Hong Kong University of Science and Technology
Department of Civil and Environmental Engineering

"The dwarf sees further than the giant when he has the giant's shoulder to mount on." *Isaac Newton*

Rubric Title of course Instructor Teaching Assistant	CIVL 3730 Fundamentals of Geotechnics Prof. Wang Yu-Hsing (Office: 3572, Phone: 8757, Email: ceyhwang@ust.hk) and Prof. Chow Jun Kang (Email: junkangchow@ust.hk) HE Zhili, LEUNG Tin Long, XU Hao, CHEN Hongqi, ZHU Pengyu, Zhang Xiaolong
Prerequisites Credit	CIVL 2120 (Mechanics of Materials) 3
Textbook(s) and/or Other materials	Required textbook: Muni Budhu (2011). Soil Mechanics and foundations, 3rd eds., John Wiley & Sons. (e version) Muni Budhu (2018). Soil mechanics fundamentals, Chichester, West Sussex, United Kingdom: Wiley Blackwell (e version) Reference textbooks: [1] Das, B.M., Sobhan, K. (2014). Principles of Geotechnical Engineering, 8th Edition, Stamford, CT: Cengage Learning. (or other editions, 2019 version is not available) [2] Holtz, R.D. and Kovacs, W.D. (1981). An Introduction to Geotechnical Engineering, Prentice Hall. [3] Holtz, R.D., Kovacs, W.D., and Sheahan, T.C. (2011). An introduction to Geotechnical Engineering. 2nd edition, Pearson. [4] Lambe, T.W. and Whitman, R.V. (1979). Soil Mechanics, SI Version, John Wiley & Sons. [5] Knappett, J.A. and Craig, R. F. (2012). Craig's Soil Mechanics, 8th Edition, Spon Press, London (e version). [6] Craig, R.F. (2004). Craig's Soil Mechanics: the solutions manual, Spon Press, London (e version). References for the laboratory section: [1] ASTM Standard (Database room) [2] British Standard (Database room) [3] Eurocode 7: Geotechnical design [4] Geoguide (GEO HK) http://www.cedd.gov.hk/eng/publications/geo/geo_geoguide.html [5] Head, K.H. (2006). Manual of Soil Laboratory Testing, 3rd Edition, CRC

	Press. (e version) [6] Head, K.H. Epps R. J. (2014). Manual of Soil Laboratory Testing, 3rd Edition, Whittles Publishing. (e version) There are three volumes in total [7] Das, B.M., (2016). Soil Mechanics: Laboratory Manual, 9th Edition, New York : Oxford University Press (e version) Class website: Canvas (Online Virtual Soil Lab.)
Course Objectives	This course will enable students to understand geotechnical mechanics and associated soil behavior, including basic engineering geology, characteristics of soils, soil compaction, the principle of effective stress, shear strength of soils, the concept of critical state modeling, permeability, seepage problems, ground settlement and consolidation.
Topics	1. Basic engineering geology and rock mechanics (including soil formation and clay minerals) 2. Characteristics of soils (including phase relationships, index properties of soils, and soil classifications) 3. Soil compaction 4. Stresses and strains of soils 5. The principle of effective stress. 6. Shear strength of soils (including field testing). 7. A critical state model to interpret soil behavior. 8. One-dimensional flow of water through soils (permeability). 9. Two-dimensional flow of water through soils (seepage). 10. One-dimensional consolidation settlement of fine-grained soils (consolidation).
Computer usage	To be advised by the lecturers
Lab Projects	Five lab sessions Lab 1: Atterberg's limits test Lab 2: Compaction test Lab 3: Direct shear test Lab 4: Constant head and falling head permeability test Lab 5: One-dimensional consolidation test; Grain size distribution test (sieve analyses)
Class/lab schedule	Two 80-minute lectures (every week); 50-minute tutorial (for ~7 times); five 3-hour lab sessions
Contribution to the professional component	100% Engineering topics
Intended Learning Outcomes (ILOs) of	1. Able to identify, formulate, and solve problems related to geotechnical engineering.

