University of Macau

Undergraduate Civil Engineering Programme

Coordinating Unit:	Department of Civil and Environmental Engineering, Faculty of Science and Technology		
Supporting Unit(s):	Nil		
Course Code:	CIVL456	Year of Study:	4
Course Title:	Application of Numerical Methods in Geotechnical Engineering		
Compulsory/Elective:	Elective		
Course Prerequisites:	CIVL 351, CIVL 352		
Prerequisite Knowledge:	Basic knowledge of soil mechanics; A good understanding of soil properties and behavior;		
Duration:	One semester	Credit Units:	3
Class/Laboratory Schedule:	Two hours of lecture and two hours of laboratory per week.		
Laboratory/Software Usage:	GeoStudio, especially SIGMA/W and SEEP/W modules, is introduced to students to solve geotechnical problems		
Course Description:	This course introduces students the application of numerical methods in geotechnical engineering. Basic background of the finite element (FE) and finite difference (FD) methods are briefly introduced with emphasis on geotechnical applications. A finite element commercial program (GeoStudio) is introduced to students to analyze geotechnical problems, especially using Sigma/W for stress and displacement modeling and Seep/W for seepage analysis. The course includes the following topics: Geotechnical analysis; Finite Element Theory for Linear Materials; Modeling of Shallow Foundations; Geotechnical Considerations; Finite Difference Method, Modeling of Construction and Excavations; Modeling of Seepage.		
Course Objectives:	1. To introduce students basic knowledge of numerical modeling and their applications in geotechnical engineering. 2. To prepare students for the effective use of GeoStudio in the analysis of geotechnical problems. 3. To develop students the ability to apply numerical methods to solve geotechnical problems and understand the limitations.		
Learning Outcomes (LO):	Upon completion of this course, students should be able to: 1. understand the basic concept of finite element method as a numerical modeling technique in geotechnical engineering [POs: a] 2. apply fundamentals of soil behavior and numerical method to solve geotechnical problems and understand the limitations [POs: a,e] 3. utilize commercial finite element software (GeoStudio) to develop finite element model and simulate real geotechnical problems and interpret modeling results. [POs: c,e,l]		
Texts & References:	1. David M Potts and Lidija Zdravkovic. (1999). “Finite Element Analysis in Geotechnical Engineering – Theory”, Thomas Telford Publishing Ltd., U.K. 2. David Muir Wood. (2004). “Geotechnical Modelling”, Spon Press, London. 3. Geo-Slope (2007). www.geo-slope.com		
Student Assessment:	• Assignments: 20% • Laboratory: 30% • Midterm: 20% • Final examination: 30%		
Learning Outcome	• Midterm and final examinations		

Assessment:	• Assignments • Laboratory • Course evaluation
Pedagogical Methods:	☑ Lecture ☐ Guest speakers ☐ Case study ☐ Role playing ☐ Student presentation ☐ Project ☐ Simulation game ☑ Exercises and problems ☐ Service learning ☐ Internship ☐ Field study ☐ Company visits ☐ e-learning ☑ Independent study ☐ Others: _____

Major Assessment Methods: For each Major Assessment Method below, please indicate the specific pedagogical methods involved (by putting a ✓ in the relevant box(es) on the right-hand side).	Case Study	Role Playing	Student Presentation	Individual project/paper	Group project/paper	Simulation Game	Exercises & problems	Service learning	Internship	Field Study	Company visits	Written examination	Oral examination	Others (please specify)
Class Participation/ Discussion (0%)														
Assignment(s) (20%)							✓							
Test(s) (20%)												✓		
Examination (30%)												✓		
Others *(please specify)* Laboratory report (30 %)				✓										
Course Web: (if any)	Course materials are available in UMMoodle (http://webcourse.umac.mo/).													

Course Content: (topic outline)

Week no.	Topics	Assignment no.	LO no.
1	**Geotechnical Analysis** Design Objectives; Design Requirements; Theoretical Considerations; Methods of Analysis	1	1
2	**Introduction of Geoslope** Geo-slope installation; Getting Started	--	3
3	**Finite Element Theory for Linear Materials** Overview; Element Discretisation; Displacement Approximation; Element Equations; Global Equations; Boundary Conditions; Solution of Global Equations; Calculation of Stresses and Strains; Example; Axi-Symmetric Finite Element Analysis	--	2
4,5	**Modeling of Shallow Foundations** Shallow Foundation Types; FE Analysis of Surface Foundations; FE Model and Meshing; Flexible Footing; Rigid Footing	2	2,3
6,7	**Geotechnical Considerations** Total Stress Analysis; Pore Pressure Calculation; Finite Elements to Model Structural Components; Finite Elements to Model Interfaces; Boundary Conditions	--	1~3
8,9	**Finite Difference Method** Overview; The principle of finite difference method; One-dimensional problems; Two-dimensional problems; The application of finite difference method in the geotechnical problems; Terzaghi one-dimensional consolidation.	--	2
10-12	**Modeling of Construction and Excavation** General guidelines for meshing, Use of infinite element, Stress conditions in a 45-degree slope, Embankment construction, Excavation with a horizontal strut	3	2,3
12-14	**Modeling of Seepage** Seepage analysis using SEEP/W Analyze unconfined flow through an earth dam	4	2,3

Percentage Content of:	

Math	Basic Science	Engineering Science	Engineering Design and Synthesis	Complementary Studies	Computer Studies	Total
10	---	40	---	---	50	100

Timetabled work in hours per week:

Lecture	Tutorial	Laboratory	Other		Total
2	2	---	---		4

Contribution to Program Outcomes:

Program Outcomes	Contribution to POs# 5 ----------> 1 Significant Least				
	5	4	3	2	1
(a) apply knowledge of mathematics, science, and engineering		✓			
(b) design and conduct experiments, and analyze data					
(c) design components, systems or processes in presence of constraints		✓			
(d) Function in a multi-disciplinary team					
(e) Engineering problem solving	✓				
(f) Understand professional and ethical responsibility					
(g) Communicate effectively					
(h) Understand the impact of engineering solutions to the society					
(i) Recognize the need and have the ability for lifelong learning					
(j) Have knowledge of contemporary issues					
(k) Apply the skills, techniques, modern engineering tools					
(l) Use the computer/IT tools relevant to the discipline	✓				

 # Note 5: Significant contribution; 4: Supporting contribution; 3: Moderate contribution; 2: Marginal support; 1: Least support

Course Instructor(s): Dr. W.H. Zhou