Module I : Engineering Mathematics   (10 Marks)

Matrices- Rank of a matrix, Inverse, systems of linear equations, consistency, eigen values, eigen vectors, Cayley Hamilton Theorem, diagonalisation, linear dependence and independence of vectors.

Partial Differentiation - Partial derivatives, Higher order derivatives, Euler's equation for homogeneous functions, chain rule, total derivatives, Taylor's series (one and two variables) – Maxima and minima of functions of two variables. Evaluation of Multiple integrals, Jacobians, Applications of multiple integrals.

Ordinary differential equations, first order equations, systems of linear first order ordinary differential equations, linear ordinary differential equations of higher order with constant coefficients, linear second order ordinary differential equations with variable coefficients (Cauchy and Legendre equations).

Vector Differentiation: Scalar and vector functions, differentiation of vector functions – velocity and acceleration – scalar and vector fields – operator – Gradient – Directional derivative – Divergence – Curl – irrotational and solenoidal fields – scalar potential, Vector identities, line, surface and volume integrals, Gauss divergence theorem, Stokes and Green's theorems, applications.

Complex analysis - analytic functions, Cauchy-Riemann equations, conformal mapping, bilinear transformation, complex integration, Cauchy's integral theorem and formula.

Fourier series of periodic functions, Euler's formulae, odd and even functions, half range series.

Module II : Fluid mechanics and Hydraulic Machines   (15 Marks)

Fluid, continuum, properties of fluids, Newtons law of Viscosity, Newtonian and non-Newtonian fluids, fluid statics, manometry, Eulerian and Lagrangian approaches, Classification of fluid flows, stream lines, path lines, streak lines, stream tubes, velocity and acceleration in fluid, Rotation, circulation and vorticity, stream function and potential function, Laplace equation, Control volume analysis of mass, momentum and energy, differential equations of continuity and momentum. Navier Stokes equation, Euler's equation, Bernoulli's equation and its applications, Viscous flow- laminar flow and turbulent flow, shear stress and velocity distribution in a pipe, head loss in pipes, Hagen Poiseuille equation. Turbulent flow: Darcy-Weisbach equation, Chezy's equation Moody's chart, Concept of Boundary Layer: Growth of boundary layer over a flat plate, boundary layer thickness, displacement and momentum thickness, turbulent boundary layers, laminar sub layer, velocity profile, Von-Karman momentum integral equation, calculation of drag, separation of boundary layer.

Compressible fluid flow - Velocity of sound, Mach number, subsonic, sonic and supersonic flow, Mach cone, sonic boom, One dimensional steady isentropic flow, area-velocity relation, nozzle and diffuser, mass flow rate and chocking, operation of a nozzle under varying pressure ratios, over expansion and under expansion in nozzles, Normal shock and oblique shock, Fanno flow, Rayleigh flow.

Hydraulic Turbines, Classification, Impulse and Reaction Turbines – Pelton Wheel, Francis and Kaplan turbines, velocity triangles, work done, and efficiencies, draft tubes, surge tanks, Cavitation in turbines, Specific speed of turbine. Pumps: Classification- rotodynamic and positive displacement pumps, Centrifugal pump - types, velocity triangles, work, cavitation, NPSH, Performance characteristics, specific speed. Reciprocating pumps, slip, negative slip, work required and efficiency indicator diagram- acceleration head - effect of acceleration and friction on indicator diagram, air vessels.

Module III Thermodynamics and Heat transfer   (15 Marks)

Thermodynamic system and control volume, Zeroth law of thermodynamics, Ideal gas equation, First law of thermodynamics, Thermodynamic processes, Quasistatic process, path and point function, computation of work and heat, Internal energy, Enthalpy, Steady and Transient flow analysis, Throttling process, Second law of thermodynamics, reversible process, Carnot cycle, Corollaries of second law, Carnot's theorem, entropy, Entropy changes in various thermodynamic process, Principle of increase of entropy, Entropy generation, irreversibility and availability, Helmholtz function and Gibbs function, behaviour of real gases, compressibility factor, law of corresponding states, Properties of pure substances, Thermodynamic property diagrams, T-v, p-v and p-T diagrams, p-v-T surface, Properties of steam, Combined first and second law, Maxwell's relations, Tds equations, Joule Thompson Coefficient, Inversion curve, Clasius-Clapeyron equation.

