MERRIMACK COLLEGE
Department of Civil Engineering

CEN 3020: GEOTECHNICAL ENGINEERING

Course Syllabus, Fall 2018

I. Course Information

Instructor:
Name: James Kaklamanos, Ph.D. ("Professor Kaklamanos")
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Office hours: Tues. and Thurs., 12–1:30 p.m.; or by appointment.

Course details:
Name: CEN 3020: Geotechnical Engineering (4 cr.); CEN 3020L: Geotechnical Engineering Lab
Class meeting times and location: Tues. and Thurs., 2:00–3:50 p.m; Mendel 140
Lab meeting times and location: Lab Section A: Mon. 12:30–3:20 p.m.; Mendel 140
Lab Section B: Mon. 3:30–6:20 p.m.; Mendel 140
Prerequisites: GEN 2012 (Mechanics II) and GEN 3040 (Fluid Mechanics)
Course website: https://blackboard.merrimack.edu

Course description (catalog): An introduction to the fundamental principles of geotechnical engineering: the interaction of earth materials with the built environment. Soil classification, compaction, seepage, consolidation, and shear strength. Intensive laboratory exercises familiarize the student with standard laboratory test methods for soil property determination and to reinforce data collection, data analysis, and report writing skills.

Course learning objectives:
Upon successful completion of this course, the student will be able to:
1. Explain the purpose of geotechnical engineering and its relationship to other disciplines.
2. Define and explain common soil types and the geologic environments in which they formed.
3. Describe and determine physical properties of soil.
4. Classify soils according to their engineering properties.
5. Construct soil compaction curves, and recommend compaction parameters for construction.
6. Evaluate one-dimensional and two-dimensional groundwater flow.
7. Calculate subsurface stresses due to geostatic and induced loadings.
8. Calculate the amount and rate of settlement due to consolidation, and interpret laboratory test results to obtain consolidation parameters.
9. Evaluate the shear strength of soil, and interpret laboratory test results to obtain strength parameters.
10. Describe common types of foundations and earth-retaining structures.
11. Conduct laboratory analyses of soils, and analyze, evaluate, and communicate experimental data from these tests.
12. Have some fun learning about dirt.

Topical outline:	*Number of sessions:*
1. Soil composition and classification	6 classes and 4 labs
2. Compaction	2 classes and 1 lab
3. Groundwater	3 classes and 1 lab
4. Stress	5 classes and 1 lab
5. Settlement	7 classes and 2 labs
6. Shear strength	6 classes and 2 labs

Case studies, applications, and workshops, with content spanning the modules listed above, will comprise additional time during some class and lab sessions.

Required course materials:

- **Textbook:** *Geotechnical Engineering: Principles and Practices (Second Edition)*, by Donald P. Coduto, Man-chu Ronald Yeung, and William A. Kitch (2011). Prentice Hall: Upