GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Master of Engineering

Level: PG

Branch: Civil (Structural Engineering)

Course / Subject Code : ME01000041

Course / Subject Name : Advanced Analysis of Structures

w. e. f. Academic Year:	2024-25
Semester:	1st Semester
Category of the Course:	PCC

Prerequisite:	Mechanics of Solids, Structural Analysis and Matrix Algebra
Rationale:	In the present era of computerization, it has become necessary to be acquainted with the analysis of the structures into systemic form that is valid for all types of structures and can be programmed for a digital computer. Direct stiffness method provides a comprehensive approach to the analysis of different structural systems and therefore offers a major advantage over many traditional methods. Direct stiffness methods are suitable for computer programming. Many structural problems involve complicated geometries, loadings and material properties for which mathematical solution involves ordinary or partial differential equations. Finite element method is such a versatile numerical method that can be used to solve any complex problem of structural mechanics. In light of above, the course on Advanced Analysis of Structures provides the students a clear understanding of determining structural response of skeletal & continuum structure using matrix method, finite element method and computer software.

Course Outcome:

After Completion of the Course, Student will able to:

No.	Course Outcomes
01	Analyze skeleton structures using computer oriented direct stiffness method,
02	Analyze skeleton structures having secondary effects using computer oriented direct stiffness method,
03	Derive element properties and analyze structure using finite element method,
04	Solve realistic engineering problems through computational simulations using direct stiffness method and finite element method.

Teaching and Examination Scheme:

Teaching Scheme(in Hours)			Total Credits L+T+ (PR/2)	Assessment Pattern and Marks				Total Marks
				Theory		Tutorial / Practical		
L	T	PR	C	ESE (E)	PA / CA (M)	PA/CA (I)	ESE (V)	
3	0	2	4	70	30	20	30	150

Course Content:

Unit No.	Content	No. of Hours	% of Weightage
1.	**Computer Oriented Direct Stiffness Method**		
	Formulation of Direct Stiffness Method, Rotation of axes in 2D and 3D, Analysis of Continuous Beam, Plane Truss, Plane Frame, Plane Grid including effects of Temperature changes, Prestrains and Support Displacements.	15	35
2.	**Finite Element Method**		
	Basic steps of FEM, Principles of discretization, Element stiffness matrix formulation based on direct, variational and weighted residual techniques	05	8
	Computations of element properties for bar elements, beam elements, truss elements, constant strain triangle and quadrilateral elements using generalized coordinates.	10	24
	Computations of element properties for bar elements, beam elements, truss elements, constant strain triangle and quadrilateral elements using natural coordinates (Isoparametric formulation). Gauss Quadrature of numerical integration.	12	26
	Axisymmetric elements	03	7
	Total	**45**	**100**

Suggested Specification Table with Marks (Theory):

Distribution of Theory Marks					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
10	**20**	**30**	**30**	**10**	**00**

Where R: Remember; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create (as per Revised Bloom's Taxonomy)

References/Suggested Learning Resources:

(a) Books:

1. Matrix Analysis of Framed Structure - Weaver W. and Gere J. M., CBS Publishers, Delhi.
2. Structural Analysis - Ghali & Nevelle, Spon Press, London.
3. Matrix Analysis of Structures - Aslam Kassimali, Cengage Learning, USA.
4. Elementary Matrix Analysis of Structures - H. Kardestuncer, Mc-Graw Hill, USA.
5. Matrix Analysis of Structures - Meghre & Deshmukh, Charotar Publication, Anand.
6. Computer Methods of Structural Analysis - Beaufait, Rowan, Hadley and Heckett
7. Linear Analysis of Frame works - Graves Smith
8. Computer Analysis of Structural Systems - Fleming J.F
9. A First Course in the Finite Element Method - D. L. Logan
10. Introduction to Finite Elements in Engineering - Chandrupatla, R.T. & Belegundu, A.D
11. Finite Element Analysis - S. S. Bhavikatti
12. Finite Element Method in Engineering - S.S.Rao
13. Finite Elements Methods - C.S.Krishnamurthy
14. Finite Element Method - Y. M. Desai, T. I. Eltho and A. H. Shah
15. Matrix Structural Analysis - McGuire, Gallagher, and Ziemian, John Wiley & Sons, Inc.
16. Finite Elements Procedures in Engineering analysis - Bathe, Wilson
17. Finite Element for Structural Analysis - Weaver & Johnston
18. The Finite Element Methods - Zienkiewicz
19. Finite Element Programming - Hinton & Owen

(b) Open source software and website:

https://ndl.iitkgp.ac.in/
https://nptel.ac.in/
www.mastan2.com/
www.scilab.org/
https://forum.code-aster.org/public/
https://www.calculix.de
https://www.openfoam.org
https://www.freecad.org/

Suggested Course Practical List:

Practical work shall consist of solution of at least five problems from each topic out of which at least half of problems shall be checked by use of professional / open source software.

List of Laboratory/Learning Resources Required:

Professional Software: STAAD-Pro, SAP2000, ETABS, ABACUS, ANSYS

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