



GUJARAT TECHNOLOGICAL UNIVERSITY

Master of Engineering

Subject Code 37243114

Semester – II

Subject Name: Computational Geomechanics

Type of course: PE-III

Prerequisite: Knowledge of Theoretical Soil Mechanics, Numerical Methods in Civil Engineering.

Rationale: Computational Geomechanics is specialized subject dealing with numerical modelling, constitutive modelling, continuum and discrete modelling of various geotechnical problems in lieu with soil and rock behaviour. Solutions of linear and non-linear equations using numerical approach and FDM approach are quite useful for many complex geotechnical issues. The course on Computational Geomechanics provides the students necessary skills to model various geotechnical problems viz. standard laboratory & field tests, analysis of tunnels, modelling flow problems, soil-structure interaction, earth retaining structures, cut slopes, embankments and foundations using numerical and theoretical approach.

Teaching and Examination Scheme:

Teaching Scheme			Credits	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	Solution of Non-linear Equations: Bisection, False Position, Newton-Raphson, Successive approximation method, Iterative methods	05
2	Solution of Linear Equations: Jacobi's method, Gauss Seidal method, Successive over relaxation method.	07
3	Finite Difference Method: Two point Boundary value problems – Disichlet conditions, Neumann conditions; ordinary and partial differential equations.	08
4	Discrete modelling: discrete versus continuum modelling , introduction to discrete element method (DEM), DEM solution procedure, contact model and detect algorithms	07
5	One-dimensional (1D) plasticity: Plasticity theory basics, 1D frictional models, initial boundary value problems, integration algorithm, FEM solution	06
6	Classical plasticity and soil behaviour: General framework of classical plasticity, elastic models; and plastic models; Tresca, Huber-von Mises, Mohr-Coulomb, Drucker-Prager, Lade-Duncan, Cam clay, soil behaviour and its relation to constitutive models.	05
7	Numerical solutions: General procedure, examples : 1D consolidation, triaxial test, embankments, foundation, Flow Through Porous Media	04

Reference Books:

1. S. Chandrakant., Desai and John T. Christian, “Numerical Methods in Geotechnical Engineering”, Mc. Graw Hill Book Company, 1977.



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2. M.K. Jain, S.R.K. Iyengar and R.K. Jain, "Numerical Methods for Scientific and Engineering computations", Third edition, New Age International (P) Ltd. Publishers, New Delhi.
3. Bowels, J.E., "Analytical and Computer methods in Foundation" McGraw Hill Book Co., New York.
4. C.O'Sullivan, "Particulate Discrete Element Modelling", A Geomechanics Perspective, Spon Press, 2011
5. S.Helwany, Applied Soil Mechanics with ABAQUS Applications, John Wiley & Sons, 2007

Course Outcomes: Students will be able to

Sr. No.	CO statement	Marks % weightage
CO-1	Distinguish between different types of linear and non-linear solutions and its particular relevance	15
CO-2	Distinguish between different types of constitutive models and identify appropriate model according to soil type and loading conditions	20
CO-3	Select the correct integration algorithm for a specific constitutive model	10
CO-4	Understand basic concepts and models for discrete modelling, numerical procedures and interpret results in the geotechnical engg context	35
CO-5	Conduct computer simulations to solve geotechnical engg problems using FDM, FEM and other numerical solutions.	20

List of Experiments/Tutorials:

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

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 and elasto-plastic constitutive models – linear and non-linear.
3. Modelling Non-linear materials – Mohr-Coulomb soil, Huber-von Mises, etc
4. FEM for seepage and consolidation problems.
5. Use of software's for soil-structure interaction problems.

List of Open Source Software/learning website:

1. <http://nptel.ac.in/>
2. <http://ocw.mit.edu/courses/civil-and-environmental-engineering/>