

Part B - Syllabus

MECHANICAL ENGINEERING (MEC)

Engineering Mechanics: Kinematics and dynamics of particles and rigid bodies; rectilinear and curvilinear motion; projectile motion; work, energy and power principles; impulse and momentum; friction (dry and belt friction); equilibrium of forces and moments; free body diagrams; analysis of structures; planar motion; impact (direct and oblique); virtual work and energy methods.

Strength of Materials: Stress and strain relations; axial loading and deformation; thermal stresses; bending stress in beams; shear stress distribution; torsion of circular shafts; combined stresses; principal stresses and Mohr's circle; deflection of beams (double integration, moment-area, energy methods); columns and buckling (Euler theory); theories of failure (Tresca, Von Mises); factor of safety; stress concentration; fatigue and creep; elastic constants and material behavior.

Theory of Machines: Kinematics of mechanisms; degree of freedom; Grashof condition; velocity and acceleration analysis; slider-crank and four-bar mechanisms; cams and followers; gear trains (simple, compound, epicyclic); governors; balancing of rotating and reciprocating masses; gyroscopic effects; flywheels; turning moment diagrams; friction in machines.

Vibrations: Free and forced vibrations; single degree of freedom systems; damping (underdamped, critically damped, overdamped); logarithmic decrement; resonance; natural frequency; vibration isolation; energy methods; phase relationships; introduction to multi-degree systems.

Machine Design: Design of machine elements; shafts and keys; riveted and welded joints; springs; clutches and brakes; bearings (rolling and sliding contact); design against fatigue; Goodman and Soderberg criteria; stress analysis; failure prevention; design considerations for safety and reliability.

Fluid Mechanics: Properties of fluids; fluid statics; pressure measurement; buoyancy and stability; fluid kinematics; continuity equation; Bernoulli's equation; flow through pipes; head losses; Reynolds number and flow regimes; boundary layer theory; dimensional analysis; compressible flow; Mach number; flow measurement devices.

Thermodynamics: Basic concepts and properties; systems and processes; first and second laws; entropy and irreversibility; availability and exergy; ideal gas relations; thermodynamic cycles (Carnot, Rankine, Otto, Diesel); heat engines; refrigeration and air-conditioning; efficiency and coefficient of performance (COP).

Heat Transfer: Conduction (steady and unsteady); Fourier's law; thermal resistance; convection (forced and natural); Newton's law of cooling; dimensionless numbers (Reynolds, Prandtl, Nusselt); radiation; Stefan-Boltzmann law; heat exchangers; fins and extended surfaces; boiling and condensation basics.

Engineering Materials: Crystal structures (BCC, FCC, HCP); atomic bonding; mechanical properties; stress-strain behavior; phase diagrams (Fe-C diagram); heat treatment processes (annealing, normalizing, quenching, tempering); alloying elements; defects in materials; deformation mechanisms; slip and twinning; strain hardening; hardness testing.

Manufacturing Engineering: Casting processes and defects; solidification; welding processes (TIG, MIG, arc); forming processes (rolling, forging, extrusion); machining processes (turning, drilling, milling, grinding); tool materials; tool wear and tool life; orthogonal cutting mechanics; surface finish; non-traditional machining (EDM, ECM); powder metallurgy.

NRIU Ph.D. ENTRANCE EXAMINATION : 2026-26

Industrial Engineering and Operations Research: Productivity and work study; method study and time study; inventory control (EOQ, holding cost, ordering cost); break-even analysis; linear programming (formulation, graphical method); transportation and assignment problems; CPM and PERT; queuing theory (arrival rate, service rate, utilization); forecasting; project management concepts.