial communication with SID and SOD, 8251 programmable communication interface, 8259 programmable interrupt controller, keyboard and display devices.

8085 assembly language programming: 8085 instructions—addressing modes. Stack and subroutines. 8085 programmer's model-CPU registers. Addition, subtraction and multiplication routines. Software delay and counting routines. Logical operations. Analog and digital I/O interface routines—ADC and DAC.

Software development systems: Assemblers and cross-assemblers. Microprocessor applications. Microprocessor-based system design aids and trouble-shooting techniques.

Group B

Introduction to microcontroller: Comparison of various microcontrollers. 8051 microcontroller architecture. Bi-directional data ports, internal ROM and RAM, counters/timers. Oscillator and clock.

8051 registers. Memory organisations—program memory and data memory, internal RAM and bit addressable memory, special functions, registers, memory map.

External memory systems and I/O interface. Accessing external program memory, accessing external data memory, available I/O ports during external memory access. Alternate port functions. Serial interface. 8031 interrupts. Power down modes.

8051 assembly language programming. 8051 instruction sets, addressing modes, bit level operations. Arithmetic routines, counting and timing under interrupt control, keyboard and display interface routines, accessing lookup tables.

Software development systems. Assemblers and simulators. Microcontroller based system design and applications.

ADVANCED ASPECTS OF ELECTRICAL MACHINES

Group A

Synchronous motor analysis taking armature resistance into account, vector diagrams, power circle and excitation circle—diagrams. Performance calculations under various operating conditions.

The equation of motion or 'swing' equation for synchronous motors and generators. Solutions of linearized swing equation, small oscillations of synchronous machines. Hunting of synchronous motors, elements of large oscillation of synchronous machines, concept of transient stability.

Starting of synchronous motors with the help of damper windings, George's phenomenon. Brushless excitation of synchronous generators and motors.

Synchronous-induction motor: Slip-ring induction motor run as synchronous motor.- Different types of motor excitation. Starting and running characteristics-combined synchronous motor and induction motor circle diagrams, performance calculation, design features.

Concept of negative sequence and zero sequence reactances of synchronous machines.

Group B

Inverter operation of induction motors, space and time harmonies and their effects on the performance of induction motors.

Induction generators; Operation from bus-bars, self-excitation equivalent circuits and performance—its utility in wind power generation.

A.C. commutator machines: General construction. Derivation of generalized expressions: (a) Transformer e.m.f. and rotational e.m.f's in phase windings; (b) Transformer and rotational e.m.f's in commutator windings, uncompensated and compensated series motor: vector diagrams, circle diagram, operational characteristics and design features.

Variable reluctance and fractional and sub-fractional h.p. motors: Different types of reluctance and stepper motors, permanent magnet motors, derivation of performance equations. Control schemes and performance.

ELECTRICAL DRIVES

Group A

Basic concepts. Dynamics of electric drives.

Mechanical system - different speed/torque characteristics of different frictional system, windage torque. N-T characteristics of deferent industrial systems, four quadrant operation of drive systems, dynamic conditions of a drive system, steady state and transient stability of electrical drive.

Drive motors: DC motor, three-phase induction motor and synchronous motor characteristics require power losses, temperature restrictions, heating and cooling, different modes of operation (continuous/short time intermittent duty/periodic intermittent duty), selection of motors.

Drive motor power supply: A general survey of different power supply systems for motor drive. Phase controlled line commutated converters.

DC choppers.

Inverters.

Cyclo converters. AC voltage controllers.

Group B

Control of electric motors: DC drives - single phase and 3 phase converter drives. Chopper drives, closed loop control of DC motor.

AC drives: 3 phase induction motor control, starter voltage control/rotor voltage control, voltage and frequency control, current control, closed loop control of 3-0 induction motor.

Synchronous motor control: Voltage and frequency control, closed loop control of synchronous motors.

ELECTRICAL POWER UTILIZATION

Group A

Radiation and vision: Physics of light-wave theory, quantum theory, unified theory, photon generation, visible wavelength range, standard observer curve, different forms of energy converted to visible radiation, spectral power distribution curve.

Quantities, units, standards and measurement: Luminous energy, luminous flux, spectral radiant flux, solid angle, luminous intensity, luminance, illuminance, luminous efficacy.

Colour temperature, colour rendering index, reflectance, diffuser, etc. Lambert's cosine law, inverse square law and cosine law of illumination. Polar curve, Roussea's diagram, illuminance (flux) meter, bench photometer (intensity measurement), integrating sphere (flux measurement).

Optical system of human eye.

Sources of light: Construction and electrical circuits of different sources of light, filament lamps, halogen temps, discharge lamps - sodium and mercury high pressure discharge lamps, tube and CFL lamps.

Lighting calculations for indoor and outdoor applications: Shop lighting, factory lighting, street lighting, flood lighting.

Group B

Electric heating, welding and electroplating: Induction heating—principle of operation, scope of high frequency and low frequency heating, induction heating, power supplies at different frequencies.

Induction heating furnaces—coreless and core types.

Arc heating: AC arc heating—different arc electrodes, direct and indirect arc furnace and their power supply systems, electrode regulators, condition for maximum output, necessity of reactor in arc furnace, general arc furnace transformer construction, energy balance in arc furnace, advantages of direct arc furnaces.

DC arc furnace supply system, different bottom electrodes, twin shell DC EAF (electrode arc furnace) system, advantages of DC arc heating.

Dielectric heating: Principle of operation, choice of voltage and frequency, electrode configuration.

Resistance heating: Different resistance heating materials and their properties, causes of failures.

Direct and indirect resistance heating furnace. Design of resistance elements.

Electric welding: Resistance and arc welding and equipment for such welding.

Electrolysis: Application of electrolysis, electro deposition, electro extraction, electro refining.

CONTROL THEORY

Group A

Continuous-time systems: Performance specifications in time-domain and frequency domain. Correlation between time domain and frequency domain specifications.

Error coefficients. Design approaches. Frequency domain vs. S-plane design. Types of compensation. Controllability and observability of control systems.

Cascade compensation: Lead, lag, and lag-lead compensators. Use of Bode diagram. Root locus, and Nyquist diagram for compensator design. Feedback compensator design, use of inverse Nyquist diagram, minor loop feedback compensation. PID controllers. Linear state variable feedback. Pole placement using state variable feedback.

Nonlinear systems: Types of common non-linearities. Properties of non-linear systems. Available techniques for analysing non-linear systems. Linearising approximations. Describing function techniques. Detecting limit crycling and instability. Phase plane methods. Lyapunov's stability criterion. Popov's Method for stability analysis of non-linear systems.

Group B

Discrete-time systems: Introduction to discrete-time systems.

Z-transforms, inverse Z-transforms and bi-linear transformations.

Pulse transfer functions. Tune response of sampled data systems. Effect of sample hold and dead times.

Frequency response: Bode plots, polar plots and gain (db) vs. phase plots. Stability using Jury criterion, Routh-Hurwitz criterion, Nyquist criterion, Bode plot and root locus. Design of compensators in Z-domain and W-domain.

State space representation of discrete systems and sampled-data systems. Deriving Z-transfer function model from state model of discrete systems. Solving time-invariant state equations. State transition matrix. Controllability and observability of time-invariant discrete systems.

PROCESS CONTROL SYSTEMS

Group A

Process control principles, process control block

diagram, loop components—sensor and transmitter, controller, final control element. Process transfer functions - process lag and dead time, self-regulating and non-self-regulating processes.

Process instrumentation diagram: Symbols and interconnections.

