

Course No.	Course Name	L-T-P-Credits	Year of Introduction
ME202	ADVANCED MECHANICS OF SOLIDS	3-1-0-4	2016
Prerequisite: ME201 Mechanics of solids			
Course Objectives: <ol style="list-style-type: none"> 1. To impart concepts of stress and strain analyses in a solid. 2. To study the methodologies in theory of elasticity at a basic level. 3. To acquaint with the solution of advanced bending problems. 4. To get familiar with energy methods for solving structural mechanics problems. 			
Syllabus Introduction, concepts of stress, equations of equilibrium, strain components, strain-displacement relations, compatibility conditions, constitutive relations, boundary conditions, 2D problems in elasticity, Airy's stress function method, unsymmetrical bending of straight beams, bending of curved beams, shear center, energy methods in elasticity, torsion of non-circular solid shafts, torsion of thin walled tubes.			
Expected outcome: At the end of the course students will be able to <ol style="list-style-type: none"> 1. Apply concepts of stress and strain analyses in solids. 2. Use the procedures in theory of elasticity at a basic level. 3. Solve general bending problems. 4. Apply energy methods in structural mechanics problems. 			
Text Books: <ol style="list-style-type: none"> 1. L. S. Sreenath, Advanced Mechanics of Solids, McGraw Hill, 2008 2. S. Jose, Advanced Mechanics of Materials, Pentagon Educational Services, 2013 			
References Books: <ol style="list-style-type: none"> 1. S. P. Timoshenko, J. N. Goodier, Theory of elasticity, McGraw Hill, 1970 2. R.J. Atkin, and N. Fox, An introduction the theory of elasticity, Longman, 1980 3. J. P. Den Hartog, Advanced Strength of Materials, McGraw Hill, 1987 4. C. K. Wang, Applied Elasticity, McGraw Hill, 1983 5. S. M. A. Kazimi, Solid Mechanics, McGraw Hill, 2008 6. L. Govindaraju, TG Sitharaman, Applied elasticity for Engineers, NPTEL 7. U. Saravanan, Advanced Solid Mechanics, NPTEL 8. www.solidmechanics.org/contents.htm - Free web book on Applied Mechanics of Solids by A.F. Bower. 			

Course Plan			
Module	Contents	Hours	Sem. Exam Marks
I	Introduction to stress analysis in elastic solids - stress at a point – stress tensor – stress components in rectangular and polar coordinate systems - Cauchy's equations – stress transformation – principal stresses and planes - hydrostatic and deviatoric stress components, octahedral shear stress - equations of equilibrium	6	15%
	Displacement field – engineering strain - strain tensor (basics only) – analogy between stress and strain tensors - strain-displacement relations (small-strain only) – compatibility conditions	4	
II	Constitutive equations – generalized Hooke's law – equations for linear elastic isotropic solids - relation among elastic constants – Boundary conditions – St. Venant's principle for end effects – uniqueness theorem	4	15%
	2-D problems in elasticity - Plane stress and plane strain problems – stress compatibility equation - Airy's stress function and equation – polynomial method of solution – solution for bending of a cantilever with an end load	4	
FIRST INTERNAL EXAM			
III	Equations in polar coordinates (2D) – equilibrium equation, strain-displacement relations, conversion of Airy's equation and definition of stress function and stress components	3	15%
	Application of stress function to Lamé's problem - stress concentration problem of a small hole in a large plate.	3	
	Axisymmetric problems – governing equations – application to thick cylinders, interference fit and rotating discs.	4	
IV	Unsymmetrical bending of straight beams – curved beams (rectangular c/s) - shear center – shear stresses in thin walled open sections	6	15%
	Strain energy of deformation – special cases of a body subjected to concentrated loads, moment or torque - reciprocal relation – strain energy of a bar subjected to axial force, shear force, bending moment and torque	3	
SECOND INTERNAL EXAM			
V	Maxwell reciprocal theorem – Castigliano's first and second theorems – virtual work principle – minimum potential energy theorem - complementary energy theorem	5	20%
	Torsion of non-circular bars: Saint Venant's theory - solutions for circular and elliptical cross-sections	4	
VI	Prandtl's method - solutions for circular and elliptical cross-sections - membrane analogy - approximate solution methods for non-circular shafts	5	20%
	Torsion of thin walled tubes, thin rectangular sections, rolled sections and multiply connected sections	5	
END SEMESTER EXAM			

Question Paper Pattern

Total marks: 100, Time: 3 hrs

The question paper should consist of three parts

Part A

4 questions uniformly covering modules I and II. Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part B

4 questions uniformly covering modules III and IV. Each question carries 10 marks
Students will have to answer any three questions out of 4 (3X10 marks =30 marks)

Part C

6 questions uniformly covering modules V and VI. Each question carries 10 marks
Students will have to answer any four questions out of 6 (4X10 marks =40 marks)

Note: In all parts, each question can have a maximum of four sub questions, if needed.

