CIE-365: Soil Mechanics

Luis Zambrano-Cruzatty, Ph.D.

Spring 2022

January 16, 2022

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Department of
Civil and Environmental Engineering

THE UNIVERSITY OF MAINE

308 Boardman Hall
Orono, Maine 04469-5711
Tel: 207.581.1277
Fax: 207.581.3888
Email: luis.zambranocruzatty@maine.edu

CIE-365: Soil Mechanics-Spring 2022

Instructor information

Luis Zambrano-Cruzatty, Ph.D.	
Office	308 Boardman Hall
Phone	207.581.1277
Email	luis.zambranocruzatty@maine.edu

Course description

Credits: 3+1(CIE-366). Soil mechanics is a fundamental discipline from which geotechnical engineers have evolved a variety of methodologies for soil stabilization, foundations, dams and levee design, among many others. This is an introductory course in which we will discover and learn many methods and procedures for characterizing soil properties, the complexities and phenomena involved with water seepage through soils, and the physical and mechanical principles that can be used to represent soil behavior.

Course information

Location	Williams Hall 110
Day and time	Monday, Wednesday, and Friday. Time 10:00 AM to 10:50 AM.
Exam date	Monday, May 2. Time: 1:30 to 3:30 PM.
Graders	Parry Seddiqi and Benjamin Zeitlin
Office hours	Tuesday-Thursday 11 AM to 12 PM (Luis) Monday-Wednesday-Friday 11 AM to 12 PM (Parry) Tuesday 10-11 AM; Friday 9-10 AM and 4-5 PM (Benjamin)
Prerequisite	MEE-251 or concurrent

Course delivery method

This is an in-person, synchronous course.

Digital services, hardware, software

Brightspace will be used as a learning management system for the course. All class handouts, homework, quizes, grades, and communications will be hosted there. In addition to Brightspace, you will often be required to program or produce spreasheets, for which you can choose your preferred programming language or spreadsheet program.

Instructional Materials

I will distribute the necessary handouts both physically and electronically through Brightspace. The following is the course textbook which can be found in the Floger Library:

- Holtz, R. D., Kovacs, W. D., & Sheahan, T. C. (1981). An introduction to geotechnical engineering (Vol. 733). Englewood Cliffs: Prentice-Hall.

ABOUT THE INSTRUCTOR

Name: Luis Zambrano-Cruzatty, Ph.D.

Office: 308 Boardman Hall

Office hours: Tuesdays and Thursdays 8-9 AM by appointment due to COVID 19.

Email: luis.zambranocruzatty@maine.edu

Phone: 207.581.1277

GRADERS

- Parry Seddiqi. OH M,W,F 11 AM- 12 PM.
- Benjamin Zeitlin. OH T 10-11 AM; F 9-10 AM and F 4-5 PM.

COURSE DESCRIPTION

- Practice oriented
- Lecture and laboratory components
- Introduction course on Geotechnical Engineering
- We will learn the basic principles of soil behavior
- We will the effect of ground water on soil's shear strength

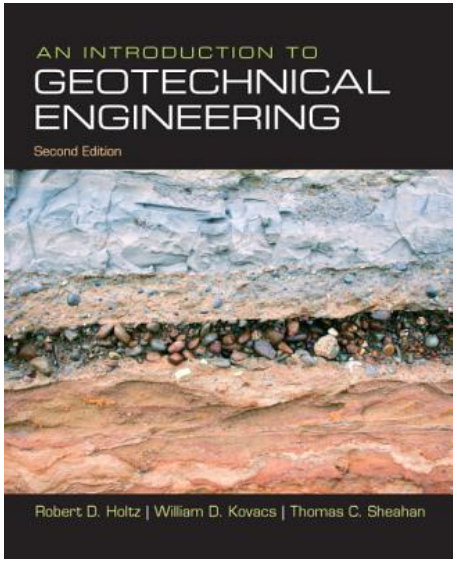
COMPUTATIONAL RESOURCES AND MATERIALS

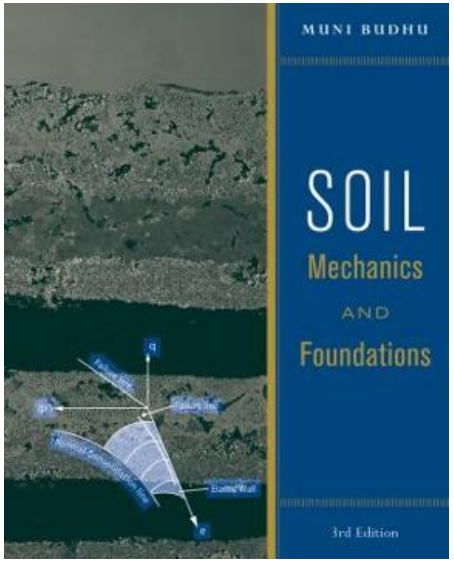
- Course materials and communications will be subministered trough Brightspace
- You will need to use spreadsheets or coding to process data (e.g., Python)
- You need a calculator, portractor, and compass.

