

GUJARAT TECHNOLOGICAL UNIVERSITY

CIVIL (STRUCTURAL ENGINEERING) (20)

FINITE ELEMENT METHOD IN STRUCTURAL ENGINEERING

SUBJECT CODE: 2722001

SEMESTER: II

Type of course: Core

Prerequisite: Mechanics of Solids, Matrix Methods of Structural Analysis and Structural Analysis

Rationale: There are many structural problems involving complicated geometries, loadings, and material properties for which it is generally not possible to obtain analytical mathematical solutions. Because of the complicated geometries, loadings, and material properties, analytical solutions generally require the solution of ordinary or partial differential equations, which are not usually obtainable. Hence, the structural engineers need to rely on numerical methods, such as the finite element method, finite difference method, boundary element method etc., for acceptable solutions. Among these numerical methods, finite element method is such a widely accepted method that can be systematically programmed to accommodate complex and difficult problems.

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)			
					ESE	OEP	PA	RP		
3	2#	0	4	70	30	30	0	10	10	150

Content:

Sr. No.	Content	Total Hrs	% Weightage
1	Introduction: Principles of discretization, Element stiffness mass formulation based on direct, variational and weighted residual techniques	05	7
2	Finite element displacement approach: Shape functions convergence criteria, Computation of element properties, plane stress, plane strain Problems	04	8
3	Computations of element properties: bar elements, beam elements, truss elements, constant strain triangle, linear strain triangle and quadrilateral elements using generalized coordinates	08	20
4	Axisymmetric solids	03	10
5	Numerical Integration Gauss Quadrature Technique	02	05
6	Computations of element properties: bar elements, beam elements, truss elements, constant strain triangle and quadrilateral elements using natural coordinates; Iso-parametric formulation	08	15

7	Analysis of plate bending problems	05	10
8	Dynamic analysis: Free vibration analysis of truss bars with two D.O.F.- considering lumped mass and consistent mass formulations. Flexural vibration of beam elements	05	10
9	Pre-processors for FEA modelling. FEA software packages and Applications.	04	10
10	Solid element: Tetrahedral element	03	5

Reference Books:

1. Finite Elements Procedures in Engineering analysis - Bathe, Wilson
2. Finite Element for Structural Analysis - Weaver & Johnston
3. The Finite Element Methods - Zienkiewicz
4. Introduction to Finite Elements in Engineering - Chandrupatla, R.T. & Belegundu, A.D
5. Finite Element Programming - Hinton & Owen
6. Finite Elements Methods - C.S.Krishnamurthy
7. A First Course in the Finite Element Method – D. L. Logan
8. Finite Element Method – Y. M. Desai, T. I. Eltho and A. H. Shah

Course Outcome:

After learning the course the students should be able to:

- (a) derive element properties and analyse structure using finite element method,
- (b) solve realistic engineering problems through computational simulations using finite element code,
- (c) develop computer program for structural analysis using finite element technique.

List of Open Source Software/learning website:

<http://www.code-aster.org/forum2/> (For open source FEA program *Code_Aster*)

<http://www.calculix.de> (For open source FEA program *Calculix*)

<http://www.openfoam.org> (For open source FEA program *OpenFOAM*)

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

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

Review Presentation (RP): The concerned faculty member shall provide the list of peer reviewed Journals and Tier-I and Tier-II Conferences relating to the subject (or relating to the area of thesis for seminar) to the students in the beginning of the semester. The same list will be uploaded on GTU website during the first two weeks of the start of the semester. Every student or a group of students shall critically study 2 papers, integrate the details and make presentation in the last two weeks of the semester. The GTU marks entry portal will allow entry of marks only after uploading of the best 3 presentations. A unique id number will be generated only after uploading the presentations. Thereafter the entry of marks will be allowed. The best 3 presentations of each college will be uploaded on GTU website

