CVEN 3708 Geotechnical Engineering 1 (Fall 2012)

Professor: **John S. McCartney, Ph.D., P.E.**
Office: ECOT 547
Office hours: Tuesday and Thursday 9:30-11:00am; Wednesday 10:00-12:00am
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Class: Time: Fall 2012, TR 8:00-9:15am
Room: ECCR 1B40

Laboratory: Section 011: Fall 2012, M 12:00-2:00 pm, ECCE 1B53
Section 013: Fall 2012, W 1:00-3:00 pm, ECCE 1B53
Section 014: Fall 2012, M 10:00-12:00 pm, ECCE 1B53

Reference: Donald Coduto, Man-Chu Ronald Yeung and William A. Kitch (2010). "Geotechnical Engineering: Principles & Practices." 2nd Edition. Prentice Hall.

Course Description:
Studies basic characteristics of geological materials; soil and rock classifications; physical, mechanical, and hydraulic properties; the effective stress principle; soil and rock improvement; seepage, consolidation; stress distribution; and settlement analysis. Selected experimental and computational laboratories. Prerequisites CVEN 3161.

Course Scope:
Geotechnical engineers solve problems involving soils and rock, including those involving the interaction between structures or the environment with soils and rock. Unlike other civil engineering materials like concrete and steel, soil is a multi-phase material containing particles, air, and water. The interaction between these phases leads to many interesting phenomena. This is a broad field which requires the integration of analysis, critical thinking, site-specific field and laboratory testing, historical empirical evidence, and knowledge of geology. Although this is challenging, every project that geotechnical engineers encounter is unique. Because of uncertainties involved in design, geotechnical engineers must be able to decipher what issues are the most important to consider. This course will provide the foundation for geotechnical analyses needed in all areas of civil engineering.

Course Outline
1. Introduction to geotechnical engineering
2. Review of engineering geology and grain size distributions
3. Subsurface investigation
4. Mass-volume relationships for soils
5. Index properties and soil classification
6. Compaction of soils
7. Permeability of Soils
8. Seepage in Earth Structures
9. Capillarity and Unsaturated Soils
10. Stress Distribution
11. Effective Stress
12. Compression of Soils
13. Time Rate of Consolidation
14. Applications

Laboratory Experiments:
Grain size analysis (sieving)
Specific gravity
Grain size analysis (hydrometer)
Atterberg limits
Compaction
Permeability
Compressibility and consolidation

Course Objectives
The course objectives listed below are based on the desired program outcomes identified for engineering education by the Accreditation Board for Engineering and Technology (ABET). For each course objective, the related ABET outcome(s) is listed. See the attached page for more information on ABET.

1. Ability to classify soils based on laboratory test results
   You will gain knowledge of the nature of soils and use it for their classification for engineering applications. (This objective maps to ABET outcomes "a", "b", "d" and "g".)
2. Ability to develop and apply knowledge of phase relations in soils to solve basic mass-volume problems in geotechnical and construction engineering
   You will gain knowledge of the different phases of soil constituents and express it in mass-volume relations. (This objective maps to ABET outcome "a".)
3. Ability to apply theory of compaction and measured soil compaction test to plan a soil compaction program in the field
   You will gain knowledge on densification of soils through the different compaction techniques and its relation to moisture content. (This objective maps to ABET outcomes "a", "d" and "g".)
4. Ability to apply data from permeability tests to analyze seepage through earth structures
   You will gain knowledge on the flow of water through porous soils and apply seepage theory to analyze flow through earth structures. You will also learn to apply seepage theory to groundwater hydrology. (This objective maps to ABET outcomes "a", "b", "c", "e" and "g".)
5. Ability to calculate the stress distribution under applied foundation loads to evaluate settlement of foundations
   You will gain knowledge on the theory of stress distribution and apply it to obtain the stresses in the foundation soil due to different boundary loads. (This objective maps to ABET outcomes "a", and "e".)
6. Ability to apply knowledge of soil compressibility obtained from oedometer testing to calculate settlement of foundations
   You will gain knowledge on the soil compressibility and study it by oedometer testing. You will then apply this knowledge to the calculation of surface settlement due to the compressibility of the underlying soils. (This objective maps to ABET outcomes "a", "b", "d" and "e".)
7. Ability to apply theory of consolidation and measured consolidation data to predict the time rate of settlement
   You will gain knowledge of effective stresses and to apply it in developing a theory of consolidation. You will then apply the theory to conduct and analyze consolidation testing, and to analyze consolidation settlement. (This objective maps to ABET outcomes "a", "b", "d" and "e".)

