

**Syllabus for Ph.D. (Mechanical Engineering) Entrance Exam Paper -II**

<b>UNIT 01</b>	<b>ENGINEERING MATHEMATICS</b>
<p><b>Linear Algebra:</b> Matrix algebra, systems of linear equations, eigenvalues and eigenvectors.</p> <p><b>Calculus:</b> Functions of single variable, limit, continuity and differentiability, mean value theorems, indeterminate forms; evaluation of definite and improper integrals; double and triple integrals; partial derivatives, total derivative, Taylor series (in one and two variables), maxima and minima, Fourier series; gradient, divergence and curl, vector identities, directional derivatives, line, surface and volume integrals, applications of Gauss, Stokes and Green's theorems.</p> <p><b>Differential equations:</b> First order equations (linear and nonlinear); higher order linear differential equations with constant coefficients; Euler-Cauchy equation; initial and boundary value problems; Laplace transforms; solutions of heat, wave and Laplace's equations.</p> <p><b>Probability and Statistics:</b> Definitions of probability, sampling theorems, conditional probability; mean, median, mode and standard deviation; random variables, binomial, Poisson and normal distributions.</p> <p><b>Numerical Methods:</b> Numerical solutions of linear and non-linear algebraic equations; integration by trapezoidal and Simpson's rules; single and multi-step methods for differential equations.</p>	
<b>UNIT 02</b>	<b>APPLIED MECHANICS</b>
<p><b>Engineering Mechanics:</b> Free-body diagrams and equilibrium; friction and its applications including rolling friction, belt-pulley, brakes, clutches, screw jack, wedge, vehicles, etc.; trusses and frames; virtual work; kinematics and dynamics of rigid bodies in plane motion; impulse and momentum (linear and angular) and energy formulations; Lagrange's equation.</p> <p><b>Mechanics of Materials:</b> Stress and strain, elastic constants, Poisson's ratio; Mohr's circle for plane stress and plane strain; thin cylinders; shear force and bending moment diagrams; bending and shear stresses; concept of shear centre; deflection of beams; torsion of circular shafts; Euler's theory of columns; energy methods; thermal stresses; strain gauges and rosettes; testing of materials with universal testing machine; testing of hardness and impact strength.</p>	
<b>UNIT 03</b>	<b>DESIGN</b>
<p><b>Theory of Machines:</b> Displacement, velocity and acceleration analysis of plane mechanisms; dynamic analysis of linkages; cams; gears and gear trains; flywheels and governors; balancing of reciprocating and rotating masses; gyroscope.</p> <p><b>Vibrations:</b> Free and forced vibration of single degree of freedom systems, effect of damping; vibration isolation; resonance; critical speeds of shafts.</p> <p><b>Machine Design:</b> Design for static and dynamic loading; failure theories; fatigue strength and the SN diagram; principles of the design of machine elements such as bolted, riveted and welded joints; shafts, gears, rolling and sliding contact bearings, brakes and clutches, springs.</p>	
<b>UNIT 04</b>	<b>FLUID MECHANICS AND THERMAL SCIENCES</b>
<p><b>Fluid Mechanics:</b> Fluid properties; fluid statics, forces on submerged bodies, stability of floating bodies; control-volume analysis of mass, momentum and energy; fluid acceleration; differential equations of continuity and momentum; Bernoulli's equation; dimensional analysis; viscous flow of incompressible fluids, boundary layer, elementary turbulent flow, flow through pipes, head losses in pipes, bends and fittings; basics of compressible fluid flow.</p> <p><b>Heat-Transfer:</b> Modes of heat transfer; one dimensional heat conduction, resistance concept and electrical analogy, heat transfer through fins; unsteady heat conduction, lumped parameter system, Heisler's charts; thermal boundary layer, dimensionless parameters in free and forced convective heat transfer, heat transfer correlations for flow over flat plates and through pipes, effect of turbulence; heat exchanger performance, LMTD and NTU methods; radiative heat transfer, Stefan-Boltzmann law, Wien's displacement law, black and grey surfaces, view factors, radiation network analysis</p>	

**Thermodynamics:** Thermodynamic systems and processes; properties of pure substances, behavior of ideal and real gases; zeroth and first laws of thermodynamics, calculation of work and heat in various processes; second law of thermodynamics; thermodynamic property charts and tables, availability and irreversibility; thermodynamic relations.

**UNIT 05**

**MATERIALS AND MANUFACTURING**

**Engineering Materials:** Structure and properties of engineering materials, phase diagrams, heat treatment, stress-strain diagrams for engineering materials.

**Casting, Forming and Joining Processes:** Different types of castings, design of patterns, moulds and cores; solidification and cooling; riser and gating design. Plastic deformation and yield criteria; fundamentals of hot and cold working processes; load estimation for bulk (forging, rolling, extrusion, drawing) and sheet (shearing, deep drawing, bending) metal forming processes; principles of powder metallurgy. Principles of welding, brazing, soldering and adhesive bonding.

**Machining and Machine Tool Operations:** Mechanics of machining; basic machine tools; single and multi-point cutting tools, tool geometry and materials, tool life and wear; economics of machining; principles of non-traditional machining processes; principles of work holding, jigs and fixtures; abrasive machining processes; NC/CNC machines and CNC programming.

**Metrology and Inspection:** Limits, fits and tolerances; linear and angular measurements; comparators; interferometry; form and finish measurement; alignment and testing methods; tolerance analysis in manufacturing and assembly; concepts of coordinate-measuring machine (CMM).

**Computer Integrated Manufacturing:** Basic concepts of CAD/CAM and their integration tools; additive manufacturing.

**Reference Books**

1	Kundu, Cohen, Dowling, "Fluid Mechanics", Elsevier India
2	Sukumar Pati, "Fluid Mechanics and Hydraulics Machines", TATA McGraw Hill.
3	Cengel and Boles, "Thermodynamics an Engineering Approach", McGraw Hill
4	P. K. Nag, "Engineering Thermodynamics", Tata McGraw Hill Publications
5	S. S. Ratan, "Theory of Mechanisms and Machines", Tata McGraw Hill Publications
6	V. B. Bhadari, "Design of Machine Elements", Tata McGraw Hill Publications
7	G. K. Grover, "Mechanical Vibrations", 8 <sup>th</sup> edition, Nem Chand And Bross
8	Kalpak Jian, "Manufacturing Engineering and Technology", Pearson Publications.
9	A. Ghosh & A. K. Mallik, "Manufacturing Science", Ellis Horwood