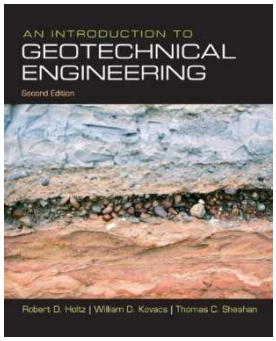
CE 3348 Geotechnical Engineering
TR 12:30-13:20, Liberal Arts Building 319

Spring 2025



Instructors: Rajib Mallick/
Office: A-216
Office Hours: Students are always welcome
Text: An Introduction to Geotechnical Engineering, 2nd edition by Holtz, Kovacs and Sheahan, Publisher: Prentice Hall,

OBJECTIVES OF COURSE

The objective of CE 3348 are: (1) to introduce the subject of soil mechanics and foundation engineering to civil engineering students; (2) to teach the students how to solve certain fundamental problems related to consolidation, shear strength, and design; (3) to familiarize the students with relevant terms and soils tests so that they can work effectively with specialists in Geotechnical Engineering; and (4) to provide those students who will go on to take advance courses in Geotechnical Engineering with the background needed for further study.

In this course, we will review what soils are and how they are identified and classified for engineering purposes. We will also review the principles that govern flow of water in soils. We will learn about settlement and heave, and strength of soils. We will talk about consolidation problems and teach you how predict the settlement of the foundations. We will discuss several case histories during the semester and show you how the concepts that were taught in class can be applied to real engineering problems. In addition, several of your homework problems will require that you analyze or solve actual field problems.

SCHEDULE

A tentative lecture schedule is attached. Reading assignments from your text are indicated in the lecture schedule. You are expected to read the appropriate assignment before the lecture. Prepared notes will occasionally be handed out in class to supplement, or in some cases to substitute for, reading material from the book. Be sure to save the notes because you will be examined over at least some of the material in them.

GRADING

Your grade for this course will be determined based on 1000 points distributed in the following manner:

1. Two 50-minute exams given in class (150 points each)
2. Final comprehensive examination (300 points)
3. Weekly Quiz (150 points)
4. Homework Submission (50 points)
5. Laboratory grade (200 points)

In accordance with University regulations, students who miss examinations will receive grades of zero. Exceptions to this rule will be made only on a carefully considered individual basis and only if the student contacts the instructor before the exam. If you know in advance that you are going to miss an exam, it is your responsibility to inform the instructor before the exam.

HOMEWORK

All homework problems are assigned for the semester on page 7. The homework problems will be collected but not graded. The solutions are posted between 8:00 AM and 5:00 PM except weekends. You can view the solutions by providing your I.D. But you will not be able to check them out to copy in any form or shape, including using your cell phone camera. You will lose this privilege if you do not follow these rules.

Experience clearly shows that a student's grade is strongly dependent upon the effort that is put into working and understanding the homework. Although the homework does not directly count towards your grade, in practice it is the single most important factor that will affect your grade. Homework solutions will be available on due dates. We encourage that you team up with your other classmates for this activity.

QUIZES

A quiz will be given every week during your lab session. The quiz will be similar to either the homework problems from the previous week or the examples solved in the class or the examples in the textbook. ***Please do not come late because we will start the quiz promptly and finish it exactly at the time allotted.*** To accommodate possible emergencies, the lowest two grades from the quizzes will not be considered.

EXAMINATIONS

Examinations are normally during the class period for about 50 minutes. The tentative dates and topics covered are included in the attached schedule on page 7. Before each examination an optional review session may be provided. Final examination, which is comprehensive, will last 3 hours. ***You need to score 50% in the final examination to pass the class.***

STUDY GROUPS

Students may form study groups of about four persons. These groups will collaborate in the laboratory sessions. Group members are also encouraged to get together to solve the homework problems.

ATTENDANCE

Students are expected to attend all class periods and must attend all laboratory periods. Those who fail to attend class regularly are inviting scholastic difficulty and, with the approval of the Dean of the College of Engineering, may be dropped from the course with a grade of F for repeated (5 or more) unexcused absences. ***Homework assignments and other material will only be distributed either in class or electronically.***

CALCULATORS AND CELL PHONES

To prepare you for the Fundamental of Engineering (FE) and Professional Engineering (PE) exams (http://www.ncees.org/exams/calculators/), the following calculators are allowed during class, labs and exams:

- Hewlett Packard – HP 33S
- Casio – FX 115MS or FX 115MSPlus
- Texas Instruments – TI 30X IIS
- Texas Instruments – TI 36X SOLAR

It is your responsibility to get acquainted with the features of the calculator you decide to use. I recommend that you use this calculator for all your work (including other courses) since this will help you learn how to use all the features of your calculator.

It is a very good manner to turn off your cell phones during the class lectures and lab sessions. However, please make sure that you do not have a cell phone or any other electronic item with you during the exams and quizzes.