this course	2. Able to conduct experiments, analyze and interpret results for geotechnical engineering design. 3. Able to apply modern engineering tools effectively and efficiently to perform geotechnical engineering analysis. 4. Have the basic knowledge to carry out technically competent geotechnical engineering-related design.
Relationship to the program objective	This course contributes to the (1) through (4) program objectives as follows: *(1) Provide students with professional skills in the design, construction and management of the civil infrastructure.* This course provides students with in-depth knowledge of geotechnical engineering. *(4) Expose students to real world engineering projects as well as cutting edge research to improve their understanding of the profession and technological advancements that can improve current practice* This course helps students realize the considerations, limitations and challenges related to the current design practice in Geotechnical Engineering.
Relationship to program outcome	This course contributes to the (1) through (12) program outcomes as follows: *(1) Acquire fundamental knowledge in mathematics and science on which civil engineering research and practice are based.* *(2) Understand fundamental principles of engineering science relevant to civil engineering disciplines* *(5) 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* Students will learn basic engineering geology and principles of soil mechanics from this course; therefore, students should be able to understand, formulate, and solve problems related to geotechnical engineering. *(3) Acquire an ability to conduct experiments, analyze and interpret results, and appreciate the importance of experimental data in establishing empirical relationships and parameters for analysis and design* Students have to attend five different laboratory sessions and submit lab reports for each experiment in this course; therefore, students should be able to conduct experiments, analyze and interpret results for geotechnical engineering design. *(4) Acquire an ability to apply modern engineering tools and IT tools effectively and efficiently for engineering analysis, design and communication* Students have to do seven assignments and prepare five laboratory reports in this course; therefore, students should have the ability to apply modern engineering tools and IT tools for geotechnical engineering related analyses. *(6) Develop technical competency to design civil engineering components and systems, with an understanding of the principles behind the design*

	methodologies. *(8) Obtain in-depth knowledge in at least one major area of specialization within civil engineering* This course provides in-depth knowledge of soil mechanics, which helps students understand the principles behind the design methodologies of geotechnical engineering. Therefore, student should be able to develop technical competency for geotechnical engineering related design in the end of the course.
Assessment of Outcomes	The learning outcomes listed above are assessed via seven graded assignments, five laboratory reports, and mid-term and final exams. Homework: 15 % Lab Report: 15 % (group report) (2-week due) Mid-term: 30 % (around the 7th or 8th week) Final exam 40 %, TBA For the Lab sessions iPeer will be used to assess the individual contributions Details of assessment of each outcome is summarized in the table below:
Prepared by	Wang Yu-Hsing
Date	20 August 2023

Course ILOs	Learning activity	Assessment
I	Lecture, tutorial	Assignment; midterm and final exams
II	Lecture, Lab	Lab report; midterm and final exams
III	Lecture, Lab, tutorial	Lab report; assignment; midterm and final exams
IV	Lecture, Lab, tutorial	Lab report; assignment; midterm and final exams

Class Schedule:

Lecture	Tutorial 1	Tutorial 2
Wednesday/Friday	Monday	Friday
15:00-16:20	9:30–10:20	10:30–11:20
LTJ	**LG5202**	**2306**

Laboratory section

Section LA1 (1A, 1B)	*Section LA2 (2A, 2B)*
Tuesday	Thursday
17:00–19:50	17:00–19:50
2209	**2209**

Lab schedules:

Divided into different subgroups (to be announced)

Lab 1: Atterberg's limits test (tests for liquid limit and plastic limit)

(LA1)	1A groups	17 September	(LA2)	2A groups	19 September
	1B groups	24 September		2B groups	26 September

Lab 2: Compaction Test

(LA1)	1A groups	8 October r	(LA2)	2A groups	10 October
	1B groups	15 October		2B groups	17 October

Lab 3: Direct Shear Test

(LA1)	1A groups	22 October	(LA2)	2A groups	24 October
	1B groups	29 October		2B groups	31 October

Lab 4: Constant Head and Falling Head Permeability Test

(LA1)	1A groups	05 November	(LA2)	2A groups	07 October
	1B groups	12 November		2B groups	14 November

Lab 5: One-dimensional Consolidation Test; Grain size Distribution Test (sieve analyses)

