Strength of Material

Course Objectives:

The purpose of the course is to provide the students for basic knowledge in material behavior, stress-strain relations and their analysis. During the course, students will review on mechanics first and obtain knowledge in stress-strain relations, their types. At the end students will have basic concept on theory of flexure and column buckling.

1. Axial Forces, Shearing Forces and Bending Moments (8 hours)
    a. Plotting shearing force, bending moment and axial force diagrams for determinate structures (beams and frames)
    b. Concept of superposition for shear forces, bending moments and axial forces due to various combinations of loads
    c. Maximum shear force and bending moments and their positions
    d. Relationship between loads, shear forces, bending moment

2. Geometrical Properties of Sections (7 hours)
    a. Axes of symmetry
    b. Centre of gravity of built-up plane figures
    c. Centre of gravity of built-up standard steel sections
    d. Moment of inertia of standard and built-up sections
    e. Polar moment of inertia
    f. Radius of gyration
    g. Product of inertia
    h. Principle moment and principle axes of inertia
    i. Moher's circle for moment of inertia

3. Simple Stress and Strain (8 hours)
    a. Definitions: deformable Bodies, internal forces, stress, strain
    b. Analysis of Internal forces
    c. Simple stress and strain
    d. Hook's law: axial and typical stress strain diagram for characteristics of mild steel
    e. Poisson's ratio
    f. Stress-strain diagram
    g. Axial stress and strain
    h. Shear stress and strain
    i. Shear deformation and shear angle
    j. Hook's law for shearing deformations
    k. Allowable stresses and factor of safety
    l. Stress concentrations
    m. Relationships between elastic constants

4. Stress and Strain Analysis (6 hours)
    a. Stresses in inclined plane: normal and shear stress
    b. Principle stresses and principle planes
    c. Relationships between normal and shear stress
    d. Maximum shear stress and corresponding plane
    e. Mohr's circle for stress

5. Thin Walled Vessels (3 hours)
    a. Definition and characteristics of thin walled vessels
    b. Types of stresses in thin walled vessels
    c. Calculation of stresses in thin walled vessels

6. Torsion (4 hours)
    a. Introduction and assumptions
    b. Derivation of torsion formulas
    c. Torsional moments in shaft
    d. Torsional stress in shaft
    e. Angle of twist

7. Theory of Flexure (5 hours)
    a. Coplanar and pure bending
    b. Elastic curve
    c. Angle of rotation
    d. Radius of curvature, flexural stiffness
    e. Small deflection theory
    f. Bending stress
    g. Flexural formula, differential equation of deflected shape
    h. Introduction to deflection

8. Column Theory (4 hours)
    a. Theory of columns according to support systems
    b. Critical load
    c. Long column by Euler's formula
    d. Limitations of Euler's formula
    e. Intermediate columns; empirical formulas

Practical:
1. Stress-Strain Curve in tension
2. Torsion test to determine modules of rigidity
3. Column behavior due to buckling
4. Deflection of simple beam

Tutorials:
1. 8 tutorials, 2 mini projects

References:

1. Timoshenko and Gere 'Mechanics of Materials",
2. Beer F.P. and E.R. Johnston "Mechanics of Material",
3. E.P. Popov "Mechanics of Material", , 2nd Edition, New Delhi, Prentice Hall of India
4. A.Pytel, F.L. Singer 'Strength of Materials", 4th Edition, Harper Collins, India, 1998