CV4111 Ground Engineering

Academic Year	2023-24	Semester	2
Course Coordinator			
Course Type	Major Prescribed Elective		
Pre-requisites	CV2014 Geotechnical Engineering		
AU	3		
Grading	Letter Grading		
Contact Hours	39 (26 hours Lecture & 13 hours Tutorial)		
Proposal Date	12 September 23		

Course Aims

Ground engineering, including ground improvement and slope stability, is commonly encountered in civil engineering projects. This course aims to acquaint you with the principles of engineering ground improvement and the methods of slope stability analysis and slope stabilization.

Intended Learning Outcomes (ILO)

By the end of this course, you (as a student) would be able to:

1. Explain the purpose and principles of ground improvement
2. Evaluate and select ground improvement methods
3. Understand the hydraulic properties and shear strength of saturated and unsaturated soil
4. Understand the principles of slope stability analyses incorporating unsaturated soil
5. Understand the mechanism and assessment of rainfall-induced slope failures
6. Understand monitoring and stabilization for slope protection against rainfall

Course Content

S/N	Topic	Lecture Hrs	Tutorial Hrs
1	Principles of ground improvement	1	1
2	Shallow surface compaction	2	1
3	Deep densification	2	1
4	Deep replacement	2	1
5	Preloading and vertical drains	2	1
6	Chemical stabilization	2	1
7	Soil reinforcement	2	1
8	Hydraulic properties and shear strength of saturated and unsaturated soil	3	1
9	Slope stability analyses using method of slices	2	1
10	Rainfall-induced slope failures: mechanism and assessment	2	1
11	Case studies of residual soil slopes	2	1

12	Slope monitoring and slope stabilization	2	1
13	Slope cover and drainage systems	2	1
	Total:	26	13

Assessment (Includes both continuous and summative assessment)

Component	ILO Tested	EAB Graduate Attributes	Weightage	Team / Individual	Rubrics
1. CA1: Quiz 1	1,2	(a), (b)	20%	Individual	N.A.
2. CA2: Quiz 2	3,4,5,6	(a), (b)	20%	Individual	N.A.
3. Final Examination		(a), (b)	60%	Individual	N.A.
Total			**100%**		

EAB Graduate Attributes[1]	
a)	**Engineering Knowledge** Apply the knowledge of mathematics, natural science, engineering fundamentals, and an engineering specialisation to the solution of complex engineering problems.
b)	**Problem Analysis** Identify, formulate, research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
c)	**Design / Development of Solutions** Design solutions for complex engineering problems and design systems, components or processes that meet the specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.
d)	**Investigation** Conduct investigations of complex problems using research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
e)	**Modern Tool Usage** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
f)	**The Engineer and Society** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
g)	**Environment and Sustainability** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for the sustainable development.
h)	**Ethics** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
i)	**Individual and Team Work**

[1] *Reference: EAB Accreditation Manual*

	Function effectively as an individual, and as a member or leader in diverse teams and in multidisciplinary settings.
j)	**Communication** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
k)	**Project Management and Finance** Demonstrate knowledge and understanding of the engineering management principles and economic decision-making, and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
l)	**Life-long Learning** Recognise the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Formative Feedback

1. Feedback will be through the dissemination of the student's performance in quizzes as well as review of the quiz questions in class.

2. We encourage you to initiate an individual consultation session, on your learning needs.

Learning & Teaching Approach

Approach	**How does this approach support students in achieving the learning outcomes?**
Lecture	Provide materials to you and guidance in scope for reading of texts and references
Tutorials	Reinforce materials covered in lectures and further explain concepts, process and design philosophy in ground engineering.
CA1 & CA2	Provide feedback to you on your understanding of the course

Readings & References

Texts

1. Jie Han. (2015). Principles and Practices of Ground Improvement, John Wiley.
2. CV4111 Course Notes.
3. Fredlund, D.G. and H. Rahardjo (1993) "Soil Mechanics for Unsaturated Soils". John Wiley & Sons, Inc., New York, 517 pages (ISBN 0-471-85008-X).

