

**CE 4348 Geotechnical Engineering**  
**Lecture Sessions: MW 12:30-1:20 pm.**  
**Liberal Arts Bldg., Room 222**  
**Laboratory Sessions: MWF 1:30-4:00 pm.**  
**Spring 2016**

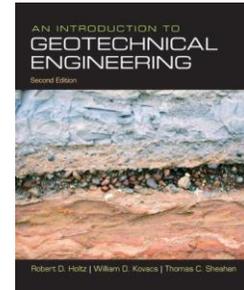
**Instructor:** Reza Ashtiani, Ph.D. ([reza@utep.edu](mailto:reza@utep.edu))  
Engineering Annex, Room 217

**Office Hours:** Students are always welcome

**Teaching Assistant:** Mr. Juan Salcido

**TA Email:** [jcsalcido@miners.utep.edu](mailto:jcsalcido@miners.utep.edu)

**Textbook:** An Introduction to Geotechnical Engineering,  
2<sup>nd</sup> Edition by Holtz, Kovacs and Sheahan, Publisher: Prentice Hall, 2011.



### **COURSE OBJECTIVES**

The objectives of CE 4348 are:

- (1) Introduce the subject of soil mechanics and foundations engineering to civil engineering students.
- (2) Teach the students how to solve certain fundamental problems related to consolidation, shear strength, and geotechnical design.
- (3) Familiarize the students with relevant terms and soils tests so that they can work effectively with specialists in the area of geotechnical engineering.
- (4) 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, expansion, and strength of soils. We will talk about consolidation problems and discuss how to calculate factors of safety for foundations and how to 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 on the class website. Reading assignments from your text and handouts will be assigned in class at the end of each lecture session. 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 on the basis of **1050 points** as follows:

1. Two mid-term exams (150 points each)
2. Final comprehensive examination (300 points)
3. Homework (200 points)
4. Laboratory Reports (200 points)
5. Critical Assessment ( attendance and involvement in discussions) (50 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.

## GRADE STRUCTURE

Final grades assigned for this course will be based on the percentage of total points earned and are assigned as follows:

Letter Grade	Percentage	Performance
A	90-100	Excellent Work
B	80-89	Very Good Work
C	70-79	Average Work
D	60-69	Below Average Work
F	0-59	Failing Work

## HOMEWORK

***All homework problems will be assigned in the class. The due date for homework submission is one week after the assigned date before 5:30 pm.*** Past experience clearly shows that a student's grade is strongly dependent upon the effort that is put into working and understanding the homework. Homework solutions will be available on due dates. Make sure to discuss the homework solutions with your teaching assistant, to properly understand the materials. We encourage that you team up with your other classmates for this activity. Please note that each student is responsible to submit the homework assignment individually.

### **EXAMINATIONS**

Exam #1 and exam #2 will last between 90 minutes to 120 minutes. Exam #1 will cover topics 1-4 and Exam #2 will cover topics 5-8. The final comprehensive exam covers all the materials discussed in the class (topics 1-9). The list of the topics is presented on page 8 of this document. Before each examination a review session will be provided. Final examination, which is comprehensive and covers all the course materials, will last two hours. ***You need to score above 50% in the final examination to pass the course.***

### **COURSE PORTFOLIO**

Students are required to prepare a course portfolio documenting all materials relevant to the course. The portfolio shall contain Power Point lecture notes, class notes, handouts, exams, homework assignments, study notes, and any relevant materials accumulated during the semester. Students should submit their course portfolio to the instructor after the final exam. All portfolios will be returned to the students at the beginning of the following semester. I believe that you will benefit from the portfolio years later when you need to review the learned subjects for advanced courses or professional engineer licensure exam.

### **STUDY GROUPS**

Students should form study groups of about two to three persons. These groups will collaborate in the laboratory sessions. Group members are also encouraged to get together to solve the homework problems. Keep in mind that every student should submit the homework problems individually. The laboratory reports however submitted as a group effort.

### **ATTENDANCE**

***Students are expected to attend all lecture sessions and must attend all laboratory sessions.*** Those who fail to attend classes 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 (4 or more) unexcused absences. ***Homework assignments and other material will only be distributed in class and will be distributed electronically.***

***Note: The attendance for the laboratory sessions will be taken toward the end of the class.***

### **CALCULATORS AND CELL PHONES**

To prepare you for the Fundamental of Engineering (FE) and Professional Engineering (PE) exams (<http://www.ncees.org/exams/calculators/>), only 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.