Heat transfer: Modes of heat transfer, Fourier law, Thermal conductivity, most general heat conduction equation, one dimensional heat conduction with and without heat generation, thermal resistance, Critical radius of insulation, Lumped system analysis, Fins, Analysis of fins with uniform cross sectional area, fin efficiency and effectiveness, Convective heat transfer, Newton's law of cooling, Hydrodynamic and thermal boundary layers, dimensionless parameters in free and forced convection, convective heat transfer correlations for flow over flat plates and through pipes, effect of turbulence, Perforrmance of Heat Exchangers, Overall heat transfer coefficient, LMTD and NTU methods. Radiation, laws of radiation, black and grey surfaces, electrical analogy, shape factors, radiation network analysis, Radiation shields. Mass transfer, diffusion mass transfer, Fick's law, convective mass transfer, heat and mass transfer analogy.

Steam turbines, Rankine cycle and modified Rankine cycle, relative efficiency, degree of reaction, reheating and regeneration, reheat factor, compounding, pressure and velocity variation, work done, efficiency, condition for maximum efficiency, multi-staging. Steam nozzles, velocity of steam, mass flow rate, critical pressure ratio and its significance, effect of friction, supersaturated flow.

Gas turbines, open, closed and semi closed cycle, ideal working cycle- Brayton cycle-P-v and T-s diagram, thermal efficiency, effect of compressor and turbine efficiencies, optimum pressure ratio for maximum specific work output. Regeneration, intercooling and reheating-

cycle efficiency and work output-Condition for minimum compressor work and maximum turbine work.

SI and CI engines, two-stroke and four-stroke engines, Air standard efficiencies of Otto cycle, Diesel Cycle and Dual Combustion Cycle, combustion in IC engines, abnormal combustion, engine fuels and fuel rating, alternate fuels, carburetion and fuel injection – MPFI, CRDI, super charging and turbo charging methods, engine emission and control.

Refrigeration, reversed Carnot cycle, Coefficient of performance, Heat pump, Gas cycle refrigeration, reversed Brayton cycle, Vapour compression systems, Effect of evaporator pressure, condenser pressure, suction super heat and liquid subcooling, multipressure systems, Properties of Refrigerants, Vapour absorption refrigeration systems, properties of moist air, psychrometric chart, psychrometric processes, factors affecting human comfort.

Module IV: Applied Mechanics and Theory of Machines   (15 Marks)

Mechanics – statistics – Coplanar forces – conditions of equilibrium. Support reactions – Simply supported and overhanging beams. Friction – Laws of friction – applications. Centre of gravity and moment of inertia of plane areas. Dynamics –rectilinear motion – Newton's laws of motion – curvilinear motion.

Mechanisms - Various mechanisms, kinematic diagrams, degrees of freedom, Grashof's criterion, inversions, mechanical advantage, displacement, velocity and acceleration analysis.

Cams - Classification of cam and follower, displacement diagrams. Gears - Terminology of spur gears, nomenclature, law of gearing, involute spur gears, gear ratio, interference, backlash, gear standardisation, centre distance. Theory and details of bevel, helical and worm gearing, gear trains, simple and compound gear trains.

Analysis of flywheel and gyroscope, balancing of reciprocating and rotating masses.

Vibrations – Free vibrations of single degree freedom systems, undamped and damped free vibrations, forced vibrations, viscous damping, critical damping, logarithmic decrement, whirling of shafts, critical speed of shaft, free torsional vibrations, vibration isolation.

Module V: Mechanics of solids and Machine Design   (15 Marks)

Stress at a point, stress tensor, stress invariants, constitutive equations-generalized Hooke's law, Principal stress and strain, Mohr's circle for plane stresses and plane strains, hydrostatic and deviatoric stress components, strain tensor, shear force and bending moment diagrams, bending and deflection of beams, torsion of circular shafts, strain energy, thermal stresses.

