

3.3 STRUCTURAL MECHANICS

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RATIONALE

This is a basic engineering subject. The purpose of the subject is to impart basic knowledge and skill regarding properties of materials, concept of stresses and strains, bending moment and shear force diagrams, second moment of area, bending and shear stresses, slope and deflection and analysis of trusses. The above knowledge will be useful for designing simple structural components. This subject is very important to develop basic concepts and principles related to strength of materials. This subject will also enable the students to continue their further education.

COURSE OUTCOMES

After undergoing the subject, the students will be able to:

- CO1: Conduct different tests on mild steel
- CO2: Analyse and explain stress-strain diagram of mild and HYSD steel
- CO3: Calculate various forces used in design of structures
- CO4: Calculate shear force, bending moment for simply supported, cantilever and overhanging beams with concentrated and uniformly distributed loads
- CO5: Calculate moment of inertia, second moments of inertia, radius of gyration, section modulus for L, T, channel and I sections
- CO6: Calculate the bending stresses, moment of resistance of simply supported beams

DETAILED CONTENTS

UNIT I

1. Properties of Materials

- 1.1 Classification of materials, elastic materials, plastic materials, ductile materials, brittle materials.
- 1.2 Introduction to tensile test, compressive test, impact test, fatigue test, torsion test on metals.

2. Simple Stresses and Strains

- 2.1 Concept of stress, normal and shear stresses,
- 2.2 Concept of strain and deformation, longitudinal and transverse strain, poisson's ratio, volumetric strain
- 2.3 Hooke's law, moduli of elasticity and rigidity, Bulk modulus of elasticity, relationship between the elastic constants.
- 2.4 Stresses and strains in bars subjected to tension and compression. Extension of uniform bar under its own weight, stress produced in compound bars due to axial load (two or three bars)
- 2.5 Stress-strain diagram for mild steel and HYSD steel, mechanical properties, factor of safety.
- 2.6 Temperature stresses and strains

UNIT II**3. Shear Force and Bending Moment**

- 3.1 Concept of a beam and supports (Hinges, Roller and Fixed), types of beams: simply supported, cantilever, propped, over hang, cantilever and continuous beams (only concept).
- 3.2 Types of loads (dead load, live load, snow load, wind load seismic load as per IS Codes etc.) and types of loading (point, uniformly distributed and uniformly varying loads)
- 3.3 Concept of bending moment and shear force, sign conventions
- 3.4 Bending Moment and shear force diagrams for cantilever and simply supported subjected to concentrated, uniformly distributed
- 3.5 Relationship between load, shear force and bending moment, point of maximum bending moment, and point of contraflexure.

UNIT III**4. Moment of Inertia**

Concept of moment of inertia and second moment of area and radius of gyration, theorems of parallel and perpendicular axis, second moment of area of common geometrical sections: rectangle, triangle, circle (without derivations). Second moment of area for L, T and I sections, section modulus.

UNIT IV**5. Bending Stresses in Beams**

- 5.1 Concept of pure/simple bending
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- 5.2 Assumptions made in the theory of simple bending, derivation and application of bending equation to circular cross-section, I section, T&L sections only
- 5.3 Moment of resistance
- 5.4 Calculations of bending stresses in simply supported beam
- 5.5 Concept of shear stresses in beams, shear stress (introduction only)

6. Slope and Deflection

Determination of slope and deflection using Moment Area Theorem for simply supported beam for pointed load and U.D.L numerical problems. (no derivation,)

UNIT V

7. Columns

- 7.1 Theory of columns
- 7.2 Problem solving using Euler's and Rankine Formula

8. Analysis of Trusses

- 8.1 Concept of a perfect, redundant, and deficient frames
- 8.2 Assumptions and analysis of trusses by:
 - a) Method of joints
 - b) Method of sections

PRACTICAL EXERCISES

- 1. Determination of yield stress, ultimate stress, percentage elongation and plot the stress strain diagram and compute the value of young's modulus on mild steel
- 2. Testing of HYSD Steel
- 3. Determination of Young's modulus of elasticity for steel wire with sear's apparatus
- 4. Determination of modulus of rupture of a concrete beam
- 5. Determination of maximum deflection and young's modulus of elasticity in simply supported beam with load at middle third point
- 6. Verification of forces in a framed structure

RECOMMENDED BOOKS

- 1. S Ramamrutham, "Strength of Materials", Dhanpat Rai and Sons, New Delhi.
- 2. Ram Chandra, "Applied Mechanics and Strength of Materials", Standard Publishers, Delhi.

3. BC Punmia, "Strength of Materials", Standard Publishers, Delhi.
4. Sadhu Singh, "Strengths of Materials", Standard Publishers, New Delhi.
5. Birinder Singh, "Structural Mechanics", Kaption Publishers, Ludhiana.
6. e-books/e-tools/relevant software to be used as recommended by AICTE/HSBTE/NITTTR.

SUGGESTED WEBSITES

1. <http://swayam.gov.in>

INSTRUCTIONAL STRATEGY

Teachers are expected to give simple exercises involving the applications of various concepts and principles being taught in the subject. Efforts should be made to prepare tutorial sheets on various topics and students should be encouraged/guided to solve tutorial sheets independently. In the practical works, individual students should be given opportunities to do practical work, make observations and draw conclusions. Teachers should also conduct viva examination in which stress should be given on the understanding of basic concepts and principles. This subject contains five units of equal weightage.