Process control sensors and transmitter, thermal sensors, mechanical sensors, analog signal conditioning— instrumentation amplifier, signal isolation, and filter.

Analog signal transmission systems.

Analog process controller, P, PI, PD and PID modes of operation, controller-tuning methods, on-off controllers, anti-integral windup, anti-derivative kick and controller saturation. Velocity or incremental controller. Design of analog process controller. Pneumatic process controllers-pneumatic amplifiers and relays.

Digital process controllers—theory. Digital controller in a process control loop, analog-to-digital and digital-to-analog converters. Realization of digital controller.

Final control elements: Actuators, positioners and control valves.

Recorders: Analog, digital and data loggers.

Group B

Control loop characteristics. Controllability and stability-root locus and Bode plot techniques.

Control schemes. Ratio-control, cascade control, feed forward control and multi-loop control-P1D control. Process loop tuning-process reaction method. Ziegler-Nichols method and frequency response methods.

Characteristics of chemical processes. Heat exchangers, distillation columns, chemical reactors, pH and blending processes, delay time and its effect. Flow control, pressure control, level control, and temperature control. Boiler control-feed water control, drum-level control, combustion control and 3-point control.

Computer control of processes. Direct digital control and supervisory control. Adaptive control systems.

INSTRUMENTATION SYSTEMS

Group A

Instrument performance characteristics and specifications: Static and dynamic, analog and digital instruments. Errors in measurements—error, correction, precision, accuracy, statistical analysis of errors, mean, median, mode, standard deviation. Confidence intervals.

Cathode Ray Oscilloscope (CRO), use of CRO in voltage measurements and waveform display.

Measurements of kVAh and kVARh in three-phase load, trivector meter, summation metering, summation current transformer.

Use of IVD in impedance comparison, low resistance comparison by using IVD.

Study of bridge balance convergence and bridge sensitivity in four-arm a.c. bridges, quad bridge for comparison of resistance with standard calculable capacitor.

Group B

A/D and D/A converters, digital voltmeters and multimeters, use of flip-flop circuits in up-down couwnters, digital displays.

Electrical transducers, linear variable differential transformers (LVDT), strain gauge, fluid flow and pressure measurements, temperature transducer, light and radiation transducer.

Introduction to instrumentation amplifier, CMRR and active filter, sample and hold circuit, data transmission in digital instrument systems and PC, IEEE-488 bus, introduction to long distance data transmission (modems).

Syllabus Of AMIE Exams: Section B

(Electronics And Communication Engineering)

Compulsory Subjects

IC 402 Engineering Management
EC 403 Communication Engineering
EC 404 Circuit Theory and Control
EC 405 Micro-processors and Micro-controllers
EC 406 Electronic Circuits
EC 407 Design of Electronic Devices and Circuits

Optional Subjects

(Any three from any one Group)

Group I Telecommunication Engineering

EC 411 Broadcast and Television Engineering
EC 412 Radar and Antenna Engineering
EC 413 Microwave Engineering
EC 414 Optical and Satellite Communication
EC 415 Computer Networks and Communication

Group II Integrated Circuits & Systems Engineering

EC 421 Digital Hardware Design
EC 422 Pulse and Digital Circuits
EC 423 IC Design Techniques

EC 424 Solid State Physics and Semiconductor Devices
EC 425 Software Engineering

Group III Control and Instrumentation

EC 431 Sensors and Transducers
EC 432 Industrial Instrumentation and Computer Control
EC 433 Biomedical Electronics
EC 434 Signal Processing
EC 435 Control Systems

Engineering Management

Group A

Management and Organisations

Management process: Definition, planning organizing, directing, controlling, coordinating, types of management.

Organisation Definition, planning, design and development, types of organizations.

Management planning and control: Classical, new classical and modern principles. General Management, scientific management, engineering management, systems management.

Planning: Procedures, resources and constraints, objectives, goals, policies and procedures.

Control: Setting of reference or standards, appraisal or evaluation, monitoring and controlling, types of control.

Human resource planning and management, selection, recruitment, training, retraining, skill development, competence development, promotion and career development, participative management, trade unions, and collective bargaining,

Management of Physical Resources

Plant: site selection procedures, factors affecting selection. Layout-types and relative merits and demerits, Maintenance-Objectives, different types of associated decisions, strategies for effective maintenance, computer applications.

Material : Functions, objectives, planning and control including inventory models with or without storage costs, price break (excluding dynamic and probabilistic considerations). Different classes of inventory. Material Requirement Planning (MRP).

Group B

Financial management: Introduction to standard forms of financial statements, ie., balance-sheet, profit and loss, and income statement. Fixed and current asset items. Fixed and current liability items. Linkage of two successive balance-sheets through income or profit and loss statement. Funds flow statement. Financial ratios and their implications.

Managerial economics: Concepts, theory of production, marginal productivity and cost. Introduction to theory of firm.

Quality management: Quality definition, quality planning, quality control and quality management, Total quality management, ISO 9000 systems, simple quality control techniques like control charts and acceptance sampling.

Marketing management consumer behavior, market research, product design and development pricing and promotion.

Project management: Introduction. Concept of a project, project management concepts, project simulation, cost or project and means of financing, economic evaluation criteria of the project, project implementation, project planning, scheduling and monitoring, project control (PERT, CPM techniques including crashing). Project evaluation.

Information technology and management. Role of information, management information system and decision support system, Information technology-introduction to e-business, e-commerce and integration tools like enterprise resource planning (ERP).

Communication Engineering

Group A

Field theory: Fields, vector calculus, gradient, Divergence, curl, Gauss's laws. Stoke' theorem, Helmholtz Theorem. Electric field intensity and potential, conducting Boundaries, coaxial cylinders, Poisson's equations and Laplace equation. Ampere's circuital law, differential equation for vector potential. Magnetic polarization and field intensity, boundary conditions for Band H. Faraday's law. Time varying fields, displacement current. Maxwell's equations in differential and integral forms.

Communication preliminaries. Signal representation in frequency and time domain. Fourier transforms, power Spectrum, energy density spectrum. ,Direct delta function. Orthogonal representatives of signals (Gram Schmidt Procedure), autocorrelation, sampling theressare (Nyquist criterion). Random signal theory. Discrete probability theory, continuous random variables, probability density functions, ergodic processes, correlation function, spectral density, white noise.

Noise: Atmospheric, thermal, shot and partition noise, noise figure and experimental determination of noise figure, minimum noise figures in networks. Analog communication. Modulation theory and circuits. Amplitude modulation, AM-DSB, AM-DSB/SC, AM-SSB and their comparison. Modulating and detector circuits for

AM, FM and phase modulation~ Automatic frequency control. Pulse modulation. PAM, PDM, PPM, PCM, delta modulation and circuits. Principle multiplexing FDM and TDM.

Group B

Transmission through network: Networks with random input, auto-correlations, special density and probability density input-output relationships, envelope of sine wave plus Gaussian noise, optimum systems and nonlinear systems. Maximum signal to noise ratio' criterion. Minimum mean square error criteria, equivalent noise bandwidth. SNR in envelope detectors and PCM systems. Comparison of modulation systems.

Digital communication: Basic information theory: Definition of information, entropy, uncertainty and information, rate of communication, redundancy, relation between systems capacity and information content of messages, discrete systems, discrete noisy channel, channel coding.

Introduction to digital communication, quantization, PCM, log-PCM, DM, DPCM, AD, PCM and LPC for speech signals, TOM. Baseband transmission, optimum detection, matched filter, optimum terminal filters. LSI pulse shapes for controlled ISI, line codes; digital RF modulation. Modems, performance of digital modulation systems. Synchronization. Timing recovery.