REFERENCES

Purchasing these books is not required, however it is strongly advised:

- Holtz, R.D., Kovacs, W.D. and Sheahan, T.C., 1981. An introduction to geotechnical engineering (Vol. 733). Englewood Cliffs: Prentice-Hall.
- Budhu, M. (2020). Soil mechanics and foundations.





COURSE OBJECTIVES

1. Understand soil phase relations, index properties, and their application to soil classification and compaction (ABET 1 and 2)
2. Understand the importance of groundawater and seepage on the effective stress in soils (ABET 1).
3. Understand the role of stiffness/compressibility of soils, seepage, and permeability on time-dependent consolidation/settlement (ABET 1 and 2).
4. Understand the use Mohr's Circle and evaluate stresses in soil (ABET 1).
5. Understand the role of shear strength in the overall stability of earthen systems (ABET 1).

LEARNING OUTCOMES

1. Identify the different phases in soil materials and their relationships.
2. Determine the index properties and the laboratory tests required to obtain them.
3. Describe the consistency of fine soils and the relative density of coarse soils.
4. Calculate the optimal water content for soil compaction in laboratory and field conditions.
5. Calculate the permeability of soils, seepage flow, forces, and potential for internal erosion.
6. Approximate in-situ pore pressure, total, and effective stress in a saturated soil mass.

LEARNING OUTCOMES

7. Calculate the time dependent total settlements in fine grained soils.
8. Characterize the state of stress, determine stress invariants, and rotate stresses.
9. Characterize the shear strength of soils using laboratory test results.
10. Select the appropriate method of analysis for drained and undrained shear strength.
11. Calculate the lateral earth pressure coefficients for at-rest, passive, and active conditions.
12. Calculate the factor of safety against shear failure using simplified approaches.

COURSE ASSESMENT

- 5-7 Homeworks: 10%
- 5 quizes: 60%
- Final exam: 30%

Grading scheme:

- A: Equal or above 93
- A-: 90-93 ⁻
- B+: 87-90 ⁻
- B: 83-87⁻
- B-: 80-83⁻
- C+: 77-80⁻
- C: 73-77⁻
- C-: 70-73⁻
- D: 60-70⁻
- F: Below 60

HOMEWORK

1. Submit a physical copy before class time (i.e., 10 AM).
2. Copying or plagiarizing is not allowed.
3. Collaboration is allowed.
4. Submit with memo. (Penalty: 25% of max possible grade)
5. Submit on time. (Penalty: 25% of max possible grade)

Department of Civil and Environmental Engineering

MEMORANDUM

TO: Dr. Luis Zambrano-Cruzatty
FROM: Student A
DATE: October 6, 2016
RE: **CIE-365 assignment 100**

As it was requested in the assignment sheet, I designed the retaining wall for the geometric conditions given. This memo addresses the main issues regarding the calculations and assumptions that were done to design the retaining wall. Additionally, a Drawing containing some technical details for possible construction is shown in the Attachment 4.

This memo is composed of:

- Attachment 1: Demonstrative hand calculations.
- Attachment 2: Tables and figures used.
- Attachment 3: Spreadsheet output.
- Attachment 4: Retaining wall detail.
- Attachment 5: Assignment sheet.
- Attachment 6: References.

Following, I summarize a list of the conclusions and details of the design:

- In order to select strength parameters for the sand backfill, I used the relationship between the relative density and the friction angle given by Decourt (1990). In a range of 68% to 80% of relative density, the angle of internal friction was found to be between 37° and 41°, therefore **37°** was selected for design with a unit weight of **127 pci**, however, the drawing specifies at least 80% of relative density to be on the conservative side of the design. You can find more information regarding this in the Attachment 1, page 1/3; Attachment 2, page 1/1; and Attachment 4, page 1/1.

HOMEWORK

Examples:

1. A student submitted an assigment on time without memo and all the answers/solutions are correct. He will get 75% of grade (e.g., 7.5/10).
2. A student submitted a late assigment with memo and all the answers/solutions are correct. He will get 75% of grade (e.g., 7.5/10).
3. A student submitted a late assigment without memo and all the answers/solutions are correct. He will get 50% of grade (e.g., 5/10).

QUIZZES

- Online in Brightspace.
- Five quizzes in total.
- They are made up of brief questions.
- closed-notes.
- The lowest grade will be dropped from the set.
- You may need to draw Mohr circles or lines. Therefore, you will need a compass, a protractor, and rulers.

FINAL EXAM

- May 2 from 1:30 PM- 3:30 PM
- Comprehensive. It may inlude questions about soil laboratory.
- Closed-notes.
- You may need to draw Mohr circles or lines. Therefore, you will need a compass, a protractor, and rulers.

CLASS POLICIES

- In-person and synchronous course. Assistance is required.
- Do not play games, or navigate Facebook, Twitter, or other social networks in class.
- Switch to silent mode on your phone. Please exit the classroom if you have an urgent call.
- Late homework will not be accepted.If you need more time let me know in advance.
- DO NOT COME TO THE CLASSROOM if you are unwell with COVID-like symptoms and are afraid of missing a quiz date. Please send me an email to arrange a new date for the quiz.
- If necessary, I'll post video lectures.

