STRENGTH OF MATERIALS

Course Code:	**L**	**T**	**P**	**C**
	3	0	0	3

Prerequisites: Engineering Mechanics, Mathematics.

Course Outcomes:

At the end of the course the student will be able to:

CO1: Analyse statistically determinate beams for shear force and bending moment and draw stress distribution (L4)

CO2: Apply Energy theorem, Double integration and Macaulay's methods for Simple Beams and calculate the deflections (L3)

CO3: Analyse principal stresses and strains using theories of failure (L3)

CO4: Estimate pure torsion and power transmitted by shaft under different loading conditions and calculate crushing load of various columns with different end conditions (L3)

CO5: Analyse the stresses and strains developed in thin and thick cylinders (L3)

UNIT-I **(10 Lectures)**

SHEAR FORCE AND BENDING MOMENT:

Definition of beam- Types of beams based on support conditions, concept of shear force and bending moment - S.F and B.M diagrams for cantilever, simply supported and overhanging beams subjected to point loads, UDL, UVL-point of contra flexure - Relation between SF, B.M and rate of loading on a beam

SHEAR STRESSES AND FLEXURAL STRESSES:

Derivation of formula – Shear stress distribution across various beam sections like rectangular, circular, triangular, I, T angle sections. Theory of simple bending – Assumptions – Derivation of bending equations, Determination of bending stresses for various beam sections.

Learning outcomes:

At the end of the unit, the student will be able to

1. analyse the determinate beams for shear force and bending moment diagrams for cantilevers, simply supported beams and Overhanging beams with different loads (L4)
2. explain the relationship between shear force and bending moments (L2)
3. derive bending and shear stress equation (L3)
4. calculate the flexural and shear stresses for different cross sections (L3)

UNIT-II **(10 Lectures)**

DEFLECTION OF BEAMS:

Conjugate beam method, Double integration and Macaulay's methods for determination of slope and deflection for cantilever and simply supported beams subjected to point loads, UDL, UVL - Moment area method – application to simple cases.

ENERGY THEOREMS:

Introduction – Strain energy in linear elastic system, expression of Strain Energy due to axial load, BM and SF., determination of deflections of simple beams using Castigliano's theorem.

Learning outcomes:
At the end of the unit, the student will be able to

1. compute slopes and deflections of beams with different boundary conditions (L3)
2. discuss effect of different loads on propped cantilever beams (L2)
3. determine the slopes & deflection using Castigliano's theorem (L3)

UNIT-III **(10 Lectures)**

PRINCIPAL STRESSES:

Introduction – Stresses on an inclined section of a bar under axial loading – compound stresses – Normal and tangential stresses on an inclined plane for biaxial stresses – Two perpendicular normal stresses accompanied by a state of simple shear – Mohr's circle of stresses– Principal stresses – Analytical and graphical solutions.

THEORIES OF FAILURES: Introduction –Various Theories of failures like Maximum Principal Stress theory – Maximum Principal Strain theory – Maximum shear stress theory – Maximum strain energy theory – Maximum shear strain energy theory, Vonmises theory including yield criteria.

Learning outcomes:
At the end of the unit, the student will be able to

1. identify critical planes in two dimensional stress systems (L3)
2. estimate principal stresses (L3)
3. assess safety of structural elements using different theories of failure (L3)

UNIT-IV **(10 Lectures)**

TORSION OF CIRCULAR SHAFTS:

Theory of pure torsion – Derivation of Torsional Rigidity equation – Assumptions made in the theory of pure torsion – Torsional moment of resistance – Polar section modulus – Power transmitted by shafts – Combined bending and torsion and end thrust

COLUMNS AND STRUTS:

Introduction – Types of columns – Axially loaded compression members – Crushing load – Euler's theorem for long columns assumptions- derivation of Euler's critical load formulae for various end conditions – Equivalent length of a column – slenderness ratio – Euler's critical stress – Limitations of Euler's theory – Rankine – Gordon formula – Secant formula Stresses under the combined action of direct loading and B.M, core of a column section

Learning outcomes:
At the end of the unit, the student will be able to

1. analyze members subjected to torsion, combined torsion and bending moment (L3)
2. calculate power transmission through shafts (L3)
3. compute load carrying capacity using different formulae (L3)

UNIT-V **(10 Lectures)**

THIN AND THICK CYLINDERS:

Thin seamless cylindrical shells – derivation of longitudinal and hoop stresses – volumetric strains and circumferential strain. Introduction to thick cylinders - derivation of Lame's formulae – design of thick cylinders – compound cylinders.

Learning outcomes:

At the end of the unit, the student will be able to

1. differentiate between thin and thick cylinders (L2)
2. calculate stresses and strains for thin and thick cylinders (L3)
3. design of thick cylinders (L3)

Text Books:

1. R.K.Bansal, "Introduction to text book of Strength of Materials", 4th Edition, Laxmi Publications Pvt. Ltd., New Delhi, 2008.
2. R.C. Hibbler- "Mechanics of Materials", 10th Edition, Pearson Publications, 2017.

References:

1. Ferdinand Beer and Johnston, "Mechanics of Solids", 6th Edition, Tata Mc Graw Hill Publications,2000.
2. Schaum'sout line series, "Strength of Materials", 10th Edition, Mc Graw Hill International Editions, 2007.
3. R. Subramanian, "Strength of Materials", 1st Edition, Oxford university press, New Delhi, 2011.
4. S.S. Bhavi Katti, "Strength of Materials", 5th Edition, S Chand And Company Ltd., 2021.
5. Timoshenko & Young, "Strength of Materials", 4th Edition, Tata Mc Graw Hill, 2003.
6. Sadhu Singh, "Strength of Materials", 2nd Edition, Khanna Publications, 2001.
7. Egor P.Popov –" Mechanics of Materials", 2nd Edition, Pearson Publications.
8. Timoshenko & Gere "Mechanics of Materials", 4th Edition, Mc Graw Hill,2003.
9. S. Ramamrutham and R.Narayanan "Strength of Materials", 11th Edition, Dhanpat Rai Publications, 2009.
10. Timoshenko & Amp; Gere "Mechanics of Materials", 4th Edition, Mc Graw Hill, 2003.

Web References:

1. https://nptel.ac.in/courses/105/105/105105108/
2. https://nptel.ac.in/courses/105/106/105106172/