***The mere possession of a disallowed calculator, any cell phone or any other electronic item on or near you during tests is the ground for dismissing you from the exam 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**

An online course/instructor evaluation will be conducted near the end of the semester. You're strongly encouraged to participate in the evaluations. Your input will be used to refine and shape the future direction of the course.

### **LABORATORY**

Each student must register for a laboratory section. ***You will not be allowed to pass this course if you do not attend all laboratories. The attendance for the laboratory sessions will be taken toward the end of the class.*** Please consult with me if you feel you have to miss a laboratory so that some type of makeup can be scheduled 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 professor 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

### Criterion A: Apply mathematics, science and engineering principles

Student should be able to:

- 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 analysis 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
- 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
- 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
      - Consolidated 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
- 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 ( $C_{ec}$ )
    - Recompression Index ( $C_{er}$ )
    - Maximum Past Pressure (Reconsolidation Pressure)
    - Over consolidation 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 calculate variation in degree of consolidation with depth at a given 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

### **Criterion B: Ability to design and conduct experiments and interpret data**

Student should be able to perform laboratory tests to:

- Classify soils (sieve analysis and Atterberg limits)
- Determine compaction parameters of soils
- Quantify aggregate shape properties (Aggregate Imaging System)
- Estimate indices used in calculating settlement and rate of settlement
- Estimate shear strength parameters of soils

Student should be able to draw conclusion based on statistics to:

- Determine compaction parameters of soils
- Estimate strength parameters of granular materials
- Estimate consolidation parameters of soils

Student should be able to validate the following principals:

- Steady state flow of water in soils
- Consolidation theory
- Mohr-Coulomb failure criteria

### **Criterion K: Ability to use the techniques, skills and modern engineering tools necessary for engineering practice**

The students will be able to:

- Use word processing software and spreadsheet software to develop their reports
- Use presentation software to prepare and present the results from their study

## CE4348 TENTATIVE CLASS OUTLINE

Lecture Sessions:

<i>Topic No.</i>	<i>Description</i>
1	<b>Introduction:</b> General definitions and the origin of the soils, mechanical behavior of soils, stress sensitivity, nonlinearity and anisotropy.
2	<b>Weight-Volume Relations:</b> Phase diagram, void ratio, porosity, moisture content, degree of saturation, density and unit weight relationships.
3	<b>Soil Classification:</b> Particle size distribution, shape factors, liquid limit, plastic limit, plasticity index, shrinkage limit, plasticity charts, classification methods: USCS and AASHTO soil classification, relationship between classification and performance.
4	<b>Compaction:</b> Standard and modified proctor test, lab and field compaction energy, moisture-density curves, macrostructure of compacted cohesive clays, fabric orientation, field compaction, compaction methods and equipment.
5	<b>Effective Stress:</b> Pore water pressure concept, calculation of effective and total stress in single and multi-layer soils, effect of change in ground water table.
6	<b>Flow of Water in Soils:</b> One dimensional flow theory, Darcy's law, hydraulic conductivity, Bernoulli's equation, pumping wells, two dimensional flow, flow nets, Laplace's equation, and seepage calculation under the dams/sheet piles. Soil permeability, constant head and falling head permeability tests. In-situ determination of soil permeability.
7	<b>Stresses in Soils:</b> Calculation of stresses due to point load, strip load, circular and rectangular area loads according to Boussinesq and Westergaard theories. Newmark's method for irregular footing shape, Trapezoidal rule.
8	<b>Shear Strength of Soils:</b> Mohr-Coulomb failure criteria, friction and cohesion components of the strength equation, laboratory tests for the determination of shear strength parameters, triaxial tests (CD, CU, and UU tests), and direct shear test. Soil dilation.
9	<b>Consolidation:</b> Consolidation theory, OCR, void ratio-effective pressure plots, normally consolidated and over consolidated soils, compression index, swell index, secondary consolidation, isochrones, and time rate of settlements.

Laboratory schedule:

<i>Lab No.</i>	<i>Description</i>
1	Laboratory Safety Workshop
2	Sieve Analysis
3	Atterberg Limits
4	Compaction (Standard and modified proctor methods)
5	Hydrometer Test
6	Aggregate Imaging System (AIMS)/Flat and elongation Test
7	Direct Shear Test
8	Triaxial Shear Test
9	Consolidation Test