CIRCUIT THEORY AND CONTROL

Group A

Graph of a network. Concept of tree, concepts of loop current and node pair voltage, circuits cut-set and cut-set matrices, formulation of equilibrium equations of the loop and node basis. Mesh and nodal analysis.

Laplace transform. Transient response using Laplace transform. Initial and final value theorems. Unit step, impulse, ramp-functions. Laplace transform for shifted and' singular functions.

The convolution integral, Fourier series, complex exponential form of the Fourier series. The frequency spectra of periodic waveforms and their relationship to Laplace transform.

The concept of complex frequency, transform impedance and admittance; series .and parallel combinations. Frequency response, coupled circuits.

Terminals and terminal pairs, driving point impedance, transfer functions, poles and zeros, restrictions on pole and zero locations in s-plane. Analysis of 1-port and 2-port networks. Time domain behavior from pole and zero plot, sinusoidal network functions in terms of poles and zeros. Resonance, Q and bandwidth of a circuit.

Introduction to synthesis of passive networks: Butterworths, Chebyshev and Bessel type low pass, high pass, band pass and band rejection filters.

Group B

Introduction: Basic concepts and symbols, open loop and closed loop systems, effects of feedback. Concepts of linear and nonlinear systems. Definition of transfer function. Block diagram representation. Signal flow graphs.

Servo components: Mathematical modelling and simulation of dynamic systems. Synchros, potentiometers, gyros. d.c. and a.c. servomotors. d.c.. and a.c. tachogenerators. Power and preamplifiers. Modulators and demodulators. Position and speed control systems.

Time response: Typical test input' signals. Time domain performance of first and second order systems to impulse, step, ramp and sinusoidal inputs. Definition of error coefficients and steady state error.

Stability: Routh-Hurwitz criteria.

Frequency response: Frequency domain specifications. Bode plots. Polar plots.

Regulators and controllers. Proportional, PI and PID controllers.

MICROPROCESSOR AND MICRO CONTROLLERS

Group A

Microprocessor architecture and microcomputer systems, memory systems, input and output devices. Number systems-binary, hexadecimal and BCD numbers, 2s complement and arithmetic operations.

8085 microprocessor architecture. Memory interfacing address decoding techniques, memory read and write operations. Memory map. Interfacing I/O devices- Memory-mapped I/O and I/O mapped I/O. Polled and interrupt modes of data transfer. 8085 interrupts, direct memory access. Introduction to 16-bit microprocessor using 8086 as an example. Concept of debugger and MASM/T ASM for PC assembly language programming.

Peripheral devices. 8255 programmable peripheral interface, 8253 programmable counter timer, serial communication with SID and SOD, 8251 programmable communication interface, 8259 programmable interrupt controller, keyboard and display devices.

8085 assembly language programming: 8085 instructions-addressing modes. Stack and subroutines. 8085 programmer's model-CPU registers. Addition, subtraction and multiplication routines. Software delay and counting routines. Logical operations. Analog and digital I/O interface routines-ADC and DAC.

Software development systems: Assemblers and cross assemblers.

Microprocessor applications. Microprocessor based system design aids and trouble-shooting techniques.

Group B

Introduction to microcontroller: Comparison of various microcontrollers. 8051 microcontroller architecture. Bi-directional data ports, internal ROM and RAM, counters/timers. Oscillator and clock.

8051 registers. Memory organisations-program memory and data memory, internal RAM and bit addressable memory, special functions, registers, memory map.

External memory systems and I/O interface. Accessing external program memory, accessing external data memory, available I/O ports during external memory access. Alternate ports functions. Serial interface. 8051 interrupts. Power down modes.

8051 assembly language programming. 8051instruction sets, addressing modes, bit level operations. Arithmetic routines, counting and timing under interrupt control, keyboard and display interface routines, accessing lookup tables.

Software development systems. Assemblers and simulators. Microcontroller based system design and applications.

Electronic Circuits

Group A

Biasting techniques of BJT and FETs; Bias stability; Self-bias, hybrid II model of BJT and 'high frequency response.

Single stage amplifiers-bipolar amplifiers, CE, CB, CC configurations, characteristics, gain, h-parameters, analysis using h-parameters. FET amplifiers.

Multistage amplifiers-classification, distortion, frequency response, step response, RC-coupled amplifiers, transformer coupled amplifiers.

Feedback amplifiers-concept, gain with feedback, negative feedback-example of Boot strapped CE amplifier, advantages and limitations, input and output impedance; voltage-series, voltage-shunt, current -series, current-shunt feedback amplifiers.

Stability and oscillators-condition of oscillation, sinusoidal oscillator, phase shift oscillator, resonant circuit oscillator, Wein bridge oscillator, crystal oscillator, stability of frequency.

Operational amplifiers-differential amplifiers, transfer characteristics, IC op-amp functions, frequency response, step response; introduction to analog computer.

Power amplifiers-class A, B, AB, C amplifiers. Distortion, efficiency, push-pull principle, power supply half wave, full wave, ripple factors, filters, regulation.

Group B

Introduction, binary numbers, binary codes.

Boolean algebra-functions and expressions, gates- OR, AND, NOT, NOR, NAND, De Morgan's theorem, laws and theorems.

Minimization of logical functions-Karnaugh map.

Arithmetic circuits-Ex-OR gate, half adder, full adder, subtraction, code conversion, etc. Basic gate structures-RTL, DTL, Tll.., ECL, MOS, CMOS.

Flip-flops-RS, T, RST, D, JK, Schmidt trigger, astable, monostable:

Counter techniques-Ripple counter, parallel counter.

BCD counter, synchronous counter, ring counter.

Shift registers, memory.

D/ A and A/D converters.

DESIGN OF ELECTRONIC DEVICES AND CIRCUITS

Group A

Introduction to linear ICs. Operational amplifiers and their basic applications; audio/radio/video ICs and their specifications.

Power supplies. Rectifiers, filters and electronic stabilization circuits, considerations regarding ripple, regulation and efficiency, short circuit protection; polyphase rectifiers, electronic converters, applications in industry. Introduction to UPS.

IC voltage regulators. Positive and negative voltage regulators, adjustable voltage regulators, high current short circuit protected regulators, dual tracking regulations, programmable supply, current regulators, witching regulators, fold back current limited and shutdown Circuits.

Amplifiers: Inverting amplifiers, non-inverting amplifiers, differential amplifiers, integrator and differentiator, logarithmic amplifiers and multipliers, filters, voltage to frequency converters, sample and hold circuit, high input impedance amplifiers, instrumentation amplifiers, sensing amplifiers and comparators, zero crossing detector.

Group B

Oscillators. Expression for oscillation frequency and conditions for maintenance of oscillations, sine wave oscillators, multivibrators, function generators, voltage controlled oscillators, crystal oscillators.

Communication circuits. RF and IF amplifiers, video amplifiers, AM detectors, balanced modulators and demodulators, phase locked loop, FM demodulation, frequency shift keying, frequency multiplication.

Digital systems. Frequency counters, A/D and D/A converters, digital voltmeters, programmable digital generators, frequency synthesizer. Design of ALU.

BROADCAST AND TELEVISION ENGINEERING

Group A

Microphones, loudspeaker recording and reproduction of sound—disc, tape, film recording, playback system. High fidelity equipment for reproduction of sound. Loudspeaker enclosures and baffles. Stereophonic sound system.

Studios and auditorium: Theory of reverberation, its limitation, measurement and adjustment. Acoustic materials, design considerations of broadcasting studios and auditorium.