Materials and their properties, elastic and plastic behaviour of metals, ductile and brittle behaviour, stress-strain diagrams, Poisson's ratio, shear, bending and torsional stresses, combined stresses, stress concentration factor.

Theories of failure, shock and impact loads, fatigue loading, endurance limit stresses, factors affecting endurance limit, factor of safety.

Principles of the design of machine elements like riveted joints, bolted joints and welded joints.

Springs- Stresses and deflection of helical springs, axial loading, curvature effect, static and fatigue loading, surging, Leaf springs, nipping. Shafts- Causes of failure in shafts, design based on strength and rigidity, design for static and fatigue loading.

Clutches - Friction clutches, multiple disc clutches, cone clutch, centrifugal clutch-Brakes, Energy equations, tangential force, torque absorbed, different types of brakes. Design principle of spur gear, helical gear and bevel gear.

Sliding contact bearings- lubrication, lubricants, viscosity, journal bearings, hydrodynamic theory. Rolling contact bearing- bearing life, static and dynamic load capacity, axial and radial loads, Selection of bearings.

Belts- Slip, creep, centrifugal tension, Flat belt,V-belt, Rope, Chain. Pressure vessels- thin and thick vessels, open and closed vessels, Dilation.

Module VI: Manufacturing Technology   (15 Marks)

Classification of materials, Structure and properties of common engineering materials, Crystalline materials, amorphous materials, composites, super alloys, crystal imperfections, phase diagrams, iron- carbon equilibrium diagram, T-T-T diagram, Annealing, hardening, normalizing, carburizing, nitriding, fracture of brittle and ductile materials, powder metallurgy.

Sand casting process- types and properties of molding sand, cores, chills and chaplets, directional solidification, Chvorinov's rule, gating and riser design, investment casting, die casting, centrifugal casting, shell molding. Metal forming processes- forging, drawing, extrusion, shearing, bending, spinning. Joining processes- Gas welding, arc welding, TIG, MIG, submerged arc welding, thermit welding, soldering, brazing.

Lathe, shaper, slotter, planer, milling machine, drilling machine, broaching machine, grinding, lapping, super finishing, honing, gear hobbing.

Metrology-Accuracy, precision, sensitivity, resolution, calibration, standards of measurement, limits fits and tolerance, comparators, gauges, surface texture, autocollimator, interferometry, laser interferometer, Co-ordinate Measuring Machine.

Advanced Manufacturing Processes: EBM, ECM, LBM, EDM, WJM, AWJM, Ultrasonic machining, CNC, PLC, CIM.

VII Industrial Engineering and Management   (15 Marks)

Principles and functions of scientific management, Levels and skills of management, organisational structure – authority, responsibility and span of control – system concept of management – line, line and staff, project and matrix organizations, proprietary partnership and joint stock companies, private limited, public limited companies, cooperative organizations and Government organizations.

Factors in selection of site, plant layout, types of layouts: process, product, fixed and group layouts.

Marketing management – objectives and function, forecasting – moving average, exponential smoothing.

Break-even analysis, capacity planning, Production Planning and Control, Routing, Scheduling, dispatching and follow up, Gantt chart.

Inventory control, EOQ model, Selective inventory control techniques.

Work study – Job evaluation and merit rating, Work measurement, Standard time estimation.

Quality control, control charts for variables and attributes, , Acceptance sampling, Basic concepts of TQM,   Basic concepts of ISO, Basic concepts of Six Sigma, Reliability concepts.

Linear programming – Graphical and Simplex solution methods, Transportation and assignment models, single server queuing models, Sequencing problem. Network theory – CPM – crashing of networks, PERT – probability of completion.

Decision theory, Decision tree analysis, Game theory.

Material Handling, Methods of Replacement analysis, Depreciation.

NOTE: - It may be noted that apart from the topics detailed above, questions from other topics prescribed for the educational qualification of the post may also appear in the question paper. There is no undertaking that all the topics above may be covered in the question paper.