भारतीय सूचना प्रौद्योगिकी अभिकल्पना, एवं विनिर्माण संस्थान, कांचीपुरम

INDIAN INSTITUTE OF INFORMATION TECHNOLOGY, DESIGN AND MANUFACTURING, KANCHEEPURAM

Department of Mechanical Engineering

PhD Admissions

Syllabus for Written Test

Instructions:

- **All Questions will be of Objective Type**
- **Part – A: Compulsory to all the candidates**
- **Part – B: Contains four Sections**
  Under Part-B, Candidate can take the test on any one Section only
- **Use of Scientific Calculator is permitted**

PART – A

Max. Marks: 20 **Duration 30 Minutes**

Engineering Mathematics:

- Linear Algebra: Matrix algebra, systems of linear equations, eigenvalues and eigenvectors.
- Differential equations: First order equations (linear and nonlinear); higher order linear differential equations with constant coefficients; Euler-Cauchy equation; initial and boundary value problems.
- 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.

PART – B: Contains four Sections
(Under Part-B, Candidate can take the test on any one Section only)

Max. Marks: 40 **Duration 60 Minutes**

SECTION- 1 (Fluid Mechanics and Thermal Sciences)

Fluid Mechanics: 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.

Heat-Transfer: 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

Thermodynamics: Thermodynamic systems and processes; properties of pure substances, behaviorof 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.

Applications: Power Engineering: Air and gas compressors; vapour and gas power cycles, conceptsof regeneration and reheat. I.C. Engines: Air-standard Otto, Diesel and dual cycles. Refrigeration and air-conditioning: Vapour and gas refrigeration and heat pump cycles; properties of moist air, psychrometric chart, basic psychrometric processes. Turbomachinery: Impulse and reaction principles, velocity diagrams, Pelton-wheel, Francis and Kaplan turbines; steam and gas turbines

SECTION- 2 (Applied Mechanics and Design)

Engineering Mechanics: 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.

Mechanics of Materials: 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.

Theory of Machines: 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.

Vibrations: Free and forced vibration of single degree of freedom systems, effect of damping;vibration isolation; resonance; critical speeds of shafts.

Machine Design: Design for static and dynamic loading; failure theories; fatigue strength and the S-N 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.

SECTION- 3 (Materials, Manufacturing and Industrial Engineering)

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.

Production Planning and Control: Forecasting models, aggregate production planning, scheduling, materials requirement planning; lean manufacturing.

Inventory Control: Deterministic models; safety stock inventory control systems.

Operations Research: Linear programming, simplex method, transportation, assignment, network flow models

SECTION- 4 Mechatronics and Automation

Overview of Mechatronics and Automation Systems: Accuracy-precision-resolution, automated feeding, transfer, retrieval mechanisms and devices, work cells and flexible manufacturing systems, material handling and storage systems, overview of sensors, transducers and control systems.

Robots Mechanics: Links and joints, kinematic pairs, chains and mechanisms, kinematic inversions, velocity and acceleration of planar mechanisms-graphical and analytical methods, loop closure equation, four-bar mechanisms, Grashof criterion, robot classification and anatomy, workspace, robot kinematics-forward/inverse, DH matrix transformation, jacobian and differential motion, dynamics and position control, path planning, industrial and medical applications.

Pneumatic & Hydraulic Systems: Production, distribution and conditioning of compressed air, flow-pressure-direction control valves, actuators, supporting and control elements, pumps, proportional valves and their applications, servo valves and actuators, design of pneumatic and hydraulic systems, performance analysis.

Mobile robots: Kinematics, degree of Mobility, steerability and maneuverability, sensors for localization and motion control, Holonomic robots.