Broadcast transmitters—master oscillators, frequency multiplier, high and low level modulation system. Class A, AB, and C power amplifiers, feeder lines.

Block diagram and principles of amplitude modulated and frequency modulated transmitters. Studio equipment and control room apparatus. OB equipment and receiving centre's facilities.

Superhetrodyne receiver, communication receiver. Intermediate frequency, image frequency. Receiver characteristics and measurement. Design considerations of modern broadcast transmitters and receivers. Transmitting and receiving antennas. FM transmitters and receivers.

Group B

Television system and standards—FCC and CCIR-B standards and their comparison.

Theory of scanning-progressive scanning, interlaced scanning. Video bandwidth.

Composite video signal-Hoz, Sync, hoz. blanking, equalizing pulses, serrations, block diagram of sync, generator.

Television pick-up cubes and cameras-vidicon, plumbicon, saticon, etc., CCD image sensors, picture tube, output coupling circuit.

Television broadcast studio facilities, block diagram of television transmitter. Digital television.

Design considerations of transmitter and receiver. Feeder line, Balun, diplexer, vestigial side band filters. Transmitter-receiver relationship, RA and TA system. Transmitting and receiving antennas.

Block diagram of intercarrier type television receiver, RF tuner, mixer and 10-circuit design. Sync, separator. IF amplifier characteristics and design. Trap circuit.

Elements of colour television, colour vector diagram, colour difference signal, I,Q,Y signals and their bandwidths. Colour cameras and picture tubes, colour killer circuit, compatibility.

Propagation of television signal, telecine, CCTV, CATV, MATV, TV booster, VCR, VCP.

RADAR AND ANTENNA ENGINEERING

Group A

Block diagram of pulse radar. Radar equation. Signal-to-noise ratio, probability density function and range, ambiguities, radar cross-section of target, target models, PRF, system losses.

CW and frequency-modulated radar Doppler effect, CW radar, FMCW radar.

MTI and pulse Doppler radar-delay line cancellers and characteristics, blind speeds, douplet cancellation. MTI radars with power amplifier and power oscillators, transmitters. MTI from moving platform, pulse Doppler radars.

Tracking radars. Tracking techniques-sequential lobing, conical scan monopulse. Tracking in range, acquisition. Tracking performance.

Electronic scanning radar system, beam forming and steering methods, fire controlled radar. SAR.

Radar transmitters, magnetron oscillators, hard tube and line-type pulser. Radar receivers, mixer amplifier, receiver noise, duplexers, displays, clutters, weather and interferences, system engineering and design. Pulse compression radar.

Group B

Fundamentals of radiation mechanism, vector potentials, radiation from current elements, radiation pattern, superposition and reciprocity theorems.

Small antennas, images, small antenna above ground, different types of linear arrays, multiplication of patterns, binomial arrays, antenna gain, effective area, antenna impedance, beam width, self and mutual impedance, folded dipole, Yaginda antennas.

Mathematical theories of antennas, aperture antennas, slot antennas, cavity back slot antennas, horn antennas, waveguide radiator, parabolic reflectors, Cassegrain antennas.

Broad band antennas, microstrip antennas, noise consideration, antenna measurements.

MICROWAVE ENGINEERING

Group A

Wave propagation through waveguides-rectangular, circular, elliptical-cutoff frequency, modes, group and phase velocities.

Cavity resonators and filters.

Network representations of discontinuity—S-matrix. Impedance transformation and matching technique.

Microwave passive components—Tee junctions, magic tee, couplers, circulators, attenuators, phase shifters, bends, twists, corners, irises, windows.

Group B

Microwave generators and amplifiers—thyristor, magnetors, TWTs, BWOs, transistors, tunnel diodes, PIN GUNN, etc. Parametric amplifier. Ferrite and ferrite devices.

Microwave propagation and link design.

Microwave measurements, network analyser concept. Anechoic chambers.

Microwave integrated circuits—MMIC, strip and microstrip lines, slot and coplanar lines.

OPTICAL AND SATELLITE COMMUNICATIONS

Group A

Optical fibre-step index, graded index, material, preparation, measurement of propagation, properties, jointing, connectors and couplers. Fibre optic communication systems.

System model. Optical channel-space, fibre optic, sources-lasers, LEDs.

Fibre laser for optical communication through guided media.

Modulation techniques—direct modulation and indirect modulation—injection modulation, A/O, E/O modulation techniques.

Optical detection—PIN diodes and APDs.

Optical communication systems—analog and digital communication system. Low bandwidth/low bit-rate to ultra wideband/ultra high bit-rate communication system.

Introduction to communication networks—LANs, MANs and WANs.

Group B

Satellite launching and control. Orbits. Launch vehicles and rockets. Space shuttles. Propagation characteristics-attenuation, noise, space environment. Frequency bands.

Types of satellite systems. Satellite sub-system, power communication, control, thermal.

Earth station equipment. Satellite link design-power budget, EIRP, G/T ratio of receivers, CNR of satellite system.

Multiple access technique, TDMA, FDMA, CDMA, SPADE. Multiple beams-spot beams.

COMPUTER NETWORKS AND COMMUNICATIONS

Group A

Introduction-Principles of data communications: Analog and digital transmission, multiplexing, transmission impairments, concepts of frequency spectrum and bandwidth, bandwidth efficient modulation techniques.

Basics of computer networks: Protocol hierarchies, design issues for the layers, interfaces and services. Concepts of circuit switching and packet switching, connection-oriented and connectionless services. Reference models—OSI model and TCP/IP reference model. Example networks.

Physical layer: Transmission media—twisted pair, coaxial cable, optical fibre. Wireless transmission—radio, microwave, infrared and millimeter waves, telephone (Systems, cell phones. RS-232C, SONET, modems.

Data link layer: Services provided to the network layer, framing, error control, flow control. Error detection and correction. Unrestricted simplex protocol, stop-and-wait protocol, sliding window protocols. HDLC.

Network layer: Design issues. Routing algorithms. Congestion control. Internetworking: concepts of subnetwork, bridges, etc. X.25 frame relay.

Group B

Transport layer: Services provided to the upper layers. Elements of transport control protocols—addressing, establishing a connection, releasing a connection, flow control and buffering, crash recovery. Example of simple protocols using services primitives. TCP and UDP.

IP: IPV4 datagram, IP addressing. ICMP.

Media access control protocols: Concept of LANs and MANs. ALOHA, slotted ALOHA, CSMA, CSMA/ €D. Ethernet, token bus, token ring, FDDL

ATM: Protocol architecture. ATM logical connections. ATM cells. Transmission of ATM cells. ATM adaptation layer. Traffic and congestion control.

Narrowband and broadband ISDN. Application layer: SNMP, SMTP, FTP, TELNET.

DIGITAL HARDWARE DESIGN

Group A

Basics of digital electronics: Number representation, Boolean algebra, logic minimization, hazard-free design.

Combinatorial and sequential design-Synchronous and asynchronous circuits.

Memories and PLA.

Finite state machines.

Group B

Processor model: Datapath synthesis and control structures.

Fast adders, multipliers, barrel shifters, etc.

Microprogrammed control unit.

Pipelined and parallel architectures.

Fault-tolerant structures.

PULSE AND DIGITAL CIRCUITS

Group A

Combinational Logic

Boolean algebra: Introduction, postulates of Boolean algebra, fundamental theorems, uniqueness properties, laws of Boolean algebra, De Morgan's theorem, the (inclusion) implication relation, bounds of Boolean algebra, duality in Boolean algebra, Boolean constants, variables and functions, two-valued Boolean algebra switching algebra, electronic gates and mechanical contacts.