The mere possession of a disallowed calculator, any cell phone or any other electronic item on or near you during quizzes and tests is the ground for dismissing you from the exam or quiz with a grade of zero.

POLICY ON CHEATING

Students are expected to be above reproach in all scholastic activities. Students who engage in scholastic dishonesty are subject to disciplinary penalties, including the possibility of failure in the course and dismissal from the university. Scholastic dishonesty includes but is not limited to cheating, plagiarism, collusion, the

submission for credit any work or materials that are attributable in whole or in part to another person, taking an examination for another person, any act designed to give unfair advantage to a student, or the attempt to commit such acts (Regents' Rules and Regulations, Part One, Chapter VI, Section 3, Subsection 3.2, Subdivision 3.22). Scholastic dishonesty harms the individual, all students, and the integrity of the university. Policies on scholastic dishonesty will be strictly enforced.

COURSE/INSTRUCTOR EVALUATION

A course/instructor evaluation will be conducted in class near the end of the semester.

LABORATORY

Each student must register for a laboratory section. ***You will not be allowed to pass this course if you do not attend <u>all</u> laboratories. The attendance for the laboratory sessions will be taken toward the end of the class.*** Please consult me if you feel you must miss a laboratory so that some type of makeup can be schedule in advance. We are very much interested in seeing that the laboratory provides you with the training that you need without being an undue burden on your time. Please keep us informed of any problems that you are having with your laboratory.

FINAL COMMENT

Good luck to all of you in this course. Please do not hesitate to ask questions in class, or if necessary, to see your instructor outside of class. Any specific comments that students have on how the course might be improved are particularly welcomed, especially during the semester.

Things You Should Know When You Complete This Course

- Understand and use weight-volume relationships
  - Can define, calculate and know reasonable ranges of
    - Moisture Content
    - Degree of Saturation
    - Various Unit Weights and Densities
    - Specific Gravity
    - Void Ratio
    - Porosity
    - Relative Density
  - Can draw, interpret and develop inter-relationships between following parameters using "Phase Diagram"
    - Moisture Content
    - Degree of Saturation
    - Various Unit Weights and Densities
    - Specific Gravity
    - Void Ratio
    - Porosity
    - Relative Density
- Classify soils
  - Can distinguish between gravel, sand, silt and clay
  - Understand sieve procedures
  - Draw gradation curve and extract information from it
    - D10, D30, D60
    - Coefficient of uniformity
    - Coefficient of curvature
  - Be able to define and determine Atterberg Limits
    - Liquid Limit
    - Plastic Limit
    - Shrinkage Limit
    - Plasticity Index
    - Liquidity Index
    - Activity
  - Be able to classify soils using information above Using Unified Soil Classification System
- Determine optimum compaction of soils
  - Be able to define the benefits of compaction
  - Be able to briefly describe methods of compaction
  - Be able to define compaction related parameters
    - Optimum moisture content
    - Maximum dry unit weight
  - Be able to calculate the amount of constituents (water and loose material from borrow) necessary to obtain certain volume of finished earthwork
- Understand basics of site investigation
  - Be able to briefly describe steps in site investigation
  - Be familiar with different aspects of site investigation
    - Drilling
    - Sampling
    - Field Testing
  - Be able to describe the Standard Penetration Test

        - Standard Penetration Resistance (N value)
        - Corrections to N value
        - Uses of N value

- Calculate Total, Effective and Neutral Pressures in Soils
    - Be able to define Total, Effective and Neutral Stresses
    - Be able to obtain vertical total, effective and neutral stresses
        - Single-layered soils
        - Multi-layered soils
    - Be able to obtain horizontal total and effective stresses
        - Single-layered soils
        - Multi-layered soils

- Understand Darcy's law and calculate permeability
    - Be able to define and calculate total head, elevation head and pressure head
    - Be able to relate pressure head to pore pressure
    - Be able to calculate hydraulic gradient
    - Calculate discharge velocity and seepage velocity
    - Interpret simple flow nets
        - Define equipotential and flow lines
        - Calculate pore pressure from flow net
        - Calculate quantity of water seeping through a medium using flow charts

- Calculate settlement of soils
    - Be able to describe Consolidation Process
    - Can define and calculate three types of settlement
        - Initial
        - Consolidation
        - Secondary Consolidation
    - Can develop and extract information from e-log p curve
        - Coefficient of Compressibility (a_v)
        - Coefficient of Volume Compressibility (m_v)
        - Compression Index (C_c)
        - Recompression Index (C_r)
        - Swell Index (C_s)
        - Compression Strain Index ($C_{\varepsilon c}$)
        - Recompression Index ($C_{\varepsilon r}$)
        - Maximum Past Pressure (Reconsolidation Pressure)
        - Overconsolidation Ratio (OCR)
        - Normally Consolidated Material
        - Overconsolidated Material
        - Coefficient of Secondary Consolidation

