STRUCTURE I

ENCE 208

Lecture : 3 **Year : II**
Tutorial : 1 **Part : I**
Practical : 0

Course Objectives:
The objective of this course is to build the basic understanding of students on material behavior, stress-strain relations, flexure and analysis of determinate and indeterminate structures. After completing this course, students will be able to develop competency on material behavior and analyze structural members under different loading conditions.

1 Material Behavior under Loading (10 hours)

1.1 Basics of strength of materials and structures
1.2 Characteristics and objectives of structural design (Strength, stiffness, stability and economy)
1.3 Concept of internal force and deformation
1.4 Stresses and strains and their types
1.5 Material behavior under axial loading (Stress-strain diagram for mild steel, yield stress, proportional limit, elastic limit, strain hardening, ultimate stress/strength, ductility, toughness, elastic and inelastic strains)
1.6 Concept of factor of safety and allowable/permissible stress
1.7 Hooke's law, Young's modulus of elasticity, modulus of rigidity and bulk modulus of elasticity
1.8 Lateral strains and Poisson's ratio
1.9 Elongation of bars under axial loadings: Uniform and varying cross-sections, tapered sections, compound and composite bars (Determinate problems)
1.10 Thermal stress and strain in simple, compound and composite bars (Determinate problems)
1.11 Concept of multi-axial loading and generalized Hooke's law
1.12 Relationships between elastic constants

2 Theory of Flexure (3 hours)

2.1 Concept of bending/flexure
2.2 Coplanar and pure bending
2.3 Derivation of bending equation
2.4 Analysis of beams for rectangular sections

3 Column Theory (2 hours)

3.1 Buckling and stability of columns
3.2 Classification based on slenderness ratio
3.3 Effect of support conditions and effective length
3.4 Buckling/crippling load formulae for different end conditions

4 Analysis of Determinate Structures (15 hours)

4.1 Real work and virtual work
4.2 Virtual work (Unit load) method to determine slope and deflection in simple beams, portal frames and simple trusses
4.3 Moment area methods: Application to cantilever and simply supported beams
4.4 Analysis of arch: Determination of horizontal thrust, axial thrust, radial shear and bending moment in three hinged circular and parabolic arches

5 Analysis of Indeterminate Structures (15 hours)

5.1 Redundant/indeterminate structures
5.2 Static and kinematic indeterminacies
5.3 Force method: Propped cantilever and fixed end beams
5.4 Slope-deflection methods: Fixed end moments due to transverse loads, fixed end moments due to support rotation and settlements, basic slope deflection equations, analysis of simple indeterminate beams and frames

Tutorial (15 hours)

1. Problems on stresses and strains
2. Design of simple rectangular beam sections under flexure
3. Problems on buckling/crippling loads for different end conditions
4. Analysis of determinate structures
5. Analysis of Indeterminate structures

Final Exam

The questions will cover all the chapters in the syllabus. The evaluation scheme will be as indicated in the table below:

Chapter	Hours	Mark distribution*
1	10	12
2	3	4
4	2	4
5	15	20
6	15	20
Total	**45**	**60**

* There may be minor deviation in marks distribution.

Reference

1. Beer F.P. and Johnston E.R. (2015). Mechanics of Material. Tata McGraw Hill.
2. Gere J.M., Timoshenko S.P. (2002). Mechanics of Materials (5th edition). Nelson Thornes.
3. Rajput R.K. (2018). A Textbook of Strength of Materials (7th edition). S. Chand and Company Limited
4. Vavikatti S.S. (2013). Strength of Materials (4th edition). New Delhi: Vikas Publishing House.
5. Popov, E.P. (1976). Introduction to Mechanics of Solids. India: Prentice-Hall.
6. Pytel A., Singer F.L. (1998). Strength of Materials (4th edition). India: Harper Collins.
7. Hibbeler R.C. (2004). Statics and Mechanics of Materials (SI edition). Prentice-Hall.
8. Motra G.B. (2021). A text book of strength of materials (2nd edition). Kathmandu: Heritage Publishers & Distributors.
9. Garrison, P. (2005). Basic Structures for Engineers and Architects. United Kingdom: Wiley.
10. Meta S.A. and Ichinose T. (2009). Understanding Structures: An Introduction to Structural Analysis. CRC Press.
11. McKenzie, W.M., Zhang, B. (2022). Examples in Structural Analysis. United States: CRC Press.