References

1. Kirsch, K. and Bell, A. (2013). Ground Improvement, 3rd Edition, CRC Press.

2. Bo, M.W., Chu, J., Low, B.K., and Choa, V. (2003). Soil Improvement: Prefabricated Vertical Drain Techniques, by Thomson Learning, Thomson Asia Pte Ltd.
3. Cornforth, D. (2005). Landslides in Practice: Investigation, Analysis, and Remedial/Preventive Options in Soils, John Wiley.
4. Fredlund, D.G., Rahardjo, H. and Fredlund, M.D. (2012). Unsaturated Soil Mechanics in Engineering Practice, John Wiley & Sons, Inc., New York. (ISBN 978-1-118-13359-0).
5. Rahardjo, H., Leong, E.C., Ortigao, J.A.R. and Rezaur, R.B. (2012) "Slopes", Chapter 7 in Handbook of Tropical Residual Soil Engineering, ed. B.B.K. Huat, D.G. Toll and A. Prasad, Taylor & Francis Group, Leiden, the Netherlands, pp. 213-282 (ISBN: 978-0-415-45731-6).

Course Policy & Student Responsibility

(1) General

Students are expected to complete all assigned pre-class readings and activities, attend all lessons punctually and take all scheduled assignments and tests by due dates. Students are expected to take responsibility to follow up with course notes, assignments, and course-related announcements that they have missed. Students are expected to participate in all discussions and activities.

(2) Absenteeism

The quizzes make up a significant portion of your course grade. Absence from quizzes without a valid reason will affect your overall course grade. Valid reasons include falling sick supported by a medical certificate and participation in NTU's approved activities supported by an excuse letter from the relevant bodies. There will be no make-up opportunities for quizzes.

If you miss a quiz, you must inform your course lecturer via email. Students who miss quizzes with valid reasons will have to apply for short term leave of absent through CEE Undergraduate Office supported with medical certificates or excuse letter from the relevant bodies.

Academic Integrity

This course encourages you to use AI tools to augment your learning but not for in-class coursework/assignments that are graded. AI tools may produce inaccuracies and introduce biases. Always check your facts from independent sources, and critically evaluate any AI-generated output.

Good academic work depends on honesty and ethical behaviour. The quality of your work as a student relies on adhering to the principles of academic integrity and to the NTU Honour Code, a set of values shared by the whole university community. Truth, Trust and Justice are at the core of NTU's shared values.

As a student, it is important that you recognise your responsibilities in understanding and applying the principles of academic integrity in all the work you do at NTU. Not knowing what is involved in maintaining academic integrity does not excuse academic dishonesty. You need to actively equip yourself with strategies to avoid all forms of academic dishonesty, including plagiarism, academic fraud, collusion and cheating. If you are uncertain about the definitions of any of these terms, you should refer to the Academic Integrity at NTU (sharepoint.com) for more information. Consult

your instructor(s) if you need any clarification about the requirements of academic integrity in the course.

Course Instructors

Instructor	Office	Phone	Email

Planned Weekly Schedule

Week	Topic	Course LO	Readings/ Activities
1	Overview and principles of ground improvement Shallow surface compaction	1, 2	Reading texts and references, Tutorial 1
2	Shallow surface compaction Deep densification	1, 2	Reading texts and references, Tutorial 2
3	Deep densification. Deep replacement	1, 2	Reading texts and references, Tutorial 3
4	Deep replacement. Preloading and vertical drains	1, 2	Reading texts and references, Tutorial 4
5	Preloading and vertical drains Chemical stabilization	1, 2	Reading texts and references, Tutorial 5
6	Chemical stabilization Soil reinforcement	1, 2	Reading texts and references, Tutorial 6
7	Soil reinforcement Hydraulic properties of saturated and unsaturated soil	1, 2 3	Reading texts and references, Tutorial 7
8	Shear strength of saturated and unsaturated soils	3	Reading texts and references, Tutorial 8
9	Slope stability analyses using method of slices	3, 4	Reading texts and references, Tutorial 9
10	Rainfall-induced slope failures: mechanism and assessment	3, 4, 5	Reading texts and references, Tutorial 10
11	Case studies of residual soil slopes	4, 5	Reading texts and references, Tutorial 11
12	Slope monitoring and slope stabilization	4, 5, 6	Reading texts and references, Tutorial 12
13	Slope cover and drainage systems	4, 5, 6	Reading texts and references, Tutorial 13