(LA1)	1A groups	19 November	(LA2)	2A groups	21 November
	1B groups	26 November		2B groups	28 November

Rules for homework and lab reports:

1. Five to six assignments will be given. Homework must be turned in at the beginning of class on the due day (typically in a 2-week interval). **Late homework will not be accepted unless you have prior permission from the instructor or acceptable reasons.**
2. Lab reports turned in late will receive a penalty, -20% deductions of the original marks for each day late.
3. Homework solutions will be provided by TAs and published on the class website.
4. **Discussions of homework or lab reports with your classmates are strongly encouraged, but "copy" is a plagiarism and not allowed**.

5. Lab reports must have a cover page with a proper title and names of all the group members. The mark allocation of reports is:
   a. Introduction and purpose of the experiment 10 %
   b. Test procedures, problems, etc. 20 %
   c. Data sheets, calculations, figures, tables, explanations. 50 %
   d. Discussions, conclusions, and comments 20 %

For the cover page of each laboratory report, you also need to write down the contributions of each member.

Name	Percentage contribution	Signature

iPeer

Items for considering homework problems (summarized by Dr. X.S. Li):

1. Make sure the presentation of your solution is complete. You have to clearly show what the problem was, what assumptions have been made, and what reasoning was followed to solve the problem. On the job you need to do these so that your colleague is able to check your work.
2. Ask yourself whether the result is reasonable. Does it make any sense?
3. Consider using figures, graphs, charts, tables, etc. in your solution. Remember to clearly define all the symbols or notations used.
4. Use more than one approach to solve the problem if possible.

Geotechnical Engineering Thinking (Summarized by Dr. Ridby):

A major goal of this course is to help you come to understand how geotechnical engineers (should) work and think. Some students have difficulty adjusting to this approach. Note that even if you chose not to engage in the practice of geotechnical engineering, there is high probability that you will work with geotechnical engineers, or read their reports, as part of your work. Below are some contrasts with common structural engineering approaches:

1. Structural designers have well-developed codes to follow but no comparable codes exist for geotechnical engineering. The codes that do exist are often poor quality.
2. The shearing and strength properties of concrete and steel are reasonably well defined because they are manufactured materials. In contrast, in geotechnical engineering our

major problem is often involved with trying to define the properties of soil material at a site.

3. Structural members are of comparatively simple shapes. Strata of soil are often discontinuous and the success of a “design” may hinge on whether or not your soil exploration program has discovered the presence of a critical stratum.
4. Structural materials are often subject to small strains and may be taken as linearly elastic, except perhaps where a plastic hinge develops. Soils are often loaded to large strains, and are almost always inelastic and have nonlinear stress-strain curves.
5. On the basis of my observations in engineering practice, structural designers may spend a significant fraction of their time of doing structural detailing, using codes, and preparing design drawings. Geotechnical engineers spend essentially none of their time on such work.
6. Structural engineer take satisfaction in being able to understand and follow complex design rules and come up with “neat” designs. Geotechnical engineers take satisfaction in coming up with acceptable (and buildable) designs that meet the functional requirements of the structure and satisfy the owner in spite of often grossly inadequate information.

Most undergraduate science, mathematics, and engineering courses taken by civil engineering students involve problem solving. Typical problems are usually well defined, little judgment is used in solving them, and there is a single correct answer. With clear right and wrong answers to questions and problems, students have the idea that the professor knows (or should know) the answer to every question. The student then acts like a sponge, simply absorbing as much knowledge as possible. This kind of teaching has its place and is important to learn basic terminology and engineering tools of the trade.

Engineering practice, however, tends to be more colored than black and white. In such a relativistic system the problems tend to be ill defined or the problem may be changing as the solution is developing. Important information is likely to be missing or may be known only approximately. Greatly simplified procedures may be widely used that may not be appropriate for a given situation. Some engineers work from a strong empirical approach (experience found through trail and error); others use a more theoretical approach (this is what we will focus on in this course). In sum, within geotechnical engineering there are likely to be a range of appropriate solutions, some better than others, but none that can be considered “right***”. Learn to be critical in your thinking.***