SYLLABUS FOR Ph.D. INTERVIEW IN MECHANICAL ENGINEERING

Engineering Mathematics:

- Vector calculus – Gradient, divergence, curl operators and properties, Line, surface and volume integrals, Divergence theorem, Stokes' theorem
- Linear algebra – Solution of system of algebraic equations, Eigenvalues and Eigenvectors of a matrix
- Ordinary differential equations – Solution of first and second order linear ODEs
- Partial differential equations – Solution of Laplace, Wave and Diffusion equations
- Complex analysis – Analytic functions, Contour integration, Taylor and Laurent series expansions
- Numerical methods – Numerical solution of systems of algebraic equations, ODEs and PDEs

Engineering Mechanics:

- Equivalent force systems
- Internal forces – Free Body Diagrams
- Truss and frame structures
- Dynamics of a particle and a system of particles
- Dynamics of a rigid body (2D)
- Vibration of a spring-mass-damper system

Strength of materials:

- Euler-Bernoulli Beam theory - shear force and bending moment, flexural and shear stresses in beams, deflection of beams.
- Torsion - Torsion of circular shafts.
- Buckling - Euler's theory of column buckling.
- Basics of elasticity - Stress and strain components and transformations, Elastic constants, plane stress and plane strain, Mohr's circle for 2D and 3D conditions

Thermodynamics:

- Thermodynamic systems
- Zeroth, First and second Law of thermodynamics
- Properties of Pure substances
- Thermodynamics cycles

Fluid Mechanics:

- Fluid Properties
- Lagrangian and Eulerian Descriptions; Material Derivative; Reynolds Transport theorem.
- Momentum and Energy Integral Equations and their applications. • Navier-Stokes Equation; Velocity Potential and Stream Function.
- Non-dimensional Numbers in Fluid Mechanics.
- Boundary Layer Theory: Pipe flow and flow over flat plate

Heat Transfer:

- Basic Modes of Heat transfer
- Electrical Resistance Analogy; Fins; Lumped Capacitance.
- Thermal and Momentum Boundary layers over a flat plate.
- Shape factor; Black and Grey body radiation.
- Non-dimensional Numbers in Heat Transfer

Materials & Manufacturing:

- Crystal structure of Solids
- Phase Diagram of Simple Binary Alloys
- Mechanical Behavior of Materials
- Metal Forming: Wire Drawing, Rolling, Extrusion
- Machining: Turning, Milling and Drilling
- Welding: Arc Welding and Oxy-acetylene Welding

Robotics:

- Under Graduate Mathematics (Calculus)
- Under Graduate Mechanics
- Vectors and Transformations
- Under Graduate Control Theory