CV2014 GEOTECHNICAL ENGINERING

Academic Year	2023-24	**Semester**	2
Course Coordinator			
Course Type	Core		
Pre-requisites	CV2013 Engineering Geology and Soil Mechanics		
AU	3		
Grading	Letter Grading		
Contact Hours	39 (26 hours Lecture & 13 hours Tutorial)		
Proposal Date	14 September 2023		

Course Aims

This course aims to complete the fundamental principles of soil mechanics and extend your understanding of it to geotechnical engineering. It is the second series of three courses that will help you reinforce your understanding of soil mechanics principles and their applications to geotechnical design.

Intended Learning Outcomes (ILO)

1. Describe the stress-strain behavior of soil and use Mohr circle to analyze stresses acting on a soil element.
2. Determine the friction angle of soil and the typical soil behavior in direct shear tests.
3. Explain the purposes of triaxial tests and the need to have different types of tests and to determine the shear strength parameters (c' and ϕ') using triaxial CD or CU tests, and explain the "ϕ =0" concept for the undrained shear strength of saturated clays.
4. Identify the 3 types of lateral earth pressures: at-rest, active, and passive and determine the limiting lateral earth pressure for each type; determine the lateral stresses induced on a retaining wall, plot the earth pressure distribution behind a retaining wall and calculate the thrust.
5. Identify and explain the assumptions, limitations and applications of Rankine's and Coulomb's earth pressure theories.
6. Calculate the vertical stress distribution in soil under: 1) Point load; 2) Strip area carrying uniform pressure; and 3) Rectangular area carrying uniform pressure.
7. Identify and determine different types of slope failure and their mechanisms, such as: circular and non-circular rotational slips as well as translational slip and compound slip.
8. Calculate the factor of safety for fully saturated clay slopes under undrained conditions.
9. Describe the slope stability analyses based on method of slices (Fellenius, Bishop, Spencer) and their assumptions
10. Explain the fundamental principles of slope stabilization measures (buttress fills, retaining walls, soil nailing, horizontal drains, vegetative covers) to ensure the stability of the slopes
11. Study the limitations and applications of different instruments for slope monitoring with respect to deformations (inclinometers) and pore-water pressure changes (piezometers)

12. Explain the importance of compaction and soil improvement in earthwork construction and determine the suitability and applicability of different types of soil improvement (compaction, temporary surcharge fills, vertical drains, in-situ densifications, soil reinforcement).

Course Content

No	Topic	Lecture Hrs	Tutorial Hrs
1	Soil as a Continuum	3	2
2	Shear Strength of Soil	7	2
3	Lateral Earth Pressure	3	1
4	Elastic Stress Distribution	1	1
5	Slope Stability	6	2
6	Compaction	3	2
7	Soil Improvement	3	2
	Total:	26	12

Assessment (Includes both continuous and summative assessment)

Component	ILO Tested	EAB Graduate Attributes	Weightage	Team / Individual	Rubrics
1. CA1: Quiz 1	1, 2, 3, 4, 5, 6	a, b	20%	Individual	N.A.
2. CA2: Quiz 2	7, 8, 9, 10, 11, 12	a, b, d, g	20%	Individual	N.A.
3. Final Examination	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12	a, b, c, d, f, g	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**

[1] *Reference: EAB Accreditation Manual*

	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** 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 your performance in quizzes as well as review of the quiz questions in class.

2. Additional channel will be through individual consultation initiated by you on your particular learning needs.

Learning & Teaching Approach

Approach	How does this approach support students in achieving the learning outcomes?

Lectures	Formal lectures on topics which cover fundamental of soil mechanics and selected topics of geotechnical engineering. The lectures will focus on the fundamentals of shear strength of soil and the application of shear strength concept to practical problems such as lateral earth pressure on retaining walls, slope stability and soil improvements. The application of these concepts will be illustrated through analysis and problem solving.
Tutorials	Reinforces concepts of lectures with example problems. To promote peer discussion and group interaction in problem solving.

Readings & References

Text

Knappett, J.A. and Craig, R.F., *Craig's Soil Mechanics*, 8th edition, Spon Press, 2012.

References

Holtz, R.D. Kovacs, W.D. and Sheahan, T.C., *An Introduction to Geotechnical Engineering*, 2nd edition, Pearson, 2011.

Coduto, D.P., *"Geotechnical Engineering, Principles and Practices"*, Prentice Hall, N. J., 1999.

Course Policy & Student Responsibility

(1) General

Students are expected to attempt all assigned tutorials before the tutorial classes. Students are expected to take responsibility to follow up with lectures, course notes, and online materials. Students are expected to participate in all lectures, tutorials, quizzes and online exercises.

(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 and coordinator via email. Students who miss quizzes with valid reasons will have to provide the CEE Undergraduate Office with medical certificates or excuse letter from the relevant bodies.

Academic Integrity

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 Handbook for more information. Consult your instructor(s) if you need any clarification about the requirements of academic integrity in the course.

This course will adopt NTU's policy on the use of AI. Give proper citations if you use any AI tool. Extending the practice of correctly citing references in your work under NTU's policies on citation and plagiarism, the University requires students to (i) identify any generative AI tools used and (ii) declare how the tools are used in submitted work. Please note that even with acknowledgement, copying of output generated by AI tools (in part or whole) may still be regarded as plagiarism.

Course Instructors

Instructor	Office	Phone	Email

Planned Weekly Schedule

Week	Topic	Course LO	Readings/Activities
1	Review of Soil Mechanics	1	Tutorials and Lectures
2	Soil as a Continuum	1, 2	Tutorials and Lectures
3	Shear Strength of Soil 1	2, 3	Tutorials and Lectures
4	Shear Strength of Soil 2	2, 3	Tutorials and Lectures
5	Shear Strength of Soil 3 / Lateral Earth Pressure	3, 4	Tutorials and Lectures
6	Lateral Earth Pressure	4, 5	Tutorials and Lectures
7	Elastic Stress Distribution	6	Tutorials and Lectures
8	Slope Stability 1	7	Tutorials and Lectures
9	Slope Stability 2	8	Tutorials and Lectures
10	Slope Stability 3	9	Tutorials and Lectures
11	Compaction & Soil Improvement 1	10, 11	Tutorials and Lectures
12	Soil Improvement 2	10, 11	Tutorials and Lectures
13	Soil Improvement 3	12	Tutorials and Lectures