Boolean functions and logic operations: Introduction, the normal form, the canonical form, fundamental products and sums, disjunctive and conjunctive normal forms, binary, octal and hexadecimal, designations, self-dual functions, logical operations, NAND and NOR operations, EXCLUSIVE-OR operation, functionally complete sets.

Minimization of switching functions: The Karnaugh map-introduction cubes and the Karnaugh map, prime cubes, maximum sum of products, minimum product of sums, don't care forms, five- and six-variable maps, multiple output minimization.

Tabular methods of minimization: Introduction, Quine-McCluskey algorithm, the dominance relation cyclic functions, the degree of adjacency and essential prime cubes.

Logic synthesis of switching functions: Introduction, AND, OR and inverter networks, NAND and NOR networks, EXCLUSIVE-OR networks, multiplexers, read only memories, programmable logic arrays (PLA), PLA minimization, essential prime cube theorems, PLA folding.

Reliable design and fault detection tests: Introduction, fault classes and models, fault diagnosis and testing, test generation, fault table method, path sensitization method, Boolean difference method, reliability through redundancy, hazards and hazard-free designs, quaded logic.

Group B

Sequential Circuits

Introduction to synchronous sequential circuits, the finite-state model-basic definitions, the memory elements and their excitation functions-S-R flip-flop, J-K flip-flop,D flip-flop, T flip-flop, synthesis of synchronous sequential circuits.

Capabilities, minimization and transformation of sequential machines, the finite-state model-further definitions, capabilities and limitations of finite-state machines, state equivalence and machine minimization, simplification of incompletely specified machines compatible states, the non-uniqueness of minimal machines, closed set of compatibles. The compatible graph and the merger table.

Asynchronous sequential circuits. Fundamental mode circuits, synthesis, state assignments in asynchronous sequential circuits, pulse mode circuits.

Finite state recognizers: Deterministic recognizers, transition graphs, converting non-deterministic into deterministic graphs, regular expressions, transition graphs recognizing regular sets, regular sets corresponding to transition graphs.

IC DESIGN TECHNIQUES

Group A

Introduction to IC design flow; System specification to final packaging.

MOS transistor, CMOS inverter, static and dynamic logic circuits, latch up problem in CMOS.

Factors for optimization (speed, power, area, etc.)

Timing issues: Clock skew, critical path, logic hazards, etc.

Interconnect: Capacitive, resistive and inductive parasitics.

Basic concepts of partitioning, floor planning, placement, routing and layout. Design rule and circuit extraction, mask making procedure.

Computer aided design, simulation and testing, behavioural modelling and hardware description language.

Group B

Memories and other replicable structures: ROM, PROM, EPROM, E2PROM, Static RAM and dynamic RAM, PLA and PAL.

Basic design methodologies: Full custom and semi-custom design. ASIC vs. field programmable devices.

Basic fabrication technology: Bipolar and MOS processing steps and important process parameters.

Importance of semiconductor device modeling. Computer aided design.

SOLID STATE PHYSICS AND SEMICONDUCTOR DEVICES

Group A

Solid state physics: Atomic structures and quantum mechanical concepts,-chemical bonds, solid state structure, band structure, election and hole concept, intrinsic, extrinsic and compensated semiconductors, carrier concentration, lattice vibrations, mobilities and drift velocities, Fermi level, energy-band diagram-Carrier transport mechanism: Scattering and drift of electrons and holes, diffusion mechanism, Hall effect, magneto-resistance, quasi-Fermi levels, generation, recombination and injection, of carriers, Boltzman transport equation and scattering rates, transient response, basic governing equations in semiconductor.

P-N junction theory:. Physical description of P-N junction, depletion approximation, biasing, transition capacitance, varacter, junction breakdown, space charge effect and diffusion approximation, current-voltage characteristics and temperature dependence, tunneling current, small signal a.c. analysis.

Bipolar junction transistors: BJT action, derivation of current components and gain expressions, breakdown voltages, Ebers-Moll model, hybrid-pi equivalent circuit, frequency response of transistors, P-N diode, SCR.

Group B

Fundamentals on technology of semiconductor devices; Unit processes for semiconductor device fabrication, oxidation, diffusion, photolithography and etching, film deposition, device isolation, integrated BJT fabrication processes.

Field effect transistors-JFET and MOSFET: Physical description and theory of JFET, static characteristics, small signal analysis, equivalent circuit, MOS structure, MOS capacitance, flat-band threshold voltages, MOS static characteristics, small signal parameters and equivalent circuit, charge-sheet model, strong, moderate and weak inversion, short-channel effects, hot-carrier effects, scaling laws of MOS transistors, LDD MOSFET, NMOS and CMOS IC technology, CMOS latch-up phenomenon.

Metal semiconductor junctions: Ideal Schottky barrier, current-voltage characteristics, MIS diode, Ohmic contacts, heterojunctions, MESFET.

Photonic devices: Optical absorption in a semiconductor, photovoltaic effect, solar cell, photoconductors, PIN photodiode, avalanche photodiode, LED, semiconductor lasers.

SOFTWARE ENGINEERING

Group A

Software project planning and management: Basic concepts of life cycles models, milestone, cost models, successive versions model, project structure, team structure. Empirical and heuristic estimation techniques.

Requirement analysis. Specifications, algebraic axioms, regular expressions, decision tables, event tables, transition tables, FS mechanism, petri nets.

Software design: Architectural and detailed design, abstraction, information hiding, modularity, concurrency, etc, coupling and cohesion, data How diagrams, structure charts, pseudo code, stepwise refinement, top-down and bottom-up programming.

Test plan and implementation issues-structured coding, recursion, documentation.

Group B

Modern programming language features: Typeless, strong type and pseudo strong type checking, user defined data types, data encapsulation, generic facilities,' concurrency mechanism, object oriented concepts.

Program verification and validation. Unit testing, integration testing, acceptance testing, formal verification.

Software maintenance: Source code metrics, Halstead's effort equation, cyclomatic metric.

Reliability and software quality assurance. Software cost estimation.

SENSORS AND TRANSDUCERS

Group A

Functional description of instrumentation systems. Performance characteristics-static and dynamic, time and frequency responses.

Electrical passive transducers. Hot wire anemometers and associated circuit, LVDT and phase-sensitive: detection, variable reluctance type transducers and associated circuits. Capacitive microphone and associated circuits.

Magnetostrictive transducers: Magnetostrictive materials and their application to measurement of force.. Hall transducers: principles and applications.

Thermocouple, semiconductor-type temperature sensors.

Piezoelectric transducers: Piezoelectric crystal and its properties, sensitive coefficients, ferroelectric materials, bimorph, charge amplifiers, measurement of force.

Group B

Signal conditioning: Push-pull arrangement and reduction of non-linearity. Linearizing circuits and their applications. Differential amplifiers, instrumentation amplifiers, logarithmic amplifiers. Sources of noise and their reduction, grounding and shielding techniques.

Special transducers: Digital shaft encoders. DC and AC tachogenerators, synchros.

Actuators and servos: DC and AC servomotors, step motors. Elastic transducers: Springs bellows, diaphragms, Bourdon tubes-their characteristics and applications, combination of elastic and electrical transducers. Pneumatic sensors.

INDUSTRIAL INSTRUMENTATION AND COMPUTER CONTROL

Group A

Ultrasonic devices and their applications for sensing and non-destructive testing.

