



GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering

Subject Code: 3174024

Semester – VII

Subject Name: Computer Aided Structural Design

Type of course: Professional Elective Course

Prerequisite: Mechanics of Solids, Fundamental Structural Analysis, Advance Structural Analysis

Rationale: Computer Aided Structural Design subject provides conceptual understanding of analysis of structures with matrix methods and its applications for development of program/ tools/ software. The course provides an excellent grounding in the fundamentals of structural engineering subjects. It also engages in a comprehensive study of computer science subjects such as programming, databases, graphics, visualization, etc. This is an innovative course focused on the combination of recent advances made in the field of structural engineering and computer science. It also provides the students a clear understanding of the structural response and help for preparing their own programs for analysis of skeletal structures or to learn how that is done.

Teaching and Examination Scheme:

Teaching Scheme			Credits C	Examination Marks				Total Marks
L	T	P		Theory Marks		Practical Marks		
				ESE (E)	PA (M)	ESE (V)	PA (I)	
3	0	2	4	70	30	30	20	150

Content:

Sr. No.	Content	Total Hrs
1	Introduction: Principles of Virtual work, Basic concepts of flexibility and stiffness. Types of skeletal structures, Internal forces, and deformations. Introduction and applications of flexibility method and stiffness method to analyze beams, Trusses, and plane frames.	5
2	Matrix concepts and Matrix analysis of structures: Matrix; vector; basic matrix operations; rank; solution of linear simultaneous equations; eigenvalues and eigenvectors. Coordinate systems; displacement and force transformation matrices, Contra- gradient principle; element and structure stiffness matrices. Element and structure flexibility matrices; equivalent joint loads; Stiffness and flexibility approaches.	5
3	Stiffness Member Approach: Analysis of Continuous beam, Plane truss, Plane frame and Composite structures including secondary effects such as Temperature variations, Pre-strains, and Restrained displacement; Programming direct stiffness method.	18
4	Special Problems: Member discontinuities, Non-prismatic members, curved members, beams on elastic supports, semi-rigid connections, effect of shear deformations by stiffness method, Sub-structure analysis and symmetry concepts.	4
5	Programming: Analysis of structures using C++ Application: Excel spread sheets for the design of (1) Reinforced Concrete members like slabs, beams, columns, isolated, footings etc. (2) Steel members like Beam/Girders, Compression & Tension members, Connections etc.	6



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6	Software Usage: Modeling (Skeletal members, Joints, Material specification, Loadings), analysis (Forces, Deflection, Stability, Displacement, stresses) and design of frame structure using tools/software.	4
Total		42

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
10	15	25	25	15	10

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Books:

1. Weaver W. and Gere J. M., "Matrix Analysis of Framed Structure", CBS Publishers, Delhi.
2. Ghali and Nevelle, "Structural Analysis", Spon Press, London.
3. Aslam Kassimali, "Matrix Analysis of Structures", Cengage Learning, USA.
4. H. Kardestuncer, "Elementary matrix analysis of structures", Mc-Graw Hill, USA.
5. Meghre and Deshmukh, "Matrix Analysis of Structures", Charotar Publication, Anand.
6. Beaufait Rowan, "Computer Methods of Structural Analysis", Hadley and Heckett.
7. Graves Smith, "Linear Analysis of Frame works", Ellis Horwood Ltd.
8. Fleming J.F, "Computer Analysis of Structural Systems", McGraw-Hill Education.
9. McGuire, Gallagher and Ziemian, "Matrix Structural Analysis", John Wiley & Sons, Inc. 2000.
10. Devdas Menon, "Advanced Structural Analysis", Narosa Publishing House, 2009.
11. Devdas Menon, "Structural Analysis", Narosa Publishing House, 2008.
12. Amin Ghali, Adam M Neville and Tom G Brown, "Structural Analysis: A Unified Classical and Matrix Approach", Sixth Edition, 2007, Chapman & Hall.
13. E. Balaguruswamy, "Programming in C++".
14. Herbert Schildt, "Teach yourself C++".
15. Robert Lafore, "Object Oriented programming in Turbo C++".
16. Voisinet, "Introduction to Computer Aided Drafting".
17. Syal & Gupta, "Computer programming and engineering analysis".

Course Outcomes: After studying this subject, students will be able to

Sr. No.	CO statement	Marks % weightage
CO-1	Gain basic knowledge of structural systems and application of concepts of flexibility and stiffness matrices for simple elements.	20
CO-2	Understand stiffness matrices to solve problems in beams, frames and trusses.	30
CO-3	Gain knowledge of direct stiffness method to solve problems in beams, frames and trusses and solving problems involving temperature changes and lack of fit.	30
CO-4	Develop computer programs for structure design & structural elements. Use software tool for analysis and design.	20



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Software based Experiments/Tutorials:

- Analysis of beams with stiffness member approach
- Analysis of trusses with stiffness member approach
- Analysis of frames with stiffness member approach

Open Ended Problems:

- A group of students has to model and analyze one frame structure using open-source/ professional software and design of members on the basis of analysis output and cross check it with software design.
- Development of computer program for design of structure elements such as beam, Column, slab, footingetc.

List of Open-Source Software/learning website:

<http://nptel.ac.in/>

<http://ocw.mit.edu/courses/civil-and-environmental-engineering/>

www.mastan2.com/ www.scilab.org/