MEPE3005 ADVANCED MECHANICS OF SOLIDS (3-0-0)

Course Objectives:
This course explores advanced concepts in solid mechanics, including 3D stress-strain analysis, unsymmetrical bending, torsion of non-circular shafts, rotating disc design, and curved beam theory. Students will apply mathematical models (Mohr's circle, Winkler-Bach formula) to solve complex engineering problems involving stress distribution and structural integrity.

Module – I: (06 hours)
Introduction: Elementary concept of elasticity, stresses in three dimensions, Principal Stresses, Stress Invariants, Mohr's Circle for 3-D state of stress, Octahedral Stresses, State of pure shear, Differential equations of equilibrium and compatibility conditions, plane stress. Analysis of strain, State of strain at a point, Strain Invariant, Principal Strains, Plane state of strain, Strain measurements.

Module – II: (06 hours)
Unsymmetrical Bending and Shear Centre: Introduction; product of inertia – parallel axes theorem for product of inertia – principal axes and principal moments of inertia; bending stresses in beams due to unsymmetrical bending; deflection of straight beams due to unsymmetrical bending. Concept of shear center; determination of shear center for symmetrical and unsymmetrical sections.

Module – III: (06 hours)
Torsion Of Non-Circular Shafts: Introduction; Membrane Analalogy; torsion of non-circular solidsections; thin wall tubular sections; thin-walled multi-cell sections.

Module – IV: (06 hours)
Design Of Rotating Discs: Introduction to Centrifugal stresses- Rotating ring; flat discs-Disc of uniform thickness and Disc of uniform strength.

Module – V: (06 hours)
Curved Beam Theory: Winkler bach formula for circumferntial stresses – Limitations; corrections factors – Radial stress in curved beams – closed rings subjected to concentrated and uniform loads.

Course Outcomes:
CO1: Remembering (Knowledge): Recall stress invariants, strain measurements, and key formulas (Winkler-Bach, Mohr's circle for 3D stress).
CO2: Understanding (Comprehension): Explain unsymmetrical bending, shear center determination, and membrane analogy for torsion.
CO3: Applying (Application): Calculate stresses in rotating discs (uniform thickness/strength) and curved beams under concentrated loads.
CO4: Analyzing (Analysis): Evaluate principal stresses/strains and compatibility conditions for 3D elasticity problems.
CO5: Creating (Synthesis): Design structural components (shafts, beams) by integrating advanced mechanics principles for optimal performance.

Reference Books:

1. Boresi, "Advanced Mechanics of Materials", 6th Edition, John Wiley and Sons, 2003.
2. Timoshenko and S. Woinowsky - Krieger, "Theory of Plates and Shells", 2nd Edition, Tata Mc Graw Hill, 2010.
3. J.P. Den Hartog, "Advanced Strength of Materials", 1st Edition, Dover Publications, 1987.
4. L.S. Srinath, "Advanced Solid Mechanics", 3rd Edition, Tata Mc Graw Hill, 2009.
5. R.K. Rajput, "Strength of Materials", 3rd Edition, S. Chand Publications, 2007.
6. B.C. Punmia, "Strength of Materials and Theory of Structures",12th Edition, Lakshmi Publications, 2004.