COURSECONTENT

THEORY OF ELASTICITY AND PLASTICITY								
I Semester: SE								
Course Code	**Category**	**Hours/ Week**			**Credits**	**Maximum Marks**		
2512012	**Core**	**L**	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
		3	0	0	3	40	60	100
contactClasses:45	**TutorialClasses:Nil**	**PracticalClasses:Nil**				**TotalClasses:45**		
Prerequisites: Strength of Materials I & II.								

Course Overview:

This course provides an advanced understanding of stress and strain analysis using tensor formulation, transformations, and invariants in two- and three-dimensional systems. It covers constitutive stress–strain relations for different material symmetries and applies analytical methods like Airy's stress functions and membrane analogy to solve elasticity problems in bending and torsion. The course also introduces plasticity theory, including yield criteria, flow rules, and hardening behavior, to evaluate material response beyond the elastic limit.

Course Objectives:

1. To understand and analyze stress components, transformations, and stress invariants.
2. To learn strain components, strain–displacement relations, and strain transformations.
3. To apply constitutive stress–strain relations for different material symmetries.
4. To solve 2D and 3D elasticity problems using stress functions and torsion methods.
5. To understand yield criteria, flow rules, and basic plasticity concepts.

Course Outcomes: After completion of the course, students will be able to

1. Analyze the state of stress in two- and three-dimensional systems using stress tensors, transformations, and invariants.
2. Interpret different components of strain and their transformations to determine principal and octahedral strains.
3. Derive stress–strain relationships and material constants for various material symmetries under plane and axi-symmetric conditions.
4. Solve two- and three-dimensional elasticity problems using stress function approaches and membrane analogy concepts.
5. Evaluate yielding behavior of materials using different yield criteria and hardening rules in plasticity.

SYLLABUS

UNIT – I

Stress: Introduction to Elasticity – Definition of Kinetics and Kinematics – Notation for forces and stress – Components of stresses – Stress tensor – Differential equations of equilibrium in 2D & 3D in Cartesian coordinates and in polar coordinates – Boundary conditions – Cauchy's postulate – Stress transformation – Direction cosines – Principal stresses – Stress invariants – Decomposition of stresses – Hydrostatic and deviatoric stresses – Octahedral stresses – Stress concentration factors

UNIT – II

Strain: Notation for strain – Components of strain – Strain tensor – Strain components – Strain-displacement relations – Strain compatibility conditions – Strain transformation – Direction cosines – Principal strains – Strain invariants – Octahedral strains – Strain rosette

UNIT – III

Stress–Strain Relationship: Navier's equation for stress-strain relationships – Relationship between material constants – Stress-strain relations in 2D and 3D – Complementary conditions for shear – Material symmetry – Reduction of material constants from anisotropic to orthotropic, monoclinic, isotropic and transversely isotropic – Plane stress, plane strain and axi-symmetric idealizations – Mohr circle in 2D and 3D – Airy's stress function – Potential function

UNIT – IV

Solution of 2D and 3D Elasticity Problems: Problem solving using stress function approach – Beam bending problems – Symmetric stress distribution problems – Plane problems
Torsion problems in elasticity – Membrane analogy approach – Application to non-circular thin walled sections

UNIT – V

Plasticity: Introduction to plasticity – Yield criteria for pressure dependent and independent materials – Tresca's criterion – Von Mises criterion – Mohr-Coulomb criterion – Rankine criterion – Flow rule – Associative and non-associative – Hardening rules and consistency conditions – Introduction to iterative and return mapping

REFERENCES:

1. Theory of Elasticity by Timoshenko, McGraw-Hill Publications
2. Theory of Elasticity by Y. C. Fung
3. Advanced Mechanics of Solids by L. S. Srinath
4. Elasticity and Plasticity for Structural Engineers by Wang & Chen

ELECTRONIC RESOURCES:

1. https://nptel.ac.in/courses/105106828
2. https://nptel.ac.in/courses/105105177
3. https://nptel.ac.in/courses/105106828

MATERIALS ONLINE:

1. Course template
2. Tutorial question bank
3. Definitions and terminology
4. Assignments
5. Model question paper – I
6. Model question paper – II
7. Lecture notes
8. E-Learning Readiness Videos (ELRV)