Ph.D. Entrance Test Syllabus
Department of Mechanical Engineering

Linear system solution: full and sparse matrices, least squares solution, Eigenvalues, Laplace and Fourier transforms, FFT, z-transforms, Other linear transforms.

Stress and strain, stress-strain relationship and elastic constants, Mohr's circle for plane stress and plane strain, shear force and bending moment diagrams; bending and shear stresses; torsion of circular shafts; Euler's theory of columns.

Free and forced vibration of single-degree-of-freedom systems; critical speeds of shafts, gear trains, and flywheels.

Design for static and dynamic loading; failure theories; fatigue strength, fracture and the σ-N diagram; Design of machine elements such as bolted, riveted and welded joints, shafts, spur gear, rolling and sliding contact bearing, brakes and clutches

Zeroth, first, and second laws of thermodynamics; thermodynamic system and processes; Carnot cycle; irreversibility and availability; behavior of ideal and real gases, properties of pure substances, calculation of work and heat in ideal processes; analysis of thermodynamic cycle related to energy conversion.

Rankine, Brayton cycle with regeneration and reheat. I.C. Engines: air-standard Otto, Diesel cycle. Refrigeration and air-conditioning: Vapor refrigeration cycle, heat pumps, gas refrigeration, Reverse Brayton cycle; psychrometric processes.

Differential equation of continuity and momentum; Bernoulli's equation; viscous flow of incompressible fluids; boundary layer; elementary turbulent flow; flow through pipes, head losses in pipes, bends, etc., Pelton wheel, Francis and Kaplan turbines- impulse and reaction principle, velocity diagrams.

Modes of heat transfer; one-dimensional heat conduction, fins; dimensionless parameters in free and forced convective heat transfer, application of correlations for heat transfer in laminar and turbulent flow over flat plates and through pipes; radiative heat transfer, black and grey surfaces, shape factor, network analysis; heat exchanger performance, LMTD and NTU methods.

Structure and properties of engineering materials, heat treatment, stress-strain diagram for engineering materials. 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.

Mechanics of matching, 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, principles of design of jigs and fixtures, Basic concepts of CAM and NC programming.

Basic finite element concepts: basic ideas in a finite element solution, General finite element solution procedure, Finite element equations using the modified Galerkin method.