



# Rajiv Gandhi Proudyogiki Vishwavidyalaya, Bhopal (M.P.)

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## Syllabus for Entrance Examination for Admission in Ph.D. Program

### MECHANICAL ENGINEERING

#### **1. Thermodynamics Cycles and IC Engines**

Basic concepts, Open and Closed systems. Heat and work. Zeroth, First and Second Law, Application to non-Flow and Flow processes. Entropy, Availability, Irreversibility and Tds relations. Claperyron and real gas equations, Properties of ideal gases and vapours. Standard vapour, Gas power and Refrigeration cycles. Two stage compressor. C-I and S.I. Engines. Pre-ignition, Detonation and Diesel-knock, Fuel injection and Carburation, Supercharging. Turbo-prop and Rocket engines, Engine Cooling, Emission & Control, Flue gas analysis, Measurement of Calorific values. Conventional and Nuclear fuels, Elements of Nuclear power production.

#### **2. Heat Transfer and Refrigeration and Air-conditioning**

Modes of heat transfer. One dimensional steady and unsteady conduction. Composite slab and Equivalent Resistance. Heat dissipation from extended surfaces, Heat exchangers, Overall heat transfer coefficient, Empirical correlations for heat transfer in laminar and turbulent flows and for free and forced Convection, Thermal boundary layer over a flat plate. Fundamentals of diffusive and connective mass transfer, Black body and basic concepts in Radiation, Enclosure theory, Shape factor, Net work analysis. Heat pump and Refrigeration cycles and systems, Refrigerants. Condensers, Evaporates and Expansion devices, Psychrometry, Charts and application to air conditioning, Sensible heating and cooling, Effective temperature, comfort indices, Load calculations, Solar refrigeration, controls, Duct design.

#### **3. Fluid Mechanics and Machines**

Properties and classification of fluids, Manometry, forces on immersed surfaces, Center of pressure, Buoyancy, Elements of stability of floating bodies. Kinematics and Dynamics. Irrotational and incompressible. Inviscid flow. Velocity potential, Pressure field and Forces on immersed bodies. Bernoulli's equation, Fully developed flow through pipes, Pressure drop calculations, Measurement of flow rate and Pressure drop. Elements of boundary layer theory, Integral approach, Laminar and turbulent flows, Separations. Flow over weirs and notches. Open channel flow, Hydraulic jump. Dimensionless numbers, Dimensional analysis, Similitude and

modelling. One-dimensional isentropic flow, Normal shock wave, Flow through convergent - divergent ducts, Oblique shock-wave, Rayleigh and Fanno lines.

Performance, Operation and control of hydraulic Pump and impulse and reaction Turbines, Specific speed, Classification. Energy transfer, Coupling, Power transmission

#### **4. Theory of Machines**

Kinematic and dynamic analysis of planer mechanisms. Cams. Gears and gear trains. Flywheels. Governors. Balancing of rigid rotors and field balancing. Balancing of single and multicylinder engines, Linear vibration analysis of mechanical systems. Critical speeds and whirling of shafts Automatic controls.

#### **5. Machine**

#### **Design**

*Design of Joints* : cotters, keys, splines, welded joints, threaded fasteners, joints formed by interference fits. Design of friction drives : couplings and clutches, belt and chain drives, power screws. Design of Power transmission systems : gears and gear drives shaft and axle, wire ropes. *Design of bearings* : hydrodynamics bearings and rolling element bearings.

#### **6. Strength of Materials**

Stress and strain in two dimensions, Principal stresses and strains, Mohr's construction, linear elastic materials, isotropy and anisotropy, stress-strain relations, uniaxial loading, thermal stresses. Beams : Bending moment and shear force diagram, bending stresses and deflection of beams. Shear stress distribution. Torsion of shafts, helical springs. Combined stresses, thick-and thin-walled pressure vessels. Struts and columns. Strain energy concepts and theories of failure.

#### **7. Engineering Materials**

Basic concepts on structure of solids. Crystalline materials. Defects in crystalline materials. Alloys and binary phase diagrams. Structure and properties of common engineering materials. Heat treatment of steels. Plastics, Ceramics and composite materials. Common applications of various materials.

#### **8. Production Engineering**

*Metal Forming*: Basic Principles of forging, drawing and extrusion; High energy rate forming; Powder metallurgy. *Metal Casting*: Die casting, investment casting, Shell Moulding, Centrifugal Casting, Gating & Riser design; melting furnaces. *Fabrication Processes*: Principles of Gas, Arc, Shielded arc Welding; Advanced Welding Processes, Weldability: Metallurgy of Welding.

*Metal Cutting:* Turning, Methods of Screw Production, Drilling, Boring, Milling, Gear Manufacturing, Production of flat surfaces, Grinding & Finishing Processes. Computer Controlled Manufacturing Systems-CNC, DNC, FMS, Automation and Robotics.

Cutting Tools Materials, Tool Geometry, Mechanism of Tool Wear, Tool Life & Machinability; Measurement of cutting forces. Economics of Machining. Unconventional Machining Processes. Jigs and Fixtures. Fits and tolerances, Measurement of surface texture, Comparators Alignment tests and reconditioning of Machine Tools.

CAD TOOLS: Definition of CAD Tools, Types of system, CAD/CAM system evaluation criteria, brief treatment of input and output devices. Graphics standard, functional areas of CAD, Modeling and viewing, software documentation, efficient use of CAD software. GEOMETRIC MODELLING: Types of mathematical representation of curves, wire frame models wire frame entities parametric representation of synthetic curves her mite cubic splines Bezier curves Bsplines rational curves.

#### **9. Industrial Engineering:**

*Production Planning and Control :* Forecasting - Moving average, exponential smoothing, Operations, scheduling; assembly line balancing, Product development, Break-even analysis, Capacity planning, PERT and CPM. *Control Operations:* Inventory control ABC analysis, EOQ model, Materials requirement planning. Job design, Job standards, Work measurement, Quality Management - Quality analysis and control.

Operations Research: Linear Programming - Graphical and Simplex methods, Transportation and assignment models. Single server queueing model.

*Value Engineering :* Value analysis for cost/value.

#### **10. Statistics & Research Aptitude**

Mean, median, mode, basic concepts of probability, coefficient of variance, standard error, standard deviation, and correlation and regression analysis. Student t-test, F-test, analysis of variance (ANOVA), data graphics and data interpretation. Principles and various models of statistical optimization techniques, optimization softwares.

National and international scenario of scientific research, literature reviewing, reference citation, scientific and research journals, impact valuation, research article and patent drafting, various scientific websites, abstracts.