

Department of Mechanical Engineering

National Institute of Technology Srinagar

Syllabus outline for PhD Entrance Examination

Thermodynamics (4 marks)

Zeroth law of thermodynamics, temperature scales, first and second law of thermodynamics, heat engines, concept of entropy, air & vapour power cycles, nozzles, boilers, steam turbines, compressors, refrigeration and air-conditioning, internal combustion engines, gas turbines

Heat Transfer (4 marks)

Fourier's law of heat conduction, three dimensional heat conduction equation in Cartesian, cylindrical and spherical coordinates, heat conduction with heat generation, fins, unsteady heat conduction with negligible internal temperature gradients, free and forced convection, thermal radiation, boiling heat transfer

Fluid Mechanics & Hydraulic Machinery (5 marks)

Fluid statics, manometers, hydrostatic state of stress, buoyancy, flotation, stability, field description of fluid motion, Continuity equation, Momentum equation, energy equation, Euler's equation, Bernoulli equation, Navier-Stokes equations, boundary layer theory, momentum-integral equation of boundary layer, Turbulent flow, Work output and efficiency of hydraulic machinery, water turbines, pumps, dimensional analysis and similitude

Theory of Machines (5 marks)

Kinematics & kinetics of mechanisms, lower pairs & higher pairs, mechanisms and DOF, inversions, velocity and acceleration analysis, instantaneous centre, Analysis of governors, flywheels, gears and cams, linear mechanical vibrations, free and forced vibrations, vibrations of multiple degree of freedom systems, vibrations of continuous systems

Mechanics of Materials (5 marks)

Free body diagrams, section forces in beams, analysis of stress and strain, pressure vessels, mechanical properties of solids, symmetric & unsymmetrical beam bending, theories of elastic failure, columns, torsion of circular shafts, strain energy due to normal and shear stresses, Castigliano's theorem, complementary energy theorem, slopes and deflections, theories of failure, stresses in hollow and solid discs, stresses in rotating disc of constant thickness, closed coiled helical springs, leaf springs, conical springs,

Machine Design (5 marks)

Introduction to design, objectives of design, design process, concept of factor of safety in design, design of riveted joints, welded joints, screw jack, design of brakes, gear design, bearing design, Various types of loading in mechanical systems, stress concentration, endurance limit, SN curves and fatigue, manufacturing consideration in design, standardization of design of friction elements, design of internal combustion engine components, introduction to fracture mechanics based design

Manufacturing Technology and Material science (5 marks)

Introduction to basic manufacturing processes and engineering materials, casting technologies, introduction to metal cutting, machine processes and machine tools, metal forming, hot working and cold working, forging, extrusion, press-work operations, explosive forming, electromagnetic forming,

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fabrication of composites, welding, resistance welding, ultrasonic welding, laser beam welding, defects in welding

Classification of materials, modern and advanced materials, primary and secondary bonds and energy related concepts, structure of metals and ceramics, concept of unit cell and lattice arrangements, ceramic crystals and density computations, crystal systems, polycrystalline materials, and single crystalline material, atomic densities (linear and planar), x-ray diffraction, diffusion mechanism, deformation and strengthening mechanisms, phase diagrams

Industrial Engineering (4 marks)

Productivity, work study, facility layout & location, material management & its techniques, SQC, techniques of operation research

Automatic Control (4 marks)

Open and closed loop systems, servo-mechanisms, block diagrams and transfer functions, system response, first and second order systems, response to step, pulse, ramp and sinusoidal inputs, modes of control, proportional, derivative and integral control, stability analysis of control systems, Routh-Hurwitz criterion, frequency response methods, Bode and Nyquist plots, State-Space analysis of control systems, Controllability, Observability.

Measurements and Instrumentation (4 marks)

Generalized measurement system, standards, calibration, uncertainty, errors, Hydraulic and pneumatic load cells, instruments for high, mid and low pressure measurement, flow measuring devices, temperature measurement and sensing techniques

Engineering Mathematics (15 marks)

Linear Algebra: Matrix algebra, systems of linear equations, eigenvalues and eigenvectors.

Calculus: 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.

Differential equations: 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.

Complex variables: Analytic functions, Cauchy-Riemann equations, Cauchy's integral theorem and integral formula, Taylor and Laurent series.

Probability and Statistics: Definitions of probability, sampling theorems, conditional probability, mean, median, mode and standard deviation, random variables, binomial, Poisson and normal distributions.

Numerical Methods: Numerical solutions of linear and non-linear algebraic equations, integration by trapezoidal and Simpson's rules, single and multi-step methods for differential equations.