

CE 437 – SOIL AND SITE IMPROVEMENT

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Prerequisites: No prerequisite required, but CE 230 Introduction to Geotechnical Engineering is preferred.

Course Text: Hausmann, M.R. (1990). *Engineering Principles of Ground Modification*, McGraw-Hill, NY.

Course Notes: Provided as PDF files or hard copies for each module

Course Objectives:

Owing to the increased need to utilize marginal sites, coupled with advanced knowledge on many weak soils, the last few decades have seen remarkable advances in soil and site improvement techniques. This course covers the principles, applications, and design procedures of some widely used soil improvement techniques. The specific objectives of the course are: to highlight the need for soil improvement techniques, to present the principles and analysis, and to provide an understanding of design procedures. Since soil improvement techniques are evolving continuously, in addition to the text, state-of-art lecture handouts of the different techniques will form an integral part of the course.

Homework Requirements:

1. All homework must be handed in on A4-sized papers or engineering grid papers. The pages should be numbered and stapled together.
2. Each problem should be clearly labeled and the solution should be presented in a logical manner. All solution steps should be included.
3. All homework will be due one week after the day it is assigned. Homework will be considered late if it is not received *at the beginning of the class* on the due date. Late Homework will be accepted up to a week after the due date for 50% of the grade. All homework, however, must be submitted before finals week to pass the course.

Test Policy:

There will be one mid-term exam and a *comprehensive* final.
Sorry, strictly no make up exams.

Midterm Exam

TBD, 8th Week, October 17–21, 2022

Final (comprehensive)

TBD, Final week, December 12–16, 2022

Special Project (*For graduate students only*):

In addition to the above requirements, graduate students who have registered must complete a technical research project. The topic of the project must be relevant to Soil and Site Improvement. The project report must have sufficient technical content for it to be published in a journal or a conference proceeding. The technical writing and style of the report must follow ASCE journal guidelines.

Students are advised to contact the instructor for suggestions on potential topics as soon as possible. The title and a proposed technical summary of the project with an associated bibliography should be submitted for approval by the 4th week. The final report is due on or before December 16, 2022.

Course Grading Policy:

The exam, project, and homework average will determine the final grade. No exception will be given. The final course average determines the letter grade. The final grading would be determined by the relative evaluation.

Grading:

Undergraduate

Quiz/Participation	10%
Homework	20%
Mid-term Exam	30%
Final Exam	40%

Graduate

Quiz/Participation	10%
Homework	15%
Mid-term Exam	25%
Final Exam	30%
Project	20%

STUDENTS WITH DISABILITIES: Reasonable accommodations are available for students with a documented disability. If you have a disability and may need accommodations to fully participate in this class, contact the instructor individually.

ACADEMIC INTEGRITY: Cheating or plagiarism in any form will not be tolerated. Cheating includes, but is not limited to, copying work or allowing your work to be copied. Plagiarism includes resubmitting previously graded homework or lab reports from a previous semester, even if they were your own work. All incidences of cheating will be reported to the Office of Student Affairs. The first incidence of cheating will result in an F for the course. A second incident of cheating will result in possible dismissal from the University.

HONOR CODE:

- This course will be conducted under the guidelines of KAIST academic Honor Code.
- Cheating of any kind is unethical and unacceptable.
- Do not cut and paste any part of your homework or lab reports. Quote and attribute any words that are not your own.
- Wireless communication systems of all kinds must be turned off while in the classroom.

Course Outline

FALL 2022

1. INTRODUCTION (1 week)

- General principles
- Review of soil mechanics
- Classification of ground modification techniques

Ref: Chapter 1, Handouts, Holtz and Kovacs (H&K)

2. MECHANICAL MODIFICATION (7 lectures – 3 weeks)

- Terminology
- Introduction to mechanical modifications
- Shallow compaction techniques
- Deep compaction techniques
- Compaction control tests

Ref: Chapters 2–6, Handouts, H&K (Chapter 5)

3. HYDRAULIC MODIFICATION (8 lectures – 5 weeks)

- Dewatering
- Hydraulics of slots and wells
- Design of dewatering systems
- Preloading and the use of vertical drains

Ref: Chapters 8–11, Handouts

4. MODIFICATION BY INCLUSIONS AND CONFINEMENT (6 lectures – 3 weeks)

- Terminology
- Earth pressure and bearing capacity theories
- Reinforced earth (geosynthesis, metal strips)
- Soil nails
- Micropiles

Ref: Chapters 16–21, Handouts

*Fall semester is total 16 weeks: two weeks for mid-term and final exams, two weeks for classroom symposium, and twelve weeks to cover class materials.

