

GUJARAT TECHNOLOGICAL UNIVERSITY

CIVIL (GEOTECHNICAL ENGINEERING) (43) FINITE ELEMENT METHODS IN GEOTECHNICAL ENGINEERING SUBJECT CODE: 2724301 SEMESTER: II

Type of course: Core

Pre-requisites: 1. Numerical Methods in Civil Engineering. 2. Theoretical Soil Mechanics and Foundation Engg

Rationale: Finite element methods is now used in many field of engineering practice and is now very widely used for analysing geotechnical problems. Using FEM many complex and specific geotechnical issues can be resolved. The understanding of assumptions and approximations in FEA, to describe constitutive models related to soil behaviour either in linear or non-linear form including elastic and elasto-plastic models, modeling various flow problems, deformations, soil parameters for various geotechnical applications are the basic aims of this subject. The course on *Finite Element Methods in Geotechnical Engg* provides the students necessary skills to model various geotechnical problems viz. standard laboratory & field tests, analysis of tunnels, earth retaining structures, cut slopes, embankments and foundations using software's PLAXIS, ANSYS etc.

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#	2	5	70	30	20	10	10	10	150

Content:

Sr. No.	Topics	Total hours	Module Weightage
1	Concepts of FDM, limitations of FDM, introduction to FEM, Steps involved in Finite Element Analysis Procedure, Merits and Demerits. Principles of Elasticity: Equations of equilibrium and compatibility, stress-strain relations, plane stress and plane strain and axi-symmetric problems	08	05
2	Element Properties: Concept of an element, various element shapes, Displacement models, Generalized coordinates, Shape functions, Convergent and Compatibility requirements, Geometric invariance, Natural coordinate system - area and volume coordinates.	07	10
3	Generation of Element Stiffness and Nodal Load Matrices, Isoparametric Formulation: Concept, Different isoparametric elements for 2D analysis, formulation of 4-noded and 8-noded isoparametric quadrilateral elements,	08	20

	Lagrangian elements, Serendipity elements.		
4	Assemblage of Elements: Discretization of a structure, numbering systems, Aspect ratio its effects, Assemblage, Direct Stiffness method.	06	15
5	Techniques of nonlinear analysis, constitutive modeling for soils, determination of soil parameters for such analysis. Applications related to Geotechnical problems such as study of embankment dams (total stress consideration, pore pressure), problem of strip footing, excavations, stress distribution around opening.	07	20
6	Application of FEM/Modelling of problems using FEM based software's like PLAXIS, ANSYS, etc. to solve various geotechnical problems.	07	15

Reference Books:

1. Krishnamoorthy, C. K., "Finite element analysis theory and programming, Tata McGraw Hill Publishing Cop., 1987.
2. Desai C. S. And Abel, J. F., Introduction to finite element method, Affiliated East-West Press Pub. Ltd.
3. Gauri Dhatt an Gilbert, Tauzot, The Finite Element Method Displayed, John Wiley & Sons.
4. Bathe, Wilson -Finite Elements Procedures in Engineering analysis
5. Chandrupatla, R.T. & Belegundu, A.D -. Introduction to Finite Elements in Engineering
6. Hinton & Owen - Finite Element Programming
7. David M Potts and Lidija Zdravkovic, 'Finite Element analysis in Geotechnical engineering – Theory', Thomas Telford, 1999.

Course Outcome:

After learning the course the students should be able to:

- The course provides good background to basics of finite difference and finite element methods of analysis.
- The course would help in application of FEM for performance evaluation of various geotechnical engineering problems, which involves complex geometry and loading conditions.
- The course would also provide insight into various FEM based software's, which can be utilized for simulation of various geotechnical engineering problems.
- The course will also provide an understanding of various nonlinear analysis techniques including constitutive modeling for soil, which will be useful to evaluate the response of soil to various loading conditions.

List of Experiments/Tutorials:

FEA for various linear and non-linear materials, constitutive models, tunnels, earth retaining structures, shallow foundations, embankments. Maximum no of problems may be equal to 5-7.

Open Ended Problems:

Apart from above tutorials/experiments a group of students has to undertake one open ended problem/modelling problem based on any one applications of geotechnical engineering using any one software. Few examples of the same are given below:

1. Modelling soil parameters based on stress analysis.
2. Modelling elastic constitutive models – linear and non-linear.
3. Modelling Non-linear materials – Mohr-Coulomb soil.
4. FEM for seepage and consolidation problems.

List of Open Source Software/learning website:

<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