Salahaddin University - Erbil
College of engineering - Civil Department

Module Name	Ground Improvement techniques			Code	1144
Course Status	Elective	Duration:	15 week – one semester	Credit point	5
Pre-requisites	Soil Mechanics		Total Work Load 135 hr	Class Attendence 60 hr	Self Studies 75 hr

Course Description	The soils at construction sites are not always totally suitable for supporting physical infrastructure such as buildings, bridges, highways, tunnels and dams. Under these conditions, soil needs to be treated using ground improvement techniques. The course addresses various ground improvement techniques along with principles, design issues and construction procedures. This is the course of ground improvement techniques for marginal and problematic soil. Various techniques for improving soil are used to: 1. Reduce the settlement of structures 2. Improve the shear strength of soil and thus increase the bearing capacity of shallow foundations 3. CIncrease the factor of safety against possible slope failure of embankments and earth dams 4. Reduce the shrinkage and swelling of soils.
Course Objectives	The objective of this course is to provide students with 1. Understand the principles, applications, and design procedures for various ground improvement techniques. 2. Use analytical/theoretical/numerical calculations to assess the effectiveness of a ground improvement technique. 3. Gain competence in properly evaluating alternative solutions, and the effectiveness before, during and after using ground improvement. 4. Application of physical and chemical ground improvement techniques using grouting, shotcrete technology.
Learning Outcome	Upon completion of this course, students should be able to: 1. Understand the principles, applications, and design procedures for various ground improvement techniques. 2. Use analytical/theoretical/numerical calculations to assess the effectiveness of a ground improvement technique. 3. Gain competence in properly evaluating alternative solutions, and the effectiveness before, during and after using ground improvement. 4. Application of physical and chemical ground improvement techniques using grouting, shotcrete technology.
Literature & text Books	1. Jie Han, Principles and Practice of Ground Improv, John Wiley & Sons, 2015. 2. Ni, P. (2023). Fundamentals of Ground Improvement Engineering: by Jeffrey Evans, 5. Daniel Ruffing, David Elton,

Type of Teaching	Theory Lectures	Tutorial	Practical
	3 hr	1 hr	0 hr

Evalution Profile

Students are required to do first midterm exam on 8 week, class room activities, quizzes, home works and final exam on week 15th. So that the final grade will be based upon the following criteria:

Course period efforts (out of 40%)	Midterm Exam (90 min written exam at week 8)	20 %
	Short exams (Quiz) at least 2 during the course period (one of them must befor week 8)	10 %
	assignments and home works at least 2 during the course period	6 %
	Class Room Activities, Reports and Seminars	4 %
	----------	----
Course period efforts (out of 60%)	Written exam (120 min written exam week 15)	60 %
	----------	----

Week	Course Outlines
one	1.1 Introduction -Course book 1.2 Problematic Geomaterials and Conditions 1.2.1 Problematic Geomaterials
Two	1.2.2 Problematic Conditions 1.4.2 Classification 1.4.3 General Description, Function, and Application
three	1.5 Selection of Ground Improvement Method 1.5.1 Necessity of Ground Improvement 1.5.2 Factors for Selecting Ground Improvement Method
Four	3. Shallow and Deep Compaction 3.1 Introduction 3.2 Densification Principles
Five	3.3 Conventional Compaction 3.3.1 Introduction to field compaction 1) smooth-wheel roller 2) Pneumatic rubber-tired rollers 3) Sheepsfoot rollers 4) Vibratory rollers
Six	3.3.2 Influence Factors - Hydraulic Barriers 3.3.2 Influence Depth 3.3.3 Design Considerations - Performance Requirements - Selection of Compaction Equipment - Optimum Moisture Content and Maximum Dry Unit Weight - Lift Thickness and Number of Passes - Borrow Volume
Seven	3.3.4 Design Parameters and Procedure - Design Procedure 34 - Field Tests to Be Performed on A Project Site 3.3.5 Design Example - Sub-Base Course (SORB / R6)
Eight	5.6 Vibroflotation 5.7 Blasting Midterm Exam
Nine	5.8 Precompression
ten	5.4 Sand Drains - Average Degree of Consolidation Due to Radial Drainage Only - Average Degree of Consolidation Due to Vertical Drainage Only
Eleven	5.10 Prefabricated Vertical Drains - Design of PVDs - A Case History 5.11 lime stabilization - Properties Of Cured Lime-Stabilized Soil - Lime Stabilization in The Field
Twelve	5.12 Cement stabilization5.13 Fly-ash stabilization 5.14 Stone Columns - Load-Bearing Capacity of Stone Columns
Thirteen	5.15 Sand Compaction Piles 5.16 Dynamic Compaction - Example
Fourteen	5.17 Jet Grouting - Single Rod System: 5.18 Deep mixing