Mechanics of Materials

L	T	P	C
3	0	2	4

Course Objectives:

- Introduce the concepts of different stresses, strains and their relationships.
- Discuss the principal stresses and components of stress on different planes under different loads.
- Explain maximum shear force and bending moment of different beams under different loading conditions.
- Demonstrate bending stress and shear stress distribution of various cross section of beams and to predict the maximum slope deflection of beams.
- Impart strain energy due to axial, bending, and torsion loading, and to solve statically indeterminate problems using Castigliano's theorem.
- Focus on the stresses and deformations of the springs.
- Familiarize the Euler's concept of buckling in columns & struts.

UNIT I:

10 Hours

Stresses and Strains: Types of stresses and strains, stress-strain relations, stress-strain diagram for ductile and other materials, axial loaded bars of uniform and varying cross section, compound bars, relation between three elastic moduli, thermal stresses.

Principal stresses and strains: Biaxial state of stress with and without shear - Mohr's Circle and analytical methods.

Learning outcomes:

After completing this unit, the student will be able to

- Determine stresses and deformations due to axial loads in simple members. (L3)
- Analyze stresses compound bars due to temperature raise. (L4)
- Correlate the elastic constants of materials.(L3)
- Construct the Mohr's circle for calculating principal stresses.(L3)
- Analyze principal stresses in biaxial state of loading. (L4)

UNIT II:

10 Hours

Analysis of Beams: Types of beams and loads, shear force and bending moment diagram for cantilever, simply supported and overhanging beams for different types of loadings, point of contra flexure, relation between shearing force and bending moment.

Deflection of Beams: Differential equations of the deflection curve, Slope and deflection: using double integration method, Macaulay's method and Moment area method for simply supported, cantilever and overhanging beams.

Learning outcomes:

After completing this unit, the student will be able to

- Draw shear force and bending moment diagrams in beams subject to bending loading.(L3)
- Determine bending stresses in beams under different loading. (L4)
- Evaluate the maximum shear force and bending moment and their location in beams. (L4)
- Demonstrate the shear stress and bending moment distribution in different cross sections of beams.(L4)

UNIT III: **8 Hours**

Bending Stresses: Flexural equation, bending stress distribution and efficiency of various cross sections of beams. **Shear Stresses**: Shear stress distribution for different cross sections of beams.

Energy Methods: Strain energy, resilience. Deflection under single and several loads, Castigliano's theorem.

Learning outcomes:

After completing this unit, the student will be able to

- Compute the slope and deflection in beam under different loading.(L3)
- Distinguish various approaches for calculating slope and deflection. (L4)
- Explain the difference between strain energy, resilience, elastic strain energy and modulus of toughness. (L2)
- Apply the Castigliano's theorem for beams. (L3)

UNIT IV: **8 Hours**

Torsion of Circular Shafts: Theory of pure torsion, transmission of power in solid and hollow circular shafts, comparison of strengths of solid and hollow shafts, shafts in series and parallel, combined bending and torsion.

Springs: Deflection of closed and open coil helical springs under axial force and axial couple, Leaf springs.

Learning outcomes:

After completing this unit, the student will be able to

- Analyze circular shafts subjected to twisting couple. (L4)
- Determine stresses in shafts subjected to combined loads.(L4)
- Determine angle of twist in shafts. (L4)
- Determine stresses and deformations in helical and leaf springs. (L5)

UNIT V: **8 Hours**

Buckling of Columns: Analysis of columns to evaluate buckling loads with different boundary conditions, Euler's formula and its limitations, Rankine's formula, columns under eccentric load, columns under initial curvature.

Thin Cylinders: hoop and stresses, longitudinal, cylindrical and spherical shells subjected to internal pressure calculation of volumetric strain.

Learning outcomes:

After completing this unit, the student will be able to

- Determine buckling load in compressive members. (L4)
- Apply concepts of elastic stability of columns. (L3)
- Assess hoop and longitudinal stresses in thin cylinders. (L3)
- Calculate volumetric strain. (L3)

Text Books:

1. F.P. Beer, E.R. Johnston, Jr&John.T. DeWolf, Mechanics of Materials, 7/e, Tata McGraw-Hill, 2016.
2. SS Rattan, Strength of materials, 3/e, Tata McGraw-Hill, 2016.

References:

1. Timoshenko, Strength of Materials Part – I& II, 3/e, CBS Publishers, 2004.
2. Popov, Mechanics of Solids, 2/e, New Pearson Education, 2015.

Course Outcomes:

After successful completion of this course student will be able to

- Apply the concepts of stress and strain to machine numbers. (L3)
- Determine, shear forces, and bending moments in beams. (L4)
- Find the slope and deflection in beams.(L4)
- Estimate the stress in machine members such as shafts and springs.(L4)
- ApplyCastigliano's theorem to determine displacements in beams. (L3)
- Analyze columns for buckling loads.(L4)
- Estimate the stresses in thin cylinders due to internal pressure.(L3)