Radio isotopes and their applications. Radio isotope sources, nucleonic detectors, ionization chambers, proportional-Geiger Mueller and scintillation-counters. Ionization gauges and nucleonic gauges for measurement of thickness, density, pressure, flow, etc.

Optical transducers: LDR, LEDs, lasers, photodiodes, photomultiplier tubes, IR and UV detectors. Applications to industrial and pollution measurement. Introduction to optical fibre based sensors.

Microwave sensors: Doppler shift technique for velocity measurement.

Sampling techniques for liquids and gases for analysis purposes. Gas analysis, gas chromatography, thermal conductivity method, heat of reaction method.

Paramagnetic oxygen meters.

Group B

Humidity and moisture measurement, measurement of viscosity, pH measurement, electrical conductivity measurement.

Spectrochemical analysis: Mass spectrometry, emission spectrometry, absorption spectrometry.

Different types of digital control. Single loop and multiloop, direct digital control, software implementation of multiloop controllers. Sequence control: Programmable logic controllers, relay ladder logic programming.

Supervisory control: Functionality, process optimization, process monitoring. Man-machine interfaces. On-line computer control of processes.

BIOMEDICAL ELECTRONICS

Group A

Introduction to human physiology: Body skeleton: Nerve physiology, membrane protenual and action potential, function of nerves and of myoneural junction.

Muscle physiology: Functions of skeleton and smooth muscle, cardiac muscle and its rhythmic contraction.

Heart physiology: Dynamics of system, blood flow, arterial pressure, ECG.

Respirations: Mechanism of respiration.

Neuro physiology: C N S function of spinal cord and cord reflexes.

Transducers and electrodes: Different types of transducers and their selection for biomedical applications. Electrode theory. Different types of electrodes-hydrogen, calomel, Ag-AgCI, pH, P02-PC02 electrodes, selection criteria of electrodes.

Group B

Measurement and recording: Cardiovascular measurement: The heart and other cardiovascular systems. Measurement of blood pressure, blood flow, cardiac output and cardiac rate. Electrocardiography, phonocardiography ballistocardiography, plethysmography, magnet cardiography, computer applications.

Measurement of electrical activities in muscles and brain. Electromyography, electroencephalograph and their interpretation.

Respiratory mechanism. Measurement of gas volume, flow rate, carbon dioxide and oxygen concentration in inhaled air, respiratory controller.

Instrumentation for clinical laboratory: Measurement of pi f value of blood, ESR measurements, haemoglobin measurement, oxygen and carbon dioxide concentration in blood, GSR measurement, polarographic measurements, computer applications.

Medical imaging: Ultrasound imaging, radiography magnetic resonance technique and applications.

Biotelemetry: Transmission and reception aspects of biological signals via long distances. Patient care monitoring.

Electronic instruments affecting the human body. Stimulator, defibrillator, pacemaker, diathermy, blood pumps, myoelectric control of paralysed muscles.

SIGNAL PROCESSING

Group A

Periodic signal analysis: Fourier series, a periodic signal analysis, Fourier transform. Discrete representation of signals, Z-transform, sampling theorem. Effect of quantization. Flow graph.

Digital filter design: IIR filter design based on analog filters, inpui variance and bilinear transformation approach.

Computer aided design. FIR filter design using windows, computer-aided design. Introduction to multirate filters.

Group B

Computation of the DFT, DCT and WHT. The FFT, mixed radix algorithm, simulation of digital filters. Hardware implementation. Effects of finite register length.

Digital signal processors (Ex TMS-320 family). Discrete random signals. Discrete correlation. Estimation of power spectral density. Application of digital signal processing.

CONTROL SYSTEMS

Group A

Frequency response techniques: Nyquist criteria—the principle of argument, the Nyquist path; Nyquist criteria for stability, effect of addition of poles and zeros on the shape of Nyquist locus.

Relative stability: Determination of gain margin and phase margin from Nyquist and Bode plots. Constant M and N loci in the G-plane; Nichol's charts. Application of Nichol's charts.

State space techniques: State variable analysis o! dynamical systems, canonical forms, controllability and observability, stability. Introduction to optimal control quadratic performance index and regulator problems.

Group B

Compensation techniques: Specifications of control systems in time and frequency domains. Series compensations—lag, lead and lag-lead design using Bode plots. Linear system design by state variable feedback.

Discrete data systems: Z-transforms and inverse Z transforms, stability-unit circle, bilinear transform, Jury' stability criterion. Difference equations. Types of digital control of plants.

Nonlinear elements and systems: Phase-plane an< describing function methods. Stability analysis am Liapunov's method.

Section B (Computer Engineering)

Compulsory Subjects

IC 402 Engineering Management
CP 403 Data Structures
CP 404 Programming Languages
CP 405 Pulse and Digital Circuits
CP 406 Computer Architecture
CP 407 Systems Analysis and Design

Optional Subjects

(Any Three From Any One Group)

Group I Computer Applications

CP 411 Graph Theory and Combinatorics
CP 412 Computer Networks
CP 413 Operating Systems
CP 414 Artificial Intelligence
CP 415 Database Management Systems

Group II Hardware Engineering

CP 421 Parallel Processing
CP 422 Computer Networks
CP 423 Operating Systems
CP 424 Computer Graphics
CP 425 Micro-processors and Micro-controllers

Group III Information Technology

CP 431 Pattern Recognition and Image Processing
CP 432 Theory of Computation
CP 433 Operating Systems
CP 434 Computer Graphics
CP 435 Software Engineering

Engineering Management

Group A

Management and Organisations

Management process: Definition, planning organizing, directing, controlling, coordinating, types of management.

Organisation Definition, planning, design and development, types of organizations.

Management planning and control: Classical, new classical and modern principles. General Management, scientific management, engineering, management, systems management.

Planning: Procedures, resources and constraints, objectives, goals, policies and procedures.

Control: Setting of reference or standards, appraisal or evaluation, monitoring and controlling, types of control.

Human resource planning and management, selection, recruitment, training, retraining, skill development, competence development, promotion and career development, participative management, trade unions, and collective bargaining.

Management of Physical Resources

Plant: site selection procedures, factors affecting selection. Layout-types and relative merits and demerits, Maintenance-Objectives, different types of associated decisions, strategies for effective maintenance, computer applications.

Material : Functions, objectives, planning and control including inventory models with or without storage costs, price break (excluding dynamic and probabilistic considerations). Different classes of inventory. Material Requirement Planning (MRP).

Group B

Financial management: Introduction to standard forms of financial statements, ie., balance-sheet, profit and loss, and income statement. Fixed and current asset items. Fixed and current liability items. Linkage of two successive balance-sheets through income or profit and loss statement. Funds flow statement. Financial ratios and their implications.

Managerial economics: Concepts, theory of production, marginal productivity and cost. Introduction to theory of firm.

Quality management: Quality definition, quality planning, quality

control and quality management, Total quality management, ISO 9000 systems, simple quality control techniques like control charts and acceptance sampling.

Marketing management consumer behavior, market research, product design and development pricing and promotion.

Project management: Introduction. Concept of a project, project management concepts, project simulation, cost or project and means of financing, economic evaluation criteria of the project, project implementation, project planning, scheduling and monitoring, project control (PERT, CPM techniques including crashing). Project evaluation.

Information technology and management. Role of information, management information system and decision support system, Information technology-introduction to e-business, e-commerce and integration tools like enterprise resource planning (ERP).

DATA STRUCTURE

Group A

Time and space analysis of algorithms. Order notation.

Linear data structures: Sequential representations: Arrays and lists, stacks, queues and dequeues; strings and their applications.