Accreditation through ABET

The Accreditation Board for Engineering and Technology (ABET) is a professional accrediting organization that accredits specific academic programs to assure quality in education. Accreditation is a voluntary, non-governmental process of peer review. It requires an educational program to meet certain defined standards or criteria. More information on ABET and accreditation can be found on the ABET website at http://www.abet.org. As part of the accreditation process, ABET sets general criteria for students, faculty, facilities, educational objectives, and institutional support, as well as program criteria for specific engineering disciplines. One major criterion established by ABET is a set of desired program outcomes, the so-called “a-k” outcomes. Specifically, engineering programs must demonstrate that their graduates have:

(a) an ability to apply knowledge of mathematics, science, and engineering
(b) an ability to design and conduct experiments, as well as to analyze and interpret data
(c) an ability to design a system, component, or process to meet desired needs
(d) an ability to function on multi-disciplinary teams
(e) an ability to identify, formulate, and solve engineering problems
(f) an understanding of professional and ethical responsibility
(g) an ability to communicate effectively
(h) the broad education necessary to understand the impact of engineering solutions in a global and societal context
(i) a recognition of the need for, and an ability to engage in life-long learning
(j) a knowledge of contemporary issues
(k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

Mapping of objectives in CVEN 3708 (Geotechnical Engineering I) against ABET outcomes:

	a	b	c	d	e	f	g	h	i	j	k
1	x	x		x			x				
2	x										
3	x			x			x				
4	x	x	x		x		x				
5	x				x						
6	x	x		x	x						
7	x	x		x	x						

Homework

- Each student is responsible for preparing their own homework and displaying their understanding of the principles behind the homework solution. Homework is due at the beginning of the class period on due date.
- 10% grade reduction will apply to any homework submitted within the 24 hours following the deadline.
- Late homework, beyond the 24 hours window will not be accepted.
- The appearance of the homework will be graded as well. To obtain the maximum grade, the submitted homework must have an appearance expected from a professional engineering report: Letters and numbers must be easily readable (no less than ¼ in height), all calculations must be presented in the proper sequence in one column and when necessary explained in words. All graphs and schematic drawings must be presented at a proper scale, straight lines drawn with the straight edge or by drafting software. Do not use spiral bound paper!
- Lab reports have to be submitted individually even though the lab work will be done in groups. For some labs the groups will have 3 or 4 students each while for other labs the groups might have as many as 6 students.
- Lab reports are due a week after the completion of the lab work. A 10% grade reduction will be given for the reports up to 24 hours late. Late reports beyond the 24 hours window will not be accepted. The reports must be typed and the calculations, graphs and drawings must be presented to the same standards as required for homework. Provide labels and make sure that plots are to scale.

Exams

- Exams will consist of a mixture between discussion and technical questions to evaluate your comprehension of the material. All exams are closed book. Design charts and similar materials will be given when needed.
- You should bring a straight edge and calculator to the exams.

Course Grade Distribution

Homework	25%
Laboratory Reports	25%
Exam 1	15%
Exam 2	15%
Final Exam	20%
Total	100%

Neatness

As engineers, you should inherently be neat and organized. You should certainly strive for neat work because you will probably have to return to design calculations at a variety of times in your careers and if you cannot figure out your own work you could be in severe difficulty. On exams, I will not give credit for answers I cannot read and will not change grading based on subsequent verbal explanations. It is your responsibility to communicate effectively.

Attendance

- Class attendance is in accordance with the published university course schedule.
- Campus policy regarding religious observances requires that faculty make every effort to deal reasonably and fairly with all students who, because of religious obligations, have conflicts with scheduled exams, assignments or required attendance. See full details at http://www.colorado.edu/policies/fac_relig.html

Academic Honesty

- The engineering profession does not need, and should not tolerate, dishonesty.
- All students of the University of Colorado at Boulder are responsible for knowing and adhering to the academic integrity policy of this institution. Violations of this policy may include: cheating, plagiarism, aid of academic dishonesty, fabrication, lying, bribery, and threatening behavior. All incidents of academic misconduct shall be reported to the Honor Code Council (honor@colorado.edu; 303-735-2273). Students who are found to be in violation of the academic integrity policy will be subject to both academic sanctions from the faculty member and non-academic sanctions (including but not limited to university probation, suspension, or expulsion). Other information on the Honor Code can be found at http://www.colorado.edu/policies/honor.html and at http://www.colorado.edu/academics/honorcode/

Disability Policy

- If you qualify for accommodations because of a disability, please submit to your professor a letter from Disability Services in a timely manner (for exam accommodations provide your letter at least one week prior to the exam) so that your needs can be addressed. Disability Services determines accommodations based on documented disabilities. Contact Disability Services at 303-492-8671 or by e-mail at dsinfo@colorado.edu. If you have a temporary medical condition or injury, see Temporary Medical Conditions: Injuries, Surgeries, and Illnesses guidelines under Quick Links at Disability Services website and discuss your needs with your professor.

