Course Plan

School: Engineering.
Department: Mechanical Engineering.
Course Code: ME501.
Course Structure: L-T-P-Cr-CH :: 3-1-0-4-4.
Course Name: Advanced Solid Mechanics.
Instructor: Dr. Sushen Kirtania, Asst. Professor, Department of Mechanical Engineering, Tezpur University, Phone: +91 3712 27 5857, Email: sushen@tezu.ac.in.

1. Abstract: After an introductory course on solid mechanics, an advanced course on this subject is essential for most engineers to acquire a good foundation in the mechanics of deformable solids. Methods of three dimensional (3D) stress and strain analysis will be extended to allow the student to obtain solutions using analytical and numerical methods. This course will provide examples of practical applications of solid mechanics analysis based on modern research techniques.

2. Objectives: The main objectives of this course are -

i. Understand the advanced concept of stress-strain behavior of materials and solution of 2D and 3D elasticity problems.
ii. Understand the axisymmetrically loaded members, advanced beam theory and energy methods.
iii. Possess the ability to apply the principles of solid mechanics to model and analyze of practical engineering structural problems.
iv. Be proficient in the use of commercial software packages for modeling and analyzing the structural problems.
v. To encourage student to do research in the field of advanced solids mechanics and materials by acquiring in-depth knowledge.

3. Prerequisites of the course: None.

4. Course outline: Analysis of stress, Analysis of strain, Stress-strain relations for linearly elastic solids, Axisymmetrically loaded members, Bending of the beams, Energy methods, Elastic stability and Torsion in the bar and thin-walled members.

5(a). Time-Plan:

Sl.	Topics	Contents	L	T
1.	Analysis of stress	State of stress at a point, Cauchy's stress formula, Principal stresses, Stress invariants, Octahedral stresses, Hydrostatic and deviatoric stresses, 3D Mohr's circle, Differential equations of equilibrium in rectangular and cylindrical coordinates.	8	2
2.	Analysis of strain	Principal strain, Strain invariants, Plane strain in rectangular and polar coordinates, Compatibility conditions.	6	1
3.	Stress-strain relations for linearly elastic solids	Generalized Hooke's law, Relations between the elastic constants, Plane stress and plane strain relation, Displacement equations of equilibrium (Lame's equations), Compatibility of elastic stress components.	5	1
4.	Axisymmetrically	Thick walled cylinders, Application of theories of failures,	6	1

	loaded members.	Composites tubes, Rotating disks.		
5.	Bending of beams	Bending of symmetrical and unsymmetrical straight beams, Shear stresses in beams, Shear center, Shear stresses in the thin-walled open section, Shear flow, Analysis of curved beam.	5	2
6.	Energy methods	The principle of superposition, Elastic strain energy and complementary strain energy, Reciprocal relations, Maxwell-Betti theorem, Castigliano's theorem, Virtual work principle, Kirchoff's theorem.	5	1
7.	Elastic stability	Euler's buckling load, Beam column, Eigenvalue problem.	3	1
8.	Torsion	Torsion of circular, elliptical, equilateral triangular and rectangular bars; Torsion of thin-walled sections.	4	1
9.	Assignment and mini-project	Modeling and analysis of structural member using any commercial software package, present their work and the submission of report.	--	4

Total number of classes [(L(42)+T(14)] = 56

5(b). Evaluation plan:

Test No.	Marks	Duration (minutes)
Sessional Test I	20	45
Sessional Test II (Mid Semester Examination)	20	45
Sessional Test III (Assignment/Mini-project)	20	---
End Semester Examination	40	120 (2 hours)

6. Pedagogy: Lecture and discussion, Class tests, Tutorials, Mini-project.

7. Expected outcome: On completion of this course, students will be able to –

CO1: Understand the advanced concept of stress-strain relations and mechanics of deformable solids.
CO2: Critical thinking and critical judgment of assumptions adopted in solving structural problems
CO3: Establish links between theoretical and practical applications.
CO4: Identify, formulate, model, and analyze the complex engineering structural problems using commercial software packages.
CO5: Develop individual skills in solving problem, presentation and writing a technical report.
CO6: Pursue research in the field of advanced mechanics of materials and structures.

Textbooks:

1. Srinath LS. *Advanced Mechanics of Solids*, 3rd ed., Tata McGraw-Hill, New Delhi, 2015.
2. Boresi AP and Schmidt RJ. *Advanced Mechanics of Materials*, 6th ed., Wiley India, 2003.

References:

1. Ugural AC and Fenster SK. *Advanced Mechanics of Materials and Applied Elasticity*, 5th ed., Prentice Hall and Pearson Education, 2012.
2. Timoshenko SP and Goodier JN. *Theory of Elasticity*, 3rd ed., McGraw Hill Education India, 2010.
3. Budynas RG. *Advanced Strength and Applied Stress Analysis*, 2nd ed., McGraw-Hill, London. 1998.
4. Raymond P. *Solid Mechanics in Engineering*, 1st ed., John Willey & Sons, 2001.