20MD003 THEORY OF ELASTICITY AND PLASTICITY

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Course Description and Objective:

The purpose of this course is to introduce at senior level graduate students and practicing engineers in Mechanical Engineering to the theories of elasticity and plasticity.

Course Outcomes: Students will be able to

- Understand the stress and strain relations in Elastic and Plastic zones
- Calculate the stress and strains under applied load beyond proportional limit
- Evaluate stresses in beams using Polynomial solutions
- Analyze stresses in rotating members when the load is beyond proportional limit

UNIT – I **L - 12**

Analysis of Stress: Stress at a Point, Equations of Equilibrium, Traction Stress Vector, Stresses on an Inclined Plane, Transformation of Stress, Principal Normal and Shear Stresses, Stress Deviator Tensor, Octahedral Stresses, Mohr's Stress Circle.

UNIT – II **L - 12**

Analysis of Strain: Displacement at a Point, Normal and Shear Strains, 2D and 3D Strain, Compatibility Conditions, Dilatation, Transformation of 2D and 3D Strain, Strain Tensor, Mathematical Strain, Principal Strains, Octahedral Strains, Mohr's Circle of Strain

UNIT – III **L – 12**

Stress–Strain Relations:

Elastic Behavior: Hooke's Law, Incompressible Material, Equations of Equilibrium in Terms of Displacements, Strain Energy, Dilatational and Distortional Strain Energy Densities, Impact Loading, Plastic Behavior, Static Tension Test, Basic Stress–Strain Relations, Models of Uniaxial Stress–Strain Relations, True Stress and Strain.

Yield Criterion: Maximum Shearing Stress Criterion, Maximum Distortion Energy Criterion, Yield Surfaces in Haigh–Wesregaard Stress Space, Strain Hardening Rules, Isotropic Hardening Rule, Kinematic Hardening Rule, Independent Hardening Rule, Plastic Stress–Strain Relations, Stress–Strain Relations for Perfectly Plastic Material, Deformation Theory of Plasticity (J2—Material)

UNIT – IV **L – 12**

Two-Dimensional Problems: Plane Stress, Plane Strain, Stress Function, Polynomial Solutions, Cantilever Beam Loaded by a Concentrated Force, Bending of a Simply Supported Beam by Uniform Load, Cantilever Beam Subjected to Hydrostatic Pressure, Saint-Venant's Principle.

UNIT – V **L – 12**

Two-Dimensional Problems: Solutions in Polar Coordinates, Solutions of the Compatibility Equation, Axially Symmetric Problems, Wedge Problems, Semi-Infinite Solid, Rotating Circular Disks, Solid Disk, Annular Disk, Angular Rotation of a Thin Ring or Cylinder.

Text Books:

1. Mumtaz Kassir, "Applied Elasticity and Plasticity", CRC Press, 2018.
2. H. Jane Helena, "Theory of Elasticity and Plasticity", Paperback, PHI Learning, 2017.
3. S. Thimoshenko and J N Goodier, "Theory of Elasticity", 3rd Edition, Tata McGraw Hill, 2017.

Reference Books:

1. Vijay G. Ukadgoenkar, "Theory of Elasticity and Fracture Mechanics", PHI Learning, 2015.
2. Sadhu Singh, "Theory of Elasticity", 1st Edition, Khanna Publishers, 1978
3. Sadhu Singh, "Theory of Plasticity and Metal Forming Process", 1st Edition, Khanna Publishers, 1980