Classroom Behavior

- Students and faculty each have responsibility for maintaining an appropriate learning environment. Those who fail to adhere to such behavioral standards may be subject to discipline. Professional courtesy and sensitivity are especially important with respect to individuals and topics dealing with differences of race, color, culture, religion, creed, politics, veteran's status, sexual orientation, gender, gender identity and gender expression, age, disability, and nationalities. Class rosters are provided to the instructor with the student's legal name. I will gladly honor your request to address you by an alternate name or gender pronoun. Please advise me of this preference early in the semester so that I may make appropriate changes to my records.

- See classroom behavior policies at:
  - http://www.colorado.edu/policies/classbehavior.html
  - http://www.colorado.edu/studentaffairs/judicialaffairs/code.html#student_code
- The University of Colorado Boulder (CU-Boulder) is committed to maintaining a positive learning, working, and living environment. The University of Colorado does not discriminate on the basis of race, color, national origin, sex, age, disability, creed, religion, sexual orientation, or veteran status in admission and access to, and treatment and employment in, its educational programs and activities. (Regent Law, Article 10, amended 11/8/2001). CU-Boulder will not tolerate acts of discrimination or harassment based upon Protected Classes or related retaliation against or by any employee or student. For purposes of this CU-Boulder policy, "Protected Classes" refers to race, color, national origin, sex, pregnancy, age, disability, creed, religion, sexual orientation, gender identity, gender expression, or veteran status. Individuals who believe they have been discriminated against should contact the Office of Discrimination and Harassment (ODH) at 303-492-2127 or the Office of Student Conduct (OSC) at 303-492-5550. Information about the ODH, the above referenced policies, and the campus resources available to assist individuals regarding discrimination or harassment can be obtained at http://www.colorado.edu/odh
- Assignments, assessments and activities for this course may be used for research purposes.

Course Schedule and Reading Guidelines (Exams will follow Each Topic)

Chapter	Pages	Topic	Estimated Date
1	1-27	Introduction	8/28
2	28-63	Engineering geology	9/4
4.4	138-147	Grain size distribution	9/6
3	64-114	Subsurface investigation	9/11
4-4.3	121-137	Phase relations	9/13
4.5-4.8	148-156	Clay soils and plasticity	9/18
5	164-185	Soil classification	9/18
6-6.2, 6.3-6.9	190-213, 213-244	Earthwork construction and compaction	
7-7.2	251-267	Groundwater and fluid mechanics	
7.3-7.4	268-286	1D flow	
		Measurement of Permeability	
8-8.1	295-298	2D flow	
8.2-8.3	298-319	Flow nets	
		Review and Examples	
		Midterm Exam 1 (Estimated)	
7.3	266-284	Unsaturated soils and capillarity	
9-9.3	361-377	State of stress (Mohr circle)	
9.4-9.5	378-381	Geostatic stresses	
9.6-9.7	381-394	Stresses induced by structures	
9.8	395-405	Effective stresses	
9.9-9.10	405-409	Effective stress and seepage force	
10.1-10.5	419-444	Compressibility of soils	
10.6-10.13, 15.3	444-465, 685-698	Settlement of shallow foundations	
		Review and Examples	
		Midterm Exam 2 (Estimated)	
11.1	478-489	Consolidation theory	
11.2	489-499	Rate of settlement	
11.3	432-444, 499-504	Interpretation of consolidation tests	
11.5-11.6	504-514	Miscellaneous consolidation issues	
		Hilf Lecture (Nick Sitar of Cal Berkeley)	11/14 at 3:00pm
11.7	513-518	Methods of accelerating consolidation	
		Thanksgiving Break	11/20 and 11/22
Readings		Earth structures applications	
8.4-8.6, 8.7	320-350	Filter, drainage layers, and well design	
Readings		Environmental geotechnics applications	
Readings		Geotechnical/building systems applications	
Readings		Transportation geotechnics applications	
		Review and Examples	
		Final Exam	Wed, 12/19 7:30-10 pm