- Calculate rate of settlement
    - Can Quantify and Qualify Consolidation Process with Time and Depth
        - Can calculate variation in total stress at a given depth with time
        - Can calculate variation in total stress with depth at a given time
        - Can calculate variation in pore pressure at a given depth with time
        - Can calculate variation in pore pressure with depth at a given time
        - Can calculate variation in effective stress at a given depth with time
        - Can calculate variation in effective stress with depth at a given time
        - Can calculate degree of consolidation at a given depth with time
    - Can Define and Calculate Average Degree of Consolidation
        - Can define coefficient of consolidation

        - Can define average degree of consolidation
        - Can define drainage path
        - Can define and calculate normalized time (time factor)
        - Can define and calculate normalized depth
        - Can calculate average degree of consolidation

- Determine the shear strength of soils
    - Can effectively use Mohr Circles
        - Can draw Mohr circles
        - Can calculate principal stresses
        - Can calculate failure surface from Mohr circle
        - Can calculate maximum shear strength from Mohr circle
    - Understand Mohr Coulomb Failure Criteria
        - Can define and calculate angle of internal friction
        - Can define and calculate cohesion
    - Can Define and Use Direct Shear Tests
        - Can define when it is applicable
        - Can define its shortcomings
        - Can extract strength parameters from test results
    - Can Define and Use Triaxial Tests
        - Can compare and contrast different types
            - Drained vs Undrained
            - Consoildated vs Unconsolidated
            - Q-type
            - R-type
            - S-type
        - Can define when it is applicable
        - Can define its shortcomings
        - Can extract strength parameters from test results

Ability to design and conduct experiments and interpret data

- perform laboratory tests to:
    - Classify soils
    - Determine compaction parameters of soils
    - Estimate permeability of soils
    - Estimate indices used in calculating settlement and rate of settlement
    - Estimate shear strength parameters of soils
- draw conclusion based on statistics to:
    - Determine compaction parameters of soils
    - Estimate permeability of soils
    - Estimate shear strength parameters of soils
- Student should be able to validate the following principals:
    - Darcy's law
    - Consolidation theory
    - Mohr-Coulomb failure criteria

TENTATIVE CLASS OUTLINE

No.	Topic	Assigned Reading
1	Introduction	Chapter 1
2	Weight-Volume Relationships Review	2.1-2.3
3	Index Tests, Soil Classification, Review	2.4-2.9
4	Compaction	Chapter 5
5	Boring and Sampling	Handout
6	Effective and Total Stress	6.1-6.3, 6.9-6.11
7	Groundwater, Darcy's Law	7.1-7.7
8	One-Dimensional Consolidation	8.1-8.7, 8.12
9	Time-Rate of Settlement	Chapter 9
10	Shear Strength	Chapters 11, 12
11	Stress Distribution and Settlement of Footings	Chapter 10

Tentative Lecture and Laboratory Schedule

Week	Tuesday	Thursday	Laboratory
1/20	Topic 1	Topic 1	Introduction to Lab
1/27	Topic 2	Topic 2	Practice lab Report
2/3	Topic 2/3	Topic 3	How to Prepare Lab Reports
2/10	Topic 4	Topic 4	Wt./Vol. Relation Exercises
2/17	Topic 5	Topic 5	Soil Classification Demonstration
2/24	Topic 5	Topic 6	Stress Calculation Exercises
3/3	Topic 6	Topic 7	**Review** & Compaction Demonstration
3/10	Topic 7	**Exam 1 Topics 1-6**	Permeability Exercises
3/17	**Spring Break**		
3/24	Topics 7	Topic 8	Consolidation Set Up
3/31	Topic 8	Topic 8	Consolidation Data Reduction
4/7	Topic 9	Topic 9	Consolidation Exercises
4/14	Topic 10	Topic 10	Direct Shear Demonstration
4/21	Topic 10	Topic 11	**Review** & Unconfined Compression Demonstration
4/28	Topic 11	**Exam 2 Topics 7-9**	Shear Strength Exercises
5/5	Practice problems	Makeup Exam	

Final Exam: Comprehensive: Tuesday, May 13th 1:00 pm – 3:45 pm

Week	Homework*	Remarks
1/20	Read Chapter 3	Provide a one-page single-spaced summary
1/27	2.6-2.18 (even problems)	
2/3	2.22-2.36 (even problems)	
2/10	2.56-2.64 (even problems)	Classification with USCS only ignore other methods
2/17	5.2-5.10 (even problems)	
2/24	6.28-6.36 (even problems)	
3/3	7.16 and 7.18 and 7.30	
3/10	8.8-8.12 (even numbers)	
3/17	**Spring Break**	
3/24	8.32 and 8.36 and 8.38	
3/31	9.1-9.7 (all problems)	
4/7	9.30, 9.31 and 9.32	
4/14	11.1, 11.12, 11.13	
4/21	12.4, 12.6, 12.7, 12.8, 12.9, 12.10	
4/28	12.32, 12.43	

**** Unless otherwise announced, homework problems are due Friday at 5:00 PM after assigned dates (same week)***