

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:-controllers, 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.

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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, Baschinger'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.

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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 and 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.

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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.

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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.

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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. Boltzmann's law, Brownian movement, equipartition 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 intermolecular forces; Chemical kinetics.

Structure of organic molecules, nomenclature. Introduction to stereochemistry; Optical activity. Titration involving potassium permanganate, potassium dichromate. Titration involving EDTA.

Oxidation-reduction reactions. Colloid 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, NO_x, SO_x, oxidant.

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Engineering Drawing & 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 conformity 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; Tolerance 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.

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Electronics & 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, biasing 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.

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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.

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Electrical Science

Group A

Review of basic concepts in electrostatics and magnetostatics, Basic laws due to Ohm, Coulomb, Faraday, Ampere and Kirchoff, 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.

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