CE 501: ADVANCED SOLID MECHANICS (3-0-0: 3)

Introduction: Review of basic concepts and equations in mechanics, Classification of materials, Outline of general techniques to solve boundary value problems.

Mathematical Preliminaries: Indicial notation, Introduction to tensors, Representation of tensors, Gradient and related operators, Divergence theorem.

Kinematics: Motion field, Displacement field, Deformation gradient, Transformation of curves, surfaces and volumes, strain measures, linearized strain measures, Principal strains and principal directions, Transformation of strain components with changes in coordinate basis, Compatibility conditions for linearized strain.

Traction and stresses: Concept of traction, Cauchy's stress theorem, Postulate of Cauchy stress tensor, Traction on arbitrary planes, Extreme normal and shear traction, Octahedral shear stress, Other stress measure – Engineering stress

Equilibrium equations: Equilibrium equations in Cartesian and cylindrical polar coordinates.

Constitutive relations: Restrictions on constitutive relations, General relationship between Cauchy stress and Cauchy Green strain for isotropic materials, General Hooke's law and its reduction for isotropic and orthotropic materials.

Boundary value problems: Formulation : Displacement method, Stress method, Airy's stress functions for plane stress and strain problems, Uniaxial Tension, Thick-walled annular cylinder subjected to uniform boundary pressure, Infinite medium with a stress free hole under far field tension loading.

Bending of prismatic straight beams: Pure bending, bending due to uniform transverse loading and bending due to transverse sinusoidal loading of a beam, Asymmetrical bending of straight beams, Shear center, Shear stresses in thin walled open sections.

End torsion of prismatic beams: Formulation of the BVP for torsion of beams with solid cross section - warping function and Prandtl stress function approach, Torsion of circular, elliptic, rectangular and triangular cross sections, Membrane analogy, Torsion of thin walled tubes, thin rectangular sections, rolled sections and multiply connected sections.

Bending of curved beams: Winkler-Bach Formula, Elasticity solution for: pure bending of curved beams, curved cantilever under end loading.
Beam on elastic foundation: Derivation of the basic governing equation, Solution to beam on an elastic foundation subjected to a point load at the center, moment at the center, uniformly distributed load over some length 'a' symmetrically about the center.

Text Books and References:

1. Srinath, L. S., "*Advanced Mechanics of Solids*", Tata McGraw Hill, 2nd Ed, New Delhi, 2003.
2. Timoshenko, S. P. and Goodier, J. N., Zienkiewicz, "*Theory of Elasticity*", McGraw Hill, 2nd Ed, New Delhi, 1970.
3. Budynas, R. G., "*Advanced Strength and Applied Stress Analysis*", McGraw Hill, 2nd Ed, New Delhi, 1999.
4. Singh, A. K., "*Mechanics of solids*", PHI Pvt. Ltd., 1st Ed, 2007.
5. Boresi, A. P. and Schmidt, R. J., "*Advanced Mechanics of Materials*", John Willey and Sons Inc, 5th Ed, 1993.
6. Chandrasekharaiah, D. S. and Debnath, L., "Continuum Mechanics", Prism Books Pvt. Ltd., Bangalore, 1994.