GUJARAT TECHNOLOGICAL UNIVERSITY

Bachelor of Engineering
Subject Code: 3170620
Subject Name: Computational Geotechnics
Semester – VII

Type of course: Program Elective

Prerequisite: Knowledge of Geotechnical Engineering, Engineering Mathematics, Mechanics of Solids

Rationale: Computational Geotechnics is specialized subject dealing with numerical modeling, constitutive modeling, continuum and discrete modeling of various geotechnical problems in lieu with soil and rock behavior. 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 Geotechnics provides the students necessary skills to model various geotechnical problems viz. standard laboratory & field tests, analysis of tunnels, modeling flow problems, soil-structure interaction, earth retaining structures, cut slopes, embankments and foundations using numerical approach.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	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 Linear &Non-linear Equations: Jacobi's method, Gauss Seidal method, Successive over relaxation method. Bisection, False Position, Newton-Raphson, Successive approximation method, Iterative methods	12
2	Finite Difference Method: Two point Boundary value problems – Disichlet conditions, Neumann conditions; ordinary and partial differential equations.	08
3	Discrete modeling: discrete versus continuum modeling, introduction to discrete element method (DEM), DEM solution procedure, contact model and detect algorithms	07
4	Classical plasticity and soil behavior: One-dimensional (1D) plasticity theory basics, 1D frictional models, initial boundary value problems, integration algorithm, General framework of classical plasticity, elastic models and plastic models: Tresca, Huber-von Mises, Mohr-Coulomb, Drucker-Prager, Lade-Duncan, Cam clay, soil behavior and its relation to constitutive models, FEM solutions	11
5	Numerical solutions: General procedure, examples : 1D consolidation, Tri-axial 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.

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 Modeling", 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	Explain basic concepts and models for discrete modelling, numerical procedures and interpret results in the geotechnical engineering context	35
CO-5	Conduct computer simulations to solve geotechnical engineering 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/modeling problem based on any one applications of geotechnical engineering using any one software. Few examples of the same are given below:

1. Modeling soil parameters based on stress analysis.
2. Modeling elastic and elasto-plastic constitutive models – linear and non-linear.
3. Modeling Non-linear materials – Mohr-Coulomb soil, Huber-Von Mises, etc
4. FEM for seepage and consolidation problems.
5. Use of software 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/