Applied Elasticity for Engineers * - Web course

COURSE OUTLINE

A course in Theory of Elasticity is a necessity for the postgraduate and senior undergraduate students in Civil, Mechanical and Aerospace engineering as well for engineers to understand the behaviour of elastic solids under given applied loads and also the limitations of the results given by the Elementary Mechanics of Materials.

The contents of the course provide the essential fundamental knowledge of the subject matter with compilation of solutions that are required in engineering practice and design.

In this web based lectures, the authors will develop the subject in detail and in stages in a student-friendly manner.

In particular, the large number of problems worked out and a variety of problems given as exercise at the end of each topic will help the students and engineers to gain a good insight into the subject.

Contents:

Introduction to the general theory of elasticity with assumptions and applications of linear elasticity.

Analysis of stress, stress tensors. Two-dimensional state of stress at a point, principal stresses in two dimensions, Cauchy's stress principle, direction cosines, stress components on an arbitrary plane with stress transformation.

Principal stresses in three dimensions, stress invariants, equilibrium equations, octahedral stresses, Mohr's stress circle, construction of Mohr Circle for two and three dimensional stress systems, equilibrium equations in polar coordinates for two-dimensional state of stresses.

General state of stress in three-Dimensions in cylindrical coordinate System.

Introduction to analysis of strain, types of strain, strain tensors, strain transformation. Principal strains, strain invariants, octahedral strains, Mohr's Circle for Strain, equations of Compatibility for Strain, strain rosettes.

Stress-strain relations, generalised Hooke's law, transformation of compatibility Condition from Strain components to stress components.Strain energy in an elastic body, St. Venant's principle, uniqueness theorem.

Two dimensional problems in Cartesian coordinate system, plane stress and plane strain problems.Stress function, stress function for plane stress and plane strain cases.

Solution of two-dimensional problems with different loading conditions by the use of polynomials.

Two dimensional problems in polar coordinate system, strain-displacement relations, compatibility equation, stress- strain relations, stress function and biharmonic equation.

Axisymmetric problems, thick-walled cylinders, rotating disks of uniform thickness, stress concentration, effect of circular holes on stress distribution in plates. Winkler's - Bach theory, stresses in closed rings.

Torsion of prismatic bars, general solution of the torsion problem, stress function, torsion of circular and elliptic cross sections.

NP-TEL

NPTEL

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Civil Engineering

Pre-requisites:

1. Strength of Materials / Mechanics of Materials.

Additional Reading:

1. Literature on Mechanics of Deformable Bodies.

Coordinators:

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Prandtl's membrane analogy, torsion of thin walled and multiple cell closed sections.

Introduction to elastic solutions in geomechanics. Solutions to the problems of Kelvin, Boussinesq, Flamant, Cerrutti, and Mindlin.

COURSE DETAIL

Sl. No.	Topic	No. of Hours
1	• Introduction to the general theory of elasticity, Assumptions and Applications of linear elasticity.	02
2	**Analysis of Stress :** • Stress tensors, two-dimensional state of stress at a point, principal stresses in two dimensions, Cauchy's stress principle, direction cosines, stress components on an arbitrary plane with stress transformation. • Principal stresses in three dimensions, stress invariants, equilibrium equations, octahedral stresses, Mohr's stress circle, construction of Mohr Circle for two and three dimensional stress systems, equilibrium equations in polar coordinates for two-dimensional state of stresses. • General state of stress in three-dimensions in cylindrical coordinate system. Numerical examples.	06
3	**Analysis of Strain :** • Types of strain, strain tensors, strain transformation. Principal strains, strain invariants, octahedral strains. • Mohr's Circle for Strain, equations of Compatibility for Strain, strain rosettes. Numerical examples.	06
4	**Stress-Strain Relations :** • Generalised Hooke's law, transformation of compatibility Condition from Strain components to stress components. • Strain energy in an elastic body, St. Venant's principle, uniqueness theorem.	06
5	**Two Dimensional Problems in Cartesian Coordinate System :** • Plane stress and plane strain problems. • Stress function, stress function for plane stress and plane strain cases. • Solution of two-dimensional problems with different loading conditions by the use of polynomials. Numerical examples.	06

6	**Two Dimensional Problems in Polar Coordinate System :** • Strain-displacement relations, compatibility equation, stress- strain relations, stress function and biharmonic equation. • Axisymmetric problems, thick-walled cylinders, rotating disks of uniform thickness, stress concentration, effect of circular holes on stress distribution in plates. • Winkler's - Bach theory, stresses in closed rings. Numerical examples.	07
7	**Torsion of Prismatic Bars :** • General solution of the torsion problem, stress function, torsion of circular and elliptic cross sections. • Prandtl's membrane analogy, torsion of thin walled and multiple cell closed sections. Numerical examples.	05
8	**Elastic Solutions in Geomechanics :** • Solutions to the problems of Kelvin, Boussinesq, Flamant, Cerrutti, and Mindlin.	02

References:

1. Y. C. Fung, "Foundations of Solid Mechanics", Prentice - Hall Publishers.
2. T.G. Sitharam and L.GovindaRaju, "Applied Elasticity", Interline Publishers, Bangalore.
3. S.P.Timoshenko and J.N. Goodier, "Theory of Elasticity", McGraw-Hill Book Company.
4. C.T. Wang, "Applied Elasticity", McGraw-Hill Book Company.