**The class will follow Education 4.0 structure. Thus, each week is structured with one 1.5h lecture class and one 1.5h discussion session.

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Weekly Schedule

FALL 2022

Week	Dates	Description	Lecture #
1	08/29-09/02	Introduction	1,2
2	09/05-09/09	Mechanical Modification (I)	3
3	09/12-09/16	Mechanical Modification (II)	4,5
4	09/19-09/23	Mechanical Modification (III)	6,7
5	09/26-09/30	Mechanical Modification (IV) <i>(Submission of outline and bibliography of the term project)</i>	8,9
6	10/03-10/07	Hydraulic Modification (I)	10,11
7	10/10-10/14	Hydraulic Modification (II)	12
8	10/17-10/21	<i>Mid-term Exam</i>	
9	10/24-10/28	Hydraulic Modification (III)	13,14
10	10/31-11/04	Hydraulic Modification (IV) – Preloading <i>(Progress report on the term project)</i>	15
11	11/07-11/11	Hydraulic Modification (V) – Preloading	16,17
12	11/14-11/18	Modification by Inclusions and Confinement (I)	18,19
13	11/21-11/25	Modification by Inclusions and Confinement (II)	20
14	11/28-12/02	Modification by Inclusions and Confinement (III)	
15	12/05-12/09	Class Symposium	
16	12/12-12/16	<i>Final Exam</i> (Comprehensive Exam / Final Report Deadline)	

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TECHNICAL PROJECT REPORT FORMAT

The main objective of the technical project is to apply the course content to a design problem or case history of your choice. The topic can involve a published case history or a design project. Please consult with instructor on the selection of your project topic as soon as possible. The topic should be finalized and submitted for approval by **September 28, 2022**.

A technical report summarizing your research methods and findings must be submitted. Use the following format to write the term paper:

- 1) Introduction (problem definition, motivation, terminology, earlier work with explicit emphasis of key contributions, plan of your study)
- 2) The main body (the model, technical details key results, significance, the crucial result)
- 3) Conclusions (summary, further research directions)

The report must be typed double spaced with 12 point font size. It may not exceed a total of 15 pages (including cover page, figures, tables, and references). The deadline for submission of the final report is **December 16, 2022**.

Some References:

Chu, J., Varaksin, S., Klotz, U., and Mengé, P. (2009), "Construction Processes", *Proceedings of the 17th International Conference on Soil Mechanics and Geotechnical Engineering* (doi: 10.3233/978-1-60750-031-5-3006).

Han, Jie (2015). Principles and practice of Ground Improvement, Wiley.

Warner, James (2004), *Practical Handbook of Grouting: Soil, Rock, and Structures*, Wiley (ISBN: 978-81-265-4178-2).

Kirsch, K. and Bell, A (Eds) (2013), Ground Improvement, 3rd Edition, CRC Press (ISBN: 978-0-415-59921-4).

Some Examples of Project Topics/Themes:

1. Clogging of geosynthetic filters and its consideration for design – Recent developments
2. Design of landfill liners using geosynthetics - Recent developments.
3. Design and construction of preloading on a soft clay deposit for airport or harbour construction
4. Design and practices of deep mixing – Recent developments and examples
5. Design and construction of chemical grouting – Materials, recent developments and examples
6. Anchors and Soil Nails – recent developments and design examples
7. Geosynthetic reinforced embankments on soft soils – recent developments and design examples.

Notes on Project:

1. Exams will include the materials covered in **all** these projects (i.e., reports, presentations and discussions)
2. Copies of the presentations and the report should be distributed to all the others taking this course
3. You should attend all the presentations and participate in the questions and discussion following the presentations. Marks may be allocated for this at the discretion of the Lecturer.
4. Wherever possible, project report and presentation should include **design examples** (including design calculations)

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GEOTECHNICAL ENGINEERING REVIEW

(SOIL MECHANICS REVIEW)

The following sections present a summary of some key geotechnical engineering concepts that are needed for CE481 course. Please refer to your CE230 (Soil Mechanics and Lab I) notes or the CE230 course text by Holtz and Kovacs, *An introduction to Geotechnical Engineering*, for additional information.

Tae-Hyuk Kwon