Department of Applied Mechanics, IIT Delhi

Syllabus for Written Test for Admission to M. Tech in Engineering Analysis and Design/ MSR in Applied Mechanics

A. Engineering Mechanics

Moving point in different coordinate systems; Rigid bodies; Translation and Rotation; Relative motion of translating systems; Angular velocity; General motion of a rigid body.

Mass and centre of mass; Resultant force systems; centre of parallel forces; Work, power and kinetic energy; Laws of motion; Equations of Equilibrium; Impulse and Angular Impulse; Impulse-momentum relations; Dry friction; Gravitational force; Free body diagrams; Belt friction, thrust bearing & clutch; Conservative forces; workless forces; Static determinacy; frames, mechanisms and constraints; Friction and impending motion (rolling and tipping); Journal bearing; Bars, beams and trusses; Principle of virtual work; potential energy & Stability.

Inertia tensor; Principal axes; Angular Impulse-momentum relations; general equations of motion of a rigid body; motion of a rigid body with a fixed axis; Euler's equations; work-energy relation; Balancing of rotors; Plane motion with examples; Centre of percussion; Impact of rigid bodies; Gyroscopic torque.

B. Solid Mechanics

State of stress at a point, equations of motion, principal stress, maximum shear stress, state of plane stress, transformation; concept of strain, strain displacement relations, compatibility conditions, principal strains, state of plane strain; Constitutive relations, uniaxial tension test, idealized stress-strain diagrams, isotropic linear elastic and elasto-plastic materials; Energy Methods; Uniaxial stress and strain analysis of bars, thermal stresses, Torsion, Bending, Deflection of beams, Buckling, Failure Theories.

C. Fluid Mechanics

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

D. Engineering Drawing

Basic engineering drawing

E. Mathematics

Matrix algebra (Transpose, Symmetric, Anti-Symmetric, Adjoint, Orthogonal, Inverse, Rank, etc.), Determinant, Linear Algebra (Linear equations, Homogeneous, Non-homogeneous, Cramer's rule, etc., Matrix Eigenvalue, Diagonalization), Ordinary Differential Equation (Solution of first order ODE's), Partial Differential Equation (Classification of 2nd order PDE's), Numerical Analysis (Euler equation), Vector algebra and calculus (Gradient, Curl, Divergence, etc.), Basics of Fourier and Laplace transforms.

F. Material Science

Bonding between atoms: metallic bonding, ionic bonding, covalent bonding, Van der Waals bond, thermal expansion, elastic modulus and melting point of materials, Miller indices of directions and planes, packing of atoms inside solids, close packed structures, structure of ceramics, ionic solids, glass and polymers, density of various materials, Imperfections in solids: vacancies, equilibrium concentration of vacancies, interstitial and substitutional impurities in solids, dislocations, types and characteristics of dislocations, interfacial defects, stacking faults, Yield strength, tensile strength and ductility of materials: stress strain behaviour of metals, ceramics and polymers, tensile test, plastic deformation, necking, Dislocations and yielding in crystals: theoretical strength of perfect crystal, role of dislocations, slip, critical resolved shear criterion, slip systems, twinning, Diffusion in solids: vacancy diffusion, interstitial diffusion, Fick’s law of diffusion, diffusion coefficient, Phase transformations: thermodynamics of transformation, equilibrium, Gibbs free energy, diffusional transformations in solids, nucleation and growth, TTT diagrams, heat treatment: annealing, normalising, quenching, Phase diagrams: phases, microstructure, binary phase diagrams: isomorphous system, eutectic system, microstructure development in isomorphous and eutectic systems, lever rule, tie line, Fe-C system, examples of ceramic systems, Strengthening methods: grain size strengthening, solid solution strengthening, precipitation hardening, dislocation hardening, Fracture of materials, mechanism of ductile tearing, brittle fracture, Griffiths theory, concept of fracture toughness, ductile to brittle transition, Fatigue behaviour of materials: fatigue curve, fatigue mechanisms, fatigue crack growth rate, examples of fatigue failure: fatigue failures in aircrafts, methods to improve the fatigue life, Creep behaviour of materials: creep curve, dependence of creep rate on stress, temperature, creep mechanism: dislocation creep, diffusion creep, grain boundary sliding, methods of resisting creep, Corrosion of materials: electrochemistry of corrosion, driving potential for corrosion, Pourbaix diagram, localised attack, galvanic corrosion, effects of environment on corrosion, methods of corrosion prevention, processing and properties of metals: steels, alloy steels, light alloys, Properties of composite materials, structure, processing and properties of polymers, thermoplastics and thermosetting, glass transition temperature, stress strain behaviour of polymers