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Annexure-3

Syllabus for Written Test and/or Interview for Ph.D. program in Department of Mechanical Engineering:

Syllabus for Written Examination

For PhD Applicants in Mechanical Engineering

Department of Mechanical Engineering IIT Jodhpur

Instructions: It is important to note that Part A and Part B are mandatory. Each carry 15% marks respectively. The applicant has to also attempt any ONE part amongst Part C OR Part D OR Part E according to the indicated research area in the application. This section will carry the 70% marks.

Part A: General Aptitude in English Language

Verbal Ability: English grammar, sentence completion, verbal analogies, word groups, instructions, critical reasoning and verbal deduction

Part B: Engineering Mathematics

Linear Algebra, Differential Equation (ODE/PDE), Transformations (Laplace/ Fourier), Optimization, Statistics

Part C: Combustion, Spray, IC Engines, Heat Transfer

Fluid Mechanics: Fluid properties; fluid statics, manometry, buoyancy; control-volume analysis of mass, momentum and energy; fluid acceleration; differential equations of continuity and momentum; Bernoulli's equation; viscous flow of incompressible fluids; boundary layer; turbulent flows; flow through pipes, head losses in pipes, bends etc.

Heat-Transfer: Modes of heat transfer; one dimensional heat conduction, resistance concept, electrical analogy, unsteady heat conduction, fins; dimensionless parameters in free and forced convective heat transfer, various correlations for heat transfer in flow over flat plates and through pipes; thermal boundary layer; effect of turbulence; radiative heat transfer, black and grey surfaces, shape factors, network analysis; heat exchanger performance, LMTD and NTU methods.

Thermodynamics: Zeroth, First and Second laws of thermodynamics; thermodynamic system and processes; Carnot cycle. irreversibility and availability; behaviour of ideal and real gases, properties of pure substances, calculation of work and heat in ideal processes; analysis of thermodynamic cycles related to energy conversion, Rankine, Brayton cycles with regeneration and reheat. I.C. Engines: air-standard Otto, Diesel cycles, Fuels

Part D: Additive Manufacturing and CNC Machine Tools

Machining and Machine Tool Operations: Mechanics of machining, Single and multi-point cutting tools, Tool geometry and materials, Tool life and wear; Kinematics of machine tools; Economics of machining; Non-traditional machining processes; Abrasive and Super-finishing Processes; Principles of work holding, Principles of jigs and fixtures design.

Metrology and Inspection: Limits, fits and tolerances; Linear and angular measurements; Comparators; Gauge design; Interferometry; Form and finish measurement; Co-ordinate Measuring Machine (CMM); Tolerance analysis in manufacturing and assembly.

CAD/CAM: Algebraic and parametric form of curves; Differential geometry of curves; Spline representations; Cubic spline interpolation; Bezier curves; B-spline curves; Rational and NURBS curves and their applications; Representations and differential geometry of surfaces; Bezier and B-Spline patches; Construction of coons patch and Bezier triangles; Applications for design of surfaces; Fundamentals of CNC machines, CNC Programming Fundamentals, CNC Hardware, CAD/CAM Integration, Computer Aided Process Planning, Rapid Prototyping

Part E: Multibody Dynamics, Robotics, Vibration, Flexible Robots, Micro/Nanotechnology, Rotor Dynamics

Engineering Mechanics: Free body diagrams and equilibrium; trusses and frames; virtual work; kinematics and dynamics of particles and rigid bodies, impulse and momentum and energy formulations; impact.

Kinematics and Dynamics of Machinery: Mechanism Synthesis- Path, Motion and Function Generation, Displacement, velocity and acceleration analysis of plane mechanisms; Cam, Gear Trains, Static and Dynamic Force Analyses (planar), Balancing.

Rigid Body Dynamics / Robotics: Description of Rotation in 3D, Rotational Transformation, Homogeneous Transformation, Parameterization of Rotations: Euler Angles, DH Parameters, Forward and Inverse Kinematics, Singular Configuration, Velocity Kinematics, Jacobian, Trajectory Planning and Control, Dynamics using Newton-Euler and Euler-Lagrange Formulations, Recursive Newton-Euler Algorithm

Mechanical Vibration: Lagrange and Hamiltonian equations for lumped systems; Variation formulations of mechanics problems; free and forced vibrations of lumped and distributed systems; fundamentals of beam theory; Torsional, and flexural vibrations of beams; modal analysis of lumped and distributed systems; approximate methods for distributed parameter systems; and nonlinear vibrations.

Rotor Dynamics: Single Mass Rotor; Gyroscopic Effects in Rotors; Torsional Vibrations; Bearing, Balancing of Rotors; Measurement & Signal Processing Techniques; Condition Monitoring of Rotors.