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:	CIVL487	Year of Study:	4
Course Title:	Introduction to Soil Improvement		
Compulsory/Elective:	Elective		
Course Prerequisites:	CIVL 352 Soil Mechanics II		
Prerequisite Knowledge:	Shear Strength, Consolidation; Settlement		
Duration:	One semester	Credit Units:	3
Class/Laboratory Schedule:	Three hours of lecture per week		
Laboratory/Software Usage:	Laboratory session involving clay stabilization		
Course Description:	The course concerns with the stabilization of soil by mechanical, physical and chemical method, covering the topics of site investigation for soil improvement, stabilization by additives, surface compaction, deep densification, preloading and vertical drains, composite ground (stone column and soil nail), stabilization by geosynthetics		
Course Objectives:	1. To furnish the students with the site investigation technique applied to soil improvement 2. To introduce the various types of mechanical, physical and chemical methods to stabilize the problematic soil 3. To design a preloading and vertical drain stabilization for a highly compressible soils 4. To design composite ground and reinforced system		
Learning Outcomes (LO):	Upon completion of this course, students should be able to: 1. comprehend the knowledge of site investigation for soil improvement [POs: a, b, e] 2. conduct the experiments to obtain the properties of treated soil [POs: a, b, c, d] 3. design various types of stabilization method to improve the problematic soil [POs: e, j, k]		
Texts & References: *(* recommended textbook(s))*	1. Mitchell, J. K., "Soil improvement : state -of - the -art", Proceeding of 10th International Conference of Soil Mechanics and Foundation Engineering, Stockholm, Sweden, Vol. 4, 509 – 565, 1981. 2. Hausmann M. R., Engineering Principles of Ground Modification, by, McGraw Hill Publishing Co., 1990. 3. Mitchell, J. K., Fundamentals of Soil Behaviour, 2nd edition, John Wiley & Sons, New York, 1993. 4. Xanthakos, P. P., Abramson L. W. and Bruce D. A., Ground Control and Improvement, John Wiley & Sons, New York, 1994. 5. Bergado D T, Anderson L R, Miura N and Balasubramaniam A. S., Soft Ground Improvement in Lowland and Other Environments, ASCE Press, New York, 1996. 6. Mitchell J K and Gallagher P. M. Engineering and Design Guidelines on Ground Improvement for Structures and Facilities, Publication No. ETL 1110-1-185, US Army Corps of Engineers, Washington DC, 1999. 7. Mitchell J M and Jardine F. M., A Guide to Ground Treatment, CIRIA, London, 2002. 8. Das B. M., Principles of Geotechnical Engineering, Adapted International Student Edition, (6th ed.), Thomson, 2007.		

Student Assessment:	• Quiz, assignments, and reports: 30%; • One midterm: 20%; • One final examination: 50%
Learning Outcome Assessment:	• Quiz, midterm and final examination. • 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: Computer software Lab.

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%)														
Quiz/Assignment/Report (30%)	✓						✓							
Test(s) (20%)												✓		
Examination (50%)												✓		
Others *(please specify)* _____ (0 %)														
Course Web: (if any)	Course materials are available in UMMoodle (http://webcourse.umac.mo/).													

SYLLABUS

Topics	**Weeks**
INTRODUCTION -Need and objective of soil improvement -Fundamental soil behaviour relevant to soil improvement **LABORATORY AND IN SITU TEST** -Laboratory tests -In situ tests: SPT and CPT -Other in situ tests **SURFACE COMPACTION** -Principles -Properties of compacted soil -Control and specifications **ADMIXTURE STABILIZATION** -Principles -Reactions -Lime stabilization -Cement stabilization -Asphalt stabilization	1-5
DEEP DENSIFICATION -Dynamic compaction -Vibro-compaction -Blasting **HYDRAULIC MODIFICATION** -Preloading -Prefabricated vertical drains (PVD) -Design of PVD in soft soil -Electro-kinetic stabilization (optional) **IN SITU REINFORCEMENT** -Granular column -Soil nailing -Grouting -Design principles	6-9

MID TERM EXAMINATION	10
CASE STUDY -A case study about project of soil improvement **GEOSYNTHETICS** -Types -Properties -Applications: -Reinforced Soil Design	11-14

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) Apply 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):	Mr. I M WAN