The Hong Kong University of Science and Technology

UG Course Syllabus

[**Course Title**] Geotechnical Analysis and Design

[**Course Code**] CIVL3740

[**No. of Credits**] 3

[**Any pre-/co-requisites**] Prerequisite: CIVL3730

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[Course Description]

Summary

This course is about the applications of fundamental principles of soil and rock mechanics to geotechnical analyses and designs. It covers lateral earth theories, design of earth retaining structures, braced cuts or multi-propped excavations, shallow and deep foundations, slope stability and reinforced earth structures, and introduction of basic rock mechanics.

Topics/chapters

1. Lateral earth pressure

1.1 Lateral earth pressure at rest (K_0)
1.2 Rankine's theory
1.3 Coulomb's theory
1.4 Assignment and worked examples

2. Design of retaining walls

2.1 General design philosophy
2.2 Gravity & cantilever concrete walls
2.3 Cantilever sheet pile walls
2.4 Anchored sheet pile walls
2.5 Soil arching
2.6 Pore pressure distributions behind retaining wall
2.7 Assignment and worked examples

3. Braced cuts or multi-propped excavations

3.1 General design philosophy
3.2 Short-term lateral wall stability & strut loads
3.3 Base heave in clays
3.4 Piping in sands
3.5 Ground settlement & swelling
3.6 Assignment and worked examples

4. Shallow foundations

4.1 General behaviour and design principles
4.2 Terzaghi's general ultimate bearing capacity theory
4.3 Other bearing capacity theories
4.4 Vertical stress distributions below shallow foundations
4.5 Settlements of shallow foundations
4.6 Assignment and worked examples

5. Deep foundations
5.1 Types and uses of pile foundations
5.2 Design principles of vertically loaded single piles
5.3 Design of rock socketed piles
5.4 Negative skin friction
5.5 Pile load tests
5.6 Assignment and worked examples

6. Slope stability
6.1 Slope characterisation
6.2 Methods of slope stability analysis
6.3 Practical consideration of methods of analysis
6.4 Choice between total and effective stress analysis
6.5 Assignment and worked examples

7. Reinforced earth structures
7.1 Types and considerations of soil reinforcement
7.2 Failure mechanisms
7.3 Assignment and worked examples

8. Introduction of rock mechanics
8.1 Composition and characteristics of the rock
8.2 Rock mechanical properties and influencing factors
8.3 Rock strength and failure criterion

Objectives and outcomes
This course will enable students to:

- Understand the basic principles of soil mechanics
- Comprehend and apply the basic soil mechanics theories in the design of earth retaining structures, braced cuts or multi-propped excavations, shallow and deep foundations, slope stability and reinforced earth structures
- Improve the ability of solving geotechnical problems independently and scientifically

The following program outcomes will be achieved:

- Understand fundamental principles of engineering science relevant to civil engineering disciplines. This course provides the fundamentals of basic soil mechanics and their applications in geotechnical problems.
- Develop an ability to identify and formulate civil engineering problems, and propose feasible solutions with an appreciation of their underlying assumptions, uncertainties, constraints, and technical limitations. This course provides the basic skills to tackle geotechnical problems and their pros and cons.
- Develop technical competency to design civil engineering components and systems, with an understanding of the principles behind the design methodologies. This course equips the students with state-of-the-art knowledge in the design of retaining wall, excavation, foundation, etc.
- Obtain in-depth knowledge in at least one major area of specialization within civil engineering. This course provides the advanced knowledge in geotechnical design.
- Develop an ability to stay abreast of contemporary issues, both nationally and internationally, and the awareness of the impact of engineering in these areas. This course can provide the basic solutions to the geotechnical disasters at home and abroad.

Methods of instruction
Lectures (i.e., 3 hours per week) and tutorial classes (i.e., 100 mins per week)

[Assessments]

Assessment Task	Contribution to Overall Course grade (%)
Assignment	10% (There are 5 assignments. Each one contributes to 2%)
Mid-term examination	30%
Final examination	60%

[Required Textbooks and Materials]

- Budhu. M. (2011). Soil Mechanics and Foundations John Wiley, 3rd edition.
- Craig. R.F. (2012) Soil Mechanics. 8th edition, E & FN SPON.
- Das. B.M. (2011). Principles of Foundation Engineering. 7th edition, 2011.
- Das. B.M. (2012). Fundamentals of Geotechnical Engineering. 4th edition.
- Ng, C.W.W., & Menzies, B. (2007). Advanced Unsaturated Soil Mechanics and Engineering, 1st edition. CRC Press.
- Ng, C.W.W., Simons, N. & Menzies, B. (2008). Soil-structure Engineering of Deep Foundations, Excavations and Tunnels. Publisher: Thomas Telford, UK. 3rd Reprint. 416p.
- Ng, C.W.W., Zhou, C., & Ni, J. (2024). Advanced Unsaturated Soil Mechanics: Theory and Applications, 2nd edition. CRC Press.
- Powrie. W. (2004). Soil Mechanics - Concept and Applications, 2nd edition, E & FN SPON.

[Optional] Additional Resources

Course notes will be uploaded to Canvas.