Approval: 9th Senate Meeting

Course Number: CE 301

Course Name: Strength of Materials and Structures

Credits: 3-0-2-4

Prerequisites: IC 240 - Mechanics of Rigid Bodies

Intended for: UG

Distribution: Discipline Core

Semester: Odd/Even

Preamble: The subject of "Structural Analysis" constitutes a major facet of civil engineering curriculum. It encompasses the study of conventional theories and methods developed on their basis to facilitate the determination of force distribution, reactions and deflections in structural systems. The present course has been designed to provide an introduction to the fundamental concepts of structural analysis for determinate structures. It concludes by providing a short description to the analysis of indeterminate structures.

The lab exercises are supplementary to the theory. It provides the student with an opportunity to practically record the nature of structural responses in relation to various loading conditions and cross sectional properties. A comparison of observations with theoretical results helps in recognizing the strengths and limitations of analysis approaches.

Course Outline: The course focuses on the basic techniques of structural analysis for beams and frames. The contents have been developed to include the fundamentals of material performance and topics of force and deflection analysis with a special emphasis on the case of determinate structures. A chapter on the slope-deflection method of analysis has been incorporated in the end to provide an introduction to the domain of indeterminate structural analysis that would lead to other advanced topics pertaining to the area.

The list of experiments has been designed to cover basic structural analysis problems. It is intended to facilitate set of exercises for each experiment using standard models and the rest using computer simulation.

Modules:

Types of structures: Free body diagram, conditions of equilibrium, statically determinate and indeterminate trusses, beams and frames. **(2 contact hours)**

Mechanics of small deformation: Concepts of stress and strain, stress-strain characteristics of ductile and brittle materials, elastic constants and their relationships, thermal stresses. **(12 contact hours)**

1. Members subjected to flexural loads: Shear force and bending moment in determinate beams. Calculation of deflection by double integration, moment-area and unit load methods.

(12 contact hours)

Columns: Euler's theory, Critical load for different end conditions, eccentric loading, columns with small initial curvature. **(4 contact hours)**

Influence lines for statically determinate structures: Moving loads on beams and trusses; Maximum shear force and bending moment due to moving loads. **(3 contact hours)**

Analysis of indeterminate structures by slope-deflection method: Statically indeterminate beams subjected to loads and uneven settlement of supports, Analysis of rigid frames with and without side sway. **(9 contact hours)**

List of experiments:

1. Study of reactions in beams with different support conditions.
2. Study of variation of bending moment and shearing force in a beam subjected to various loading conditions.
3. Study of load-deflection characteristics of determinate and indeterminate trusses.
4. Study of load-deflection characteristics of rectangular portal frames with uniform and non-uniform sections.
5. Study of stress and strains in the members of pin jointed frames.
6. Study of plastic bending of portal frames.
7. Load-deflection study of pinned and fixed arches.
8. Study of buckling characteristics of struts.
9. Study of horizontal and vertical deflections of asymmetric sections at various angles and loads.
10. Study of behavior of circular section under torsion.

Text Books:

a) C. T. F. Ross, J. Case and L. Chivler, 'Strength of Materials and Structures, 4th edition', Butterworth Heinemann, UK, 1999.
b) C.S.Reddy, ‘Basic Structural Analysis’, Tata McGraw Hill, New Delhi, 2001.
c) C.K. Wang, ‘Intermediate Structural Analysis’, Tata McGraw Hill, New Delhi, 2010.
d) R.C. Hibbeler, 'Structural Analysis', Pearson Education, 6th edition', New Delhi, 2008.
e) C.H. Norris, J.B. Wilbur, S.Utku, 'Elementary Structural Analysis', Tata McGraw Hill, New Delhi, 1991.
f) L. S. Negi and R. S. Jangjid, 'Structural Analysis', Tata Mc. Graw, New Delhi, 1997.

Reference Books:

a) B. Onouye and K. Kane, 'Statics and strength of materials for architecture and building construction, 4th edition', Prentice Hall, USA, 2013.
b) G. Ranzi and I.B. Raymond, ‘Structural analysis: principles, methods and modelling’, CRC press, FL, 2014.
c) A. Williams, ‘Structural analysis: in theory and practice’, Butterworth-Heinemann, UK and USA, 2009.
d) T.H.G. Megson, ‘Structural and stress analysis’, Butterworth-Heinemann, UK and USA, 2014.