COURSE SCHEDULE DISCLAIMER

In the event of an extended disruption of normal classroom activities (due to COVID-19 or other long-term disruptions), the format for this course may be modified to enable its completion within its programmed time frame. In that event, you will be provided an addendum to the syllabus that will supersede this version.

ACADEMIC HONESTY

Please see the University of Maine System's Academic Integrity Policy listed in the Board Policy Manual as Policy 314: https://www.maine.edu/board-of-trustees/policy-manual/section-314/

ACCESSIBILITY SERVICES

If you have a disability for which you may be requesting an accommodation, please contact Student Accessibility Services, 121 East Annex, 581.2319, as early as possible in the term. Students who have already been approved for accommodations by SAS and have a current accommodation letter should meet with me Luis Zambrano-Cruzatty privately as soon as possible.

SEXUAL VIOLENCE POLICY

Your teacher is required to report sexual violence events to Title IX Student Services or the Office of Equal Opportunity. If you want to talk in confidence to someone about an experience of sexual discrimination, please contact these resources: For confidential resources on campus: Counseling Center. For confidential resources off campus: Rape Response Services or Partners for Peace. Other resources: For support services on campus: Title IX Student Services, Office of Community Standards, University of Maine Police or 911.

COURSE CONTENTS AND SCHEDULE

Civil and Environmental Engineering

Fax: 207.581.3888
Email: luis.zambranocruzatty@maine.edu

Tentative schedule

Day	Date	Topic	Lab.
W	1/19/2022	Class introduction, syllabus, policies	Soil
F	1/21/2022	Invited speaker: Topic TBD	components
M	1/24/2022	Introduction: The geological cycle, soil origin	Grain size
W	1/26/2022	Introduction: Site investigation	dist.
F	1/28/2022	Index properties: Phase relationships	
M	1/31/2022	Index properties: Grain size distribution, Atterberg limits	Atterberg
W	2/2/2022	Index properties: Soil classification	limits
F	2/4/2022	Compaction	
M	2/7/2022	Quiz 1: Introduction, index properties, compaction, in-situ testing	Visual
W	2/9/2022	Water in soils: Groundawater table, pore pressure, total and effective stresses	classification
F	2/11/2022	Water in soils: Darcy's law	
M	2/14/2022	Water in soils: Permeability and hydraulic conductivity	Compaction
W	2/16/2022	Water in soils: One-dimensional seepage	
F	2/18/2022	Water in soils: 2D-3D seepage, flow nets, pore pressure, uplift force, seepage force	
M	2/21/2022	President's day: no class	In-situ
W	2/23/2022	Water in soils: piping	density
F	2/24/2022	Quiz 2: Water in soils	
M	2/28/2022	Induced stress: Approximations, Bousinesq's elastic solution	Permeability
W	3/2/2022	Induced stress: Bousinesq's elastic solution, superposition	
F	3/4/2022	Induced stress: Stress tensor, elastic deformations	
M	3/7/2022	Consolidation: Oedometer test, primary and secondary consolidation	Site
W	3/9/2022	Consolidation: Preconsolidation pressure, OCR	investigation
F	3/11/2022	Consolidation: Primary consolidation parameters	
M	3/14/2022	Spring break: no class	
W	3/16/2022	Spring break: no class	
F	3/18/2022	Spring break: no class	
M	3/21/2022	Consolidation: rate of consolidation	Bonus
W	3/23/2022	Consolidation: preloading, radial consolidation	
F	3/25/2022	Quiz 3: Induced stress and consolidaiton	
M	3/28/2022	State of stress: 2D stresses and Mohr's circle	Consolidation
W	3/30/2022	State of stress: principal stresses, stress invariants, rotations	
F	4/1/2022	State of stress:: Usage of Mohr's circle	
M	4/4/2022	State of stress: stress paths, simple shear, triaxial compression	Settlement
W	4/6/2022	Quiz 4: State of stress	estimates
F	4/8/2022	Shear strength: Mohr-Coulomb failure criteria	
M	4/11/2022	Shear strength: drained and undrained behavior	Unconfined
W	4/13/2022	Shear strength: Shear strength of clays	compression
F	4/15/2022	Shear strength: Shear strength of sands	test
M	4/18/2022	Quiz 5: Shear strength	Direct
W	4/20/2022	Lateral earth pressure: at-rest, passive, and active conditions [2]	shear
F	4/22/2022	Intro to slope stability [2]	
M	4/25/2022	Intro to bearing capacity [2]	Direct
W	4/27/2022	Maine's day: no class	shear
F	4/29/2022	Classes end: Q&A session	
M	5/2/2022	Final exam (1:30 PM- 3:30 PM) Williams Hall 110	

M: Monday - W: Wednesday - F: Friday

Questions or comments?