Linked representations: Linear linked list, circular linked list, doubly linked list and their applications. Recursion: Design of recursive algorithms. Tail recursion, when not to use recursion, removal of recursion.

Group B

Nonlinear data structures: Trees, binary trees, traversals and threads, binary search trees, insertion and deletion algorithms, height-balanced and weight-balanced trees, B-trees, B+ trees, application of trees.

Graph representation. Breadth first search, depth first search. Hashing, hashing functions, collision resolving techniques. Sorting and searching algorithms, bubble sort, selection sort, insertion sort, quick sort, merge sort,

heapsort, radix sort.

File structures: Sequential and direct access, relative files, indexed files-B+tree as index, multi-indexed files, inverted files, hashed files.

PROGRAMMING LANGUAGE

Group A

Principles of high-level language programming, file structure and file handling, block structured languages, design principles, abstractions, control and data Structures, binding, parameter passing mechanism.

LISP. Overviews of LISP functions, conditions, arithmetic, recursion, iteration, application of LISP in, artificial intelligence problems.

C language: Fundamentals of C, types, operators and expressions, control flow, C-functions, recursion, pointers and arrays, structures, common line arguments, unions, Bitwise operators: file handling in C.

Group B

C++: Overview of C+ +, class and objects, arrays of objects, operator overloading, concepts of inheritance, base class, derived class, multilevel inheritance, nesting of classes, file concepts, library functions, streams, templates.

Java: Features of Java, Java arrays, two-dimensional array, multidimensional arrays, Java files, file I/O and streams, event-driven programming, events and applets, passing parameters to Applets. Examples.

PULSE AND DIGITAL CIRCUITS

Group A

Combinational Logic

Boolean algebra: Introduction, postulates of Boolean algebra, fundamental theorems, uniqueness properties, laws of Boolean algebra, De Morgan's theorem, the (inclusion) implication relation, bounds of Boolean algebra, duality in Boolean algebra, Boolean constants, variables and functions, two-valued Boolean algebra switching algebra, electronic gates and mechanical contacts.

Boolean functions and logic operations: Introduction, the normal form, the canonical form, fundamental products and sums, disjunctive and conjunctive normal forms, binary, octal and hexadecimal, designations, self-dual functions, logical operations, NAND and NOR operations, EXCLUSIVE-OR operation, functionally complete sets.

Minimization of switching functions: The Karnaugh map-introduction cubes and the Karnaugh map, prime cubes, maximum sum of products, minimum product of sums, don't care forms, five- and six-variable

maps, multiple output minimization.

Tabular methods of minimization: Introduction, Quine-McCluskey algorithm, the dominance relation cyclic functions, the degree of adjacency and essential prime cubes.

Logic synthesis of switching functions: Introduction, AND, OR and inverter networks, NAND and NOR networks, EXCLUSIVE-OR networks, multiplexers, read only memories, programmable logic arrays (PLA), PLA minimization, essential prime cube theorems, PLA folding.

Reliable design and fault detection tests: Introduction, fault classes and models, fault diagnosis and testing, test generation, fault table method, path sensitization method, Boolean difference method, reliability through redundancy, hazards and hazard-free designs, quaded logic.

Group B

Sequential Circuits

Introduction to synchronous sequential circuits, the finite-state model-basic definitions, the memory elements and their excitation functions-S-R flip-flop, J-K flip-flop,D flip-flop, T flip-flop, synthesis of synchronous sequential circuits.

Capabilities, minimization and transformation of sequential machines, the finite-state model-further definitions, capabilities and limitations of finite-state machines, state equivalence and machine minimization, simplification of incompletely specified machines compatible states, the non-uniqueness of minimal machines, closed set of compatibles. The compatible graph and the merger table.

Asynchronous sequential circuits. Fundamental mode circuits, synthesis, state assignments in asynchronous sequential circuits, pulse mode circuits.

Finite state recognizers. Deterministic recognizers, transition graphs, converting non-deterministic into deterministic graphs, regular expressions, transition graphs recognizing regular sets, regular sets corresponding to transition graphs.

Computer Architecture

Group A

Introduction to basic structure and operational concepts, instruction formats, instruction execution process, addressing modes, stacks and subroutine handling, instruction sets and organisational features of some representative machines.

Control unit: Hardware control unit design, microprogramming and micro programmed control unit design, micro sequencer and bit sliced microprocessor (AMD 2900) based micro program control unit design, horizontal and vertical microprogramming, nanoprogramming, emulation.

Main memory organisation: Memory hierarchy, virtual memory, cache memory, interleaved memory and linear addressing techniques.

I/O organisation: Addressing of I/O devices, memory mapped I/O and I/O mapped I/O, data transfer techniques-programmed, interrupt driven, DMA, I/O channels programming, data transfer over synchronous and asynchronous buses, some standard. interface bus like VME/IEEE-488.

Group B

Introduction to RISC and CISC architecture and their comparison.

Pipelining: Classification, scalar and vector pipelining, instruction pipelining and execution pipelining, control strategy for pipeline scheduling and performance analysis.

Associative memory and its implementation with example algorithms to run on associative memory machines.

Flynn's classification of multiprocessor machines, SISD, SIMD, MIMD (both, loosely coupled and tightly coupled).

Introduction to some interconnection network (mesh, cube, cycle, hypercubes, pyramid and omega).

SYSTEMS ANALYSIS AND DESIGN

Group A

Systems Development Life Cycle, classic life cycle. Prototyping.

Feasibility study: Cost estimation, cost-benefit analysis.

Physical and logical data flow diagrams.

Requirement analysis: Entity-relationship diagrams. decision tables, CASE tools.

Systems design: Refinement. Software architecture, program design fundamentals.

Group B

Structured programming modularity-cohesion and coupling.

Design documentation.

System implementation: System simulation, planning for coding and

testing, verification and validation.

Project review and walkthrough.

Input-output design, forms design, dialogue design.

File design, security and control.

Management Information System.

GRAPH THEORY AND COMBINATIONS

Group A

Graphs and digraphs, subgraphs, degree, walk path, cycle, trees, spanning trees, distance, connectivity, reactivity and reachability, adjacency matrix.

Eularian paths and circuits in graphs and diagraphs.

Hamiltonian paths and circuits in graphs and tournaments.

Matching, perfect matching, 4-colour theorem, vertex colouring, chromatic polynomial edge colouring.

Group B

Planar and non-planar graphs, Euler's formula, Kuratowgki's theorem. Network, Max flow-Min cut theorem. Graph enumeration-Polya's counting theorem. Graph algorithms-shortest path, minimal spanning tree, etc.

Basic combinatorial numbers, recurrence, generating functions, multinomials. Counting principles. Polya's theorem, inclusion and exclusion principles. Block design and error correcting codes. Hadamard matrix. Finite geometries.

COMPUTER NETWORKS

Group A

Introduction: Goals and applications of networks, WAN, MAN and LAN, computer networks and distributed computers.

Network architecture: ISO/OSI model, topology, connectivity analysis, queuing theory and delay analysis.

Physical layer: Theoretical basis of data communication, modems, FDM and TDM, X21, communication satellites, message and packet switching, terminal handling polling, multiplexing and concentration, error detection and correction techniques. Hamming codes and polynomial codes.

Group B

Data link layer and network layer: Framing techniques, network protocols—stop and wait protocol and its performance, sliding window protocol.

LANs: Ethernet and token ring. CCITT recommendation of X.25.

Introduction and overview of internet, TCP/IP, internet address. Introduction to web, web design and search engine. Mapping of internet address to physical address, ARP.

Routing, flow control and congestion analysis.

OPERATING SYSTEMS

Group A

Functions and features of OS. Different types of OS viz., single user, batch processing, multiprogramming, time sharing.

Single user system: Basic I/O system, ROM resident and disk based I/O system.

Command interpreter with reference to any available operating systems (like MSDOS).

File management and directory structures.

Memory management, partitioned, paging, segmentation and thrashing.

Processor management and different scheduling techniques.

Resource management, disk allocation and scheduling.

Deadlock detection, recovery, prevention and avoidance.

Group B

Concurrent processor issues—functionality, mutual exclusion, synchronization, interprocess communication.

Primitives like semaphores and their implementation using machine primitives.

Concept of conditional critical region and monitors.

Interrupt handlers, device drivers and controllers, device independent I/O and piping.

Design issue of multiuser operating systems (with reference to UNIX).

Advanced concepts of program and data security and protection.

Distributed systems concepts and few basic results.

ARTIFICIAL INTELLIGENCE

Group A

Introduction. Cognitive science and perception problems. Problem solving paradigm, introduction to search techniques, problem representations through heuristics, search spaces and/or graphs.

Basic heuristic search procedures, specialized search techniques, decomposable search strategies.

Knowledge representation through propositional and predicate logic, fuzzy logic and some applications. Solutions of artificial intelligence problems by PROLOG.

Group B

Rule based deduction and expert systems with an example of MYCIN.

Knowledge engineering, inference engines and expert system shells.

Computer vision and natural language processing.

Concept of neural network.

DATABASE MANAGEMENT SYSTEMS

Group A

Introduction. Database concepts, architecture, physical data organization, entity relationship, data models-network, hierarchical and relational.

Relational model. Storage organization, relational algebra, relational calculus, query languages, functional dependencies, decomposition of relational schemes, query

optimisation.

Group B

Database Management System (DBMS): Typical DBMS based on relational model, DDL, creating, editing, searching, sorting, relational operations, formatted report, etc.

Features of a commercially available RDBMS as case study (ORACLE).

Data administration. Processing system life cycle, security and integrity, office automation system.

PARALLEL PROCESSING

Group A

Introducing to parallel processing, architectural classification and techniques.

Arithmetic and instruction pipelines, pipelining hazards and scheduling theory.

Super scalar architectures, asynchronous pipelines.

Interconnection networks—Hyper cubes, shuffle

exchange, Tree, Mesh and Butterfly networks.

Group B

Parallel algorithm for linear algebra, sorting, Fourier transform, systolic arrays, etc.

Vector processors, shared memory multiprocessor systems.

Data flow architectures-merits and demerits.

Operating systems for parallel processors.

Some case studies, namely, IBM 370, Cray X-MP, Cray 1, Cray 2, Cyber 205.

COMPUTER GRAPHICS

Group A

Various graphic display devices and interactive devices.

Line and curve drawing algorithms.

Area filling—Scan line algorithm, seed fill algorithm, half toning.

Two-dimensional transformation—translation, scaling, rotation.

Group B

Windowing and clipping techniques.

Three-dimensional graphics and transformations, reflections and viewing projections.

Hidden line and hidden surfaces removal algorithms.

Animation techniques.

MICROPROCESSOR AND MICRO CONTROLLERS

Group A

Microprocessor architecture and microcomputer systems, memory systems, input and output devices. Number systems-binary, hexadecimal and BCD numbers, 2s complement and arithmetic operations.

8085 microprocessor architecture. Memory interfacing address decoding techniques, memory read and write operations. Memory map. Interfacing I/O devices- Memory-mapped I/O and I/O mapped I/O. Polled and interrupt modes of data transfer. 8085 interrupts, direct memory access. Introduction to 16-bit microprocessor using 8086 as an example. Concept of debugger and MASM/T ASM for PC assembly language programming.

Peripheral devices. 8255 programmable peripheral interface, 8253 programmable counter timer, serial communication with SID and SOD, 8251 programmable communication interface, 8259 programmable interrupt controller, keyboard and display devices.

8085 assembly language programming: 8085 instructions-addressing modes. Stack and subroutines. 8085 programmer's model-CPU registers. Addition, subtraction and multiplication routines. Software delay and counting routines. Logical operations. Analog and digital I/O interface routines-ADC and DAC.

Software development systems: Assemblers and cross assemblers.

Microprocessor applications. Microprocessor based system design aids and trouble-shooting techniques.

Group B

Introduction to microcontroller: Comparison of various microcontrollers. 8051 microcontroller architecture. Bi-directional data ports, internal ROM and RAM, counters/timers. Oscillator and clock.

8051 registers. Memory organisations-program memory and data memory, internal RAM and bit addressable memory, special functions, registers, memory map.

External memory systems and I/O interface. Accessing external program memory, accessing external data memory, available I/O ports during external memory access. Alternate ports functions. Serial interface. 8051 interrupts. Power down modes.

8051 assembly language programming. 8051instruction sets, addressing

modes, bit level operations. Arithmetic routines, counting and timing under interrupt control, keyboard and display interface routines, accessing lookup tables.

Software development systems. Assemblers and simulators. Microcontroller based system design and applications.

PATTERN RECOGNITION AND IMAGE PROCESSING

Group A

Hyperplane properties and decision functions. Minimum distance pattern classification with simple and multiple prototypes.

Clustering: K means and isodata algorithm, pattern classification by likelihood functions, bayes classifier, learning and estimation of mean vector and covariance matrix.

Trainable pattern classifier—Gradient technique, Robbins-Monre algorithm, potential functions and least mean square errors.

Feature selection by entropy minimization, Karhuner-Lucke expansion and divergence maximization.

Group B

Image representation, digitization, quantization, compression and coding.

Transform for image processing, restoration enhancement, segmentation, thinning.

Description of line and shape, statistical and syntactic models of image classification.

Morphological methods of image analysis.

THEORY OF COMPUTATION

Group A

Regular sets and regular expression, deterministic and non-deterministic and finite automata, equivalent finite automation of both. Minimization of states for deterministic finite automata.

Chomsky hierarchy of grammars, equivalent context-free grammars.

Chomsky normal form, recursiveness of context-sensitive grammar, syntax-directed translations.

Pushdown automata, pumping lemma for context-free languages, automata for syntax-directed translations.

Group B

Turing machines and its variants, universal luring machines, recursive functions and sets. Equivalence of recursive functions and computable functions.

Complexity theory. Space complexity, time complexity, simulation of RAM by TM and its complexity, NP-completeness concepts and some standard NP-complete problems.

SOFTWARE ENGINEERING

Group A

Software project planning and management: Basic concepts of life cycles models, milestone, cost models, successive versions model, project structure, team structure. Empirical and heuristic estimation techniques.

Requirement analysis. Specifications, algebraic axioms, regular expressions, decision tables, event tables, transition tables, FS mechanism, petri nets.

Software design: Architectural and detailed design, abstraction, information hiding, modularity, concurrency, etc, coupling and cohesion, data How diagrams, structure charts, pseudo code, stepwise refinement, top-down and bottom-up programming.

Test plan and implementation issues-structured coding, recursion, documentation.

Group B

Modern programming language features: Typeless, strong type and pseudo strong type checking, user defined data types, data encapsulation, generic facilities,' concurrency mechanism, object oriented concepts.

Program verification and validation. Unit testing, integration testing, acceptance testing, formal verification.

Software maintenance: Source code metrics, Halstead's effort equation, cyclomatic metric.

Reliability and software quality assurance.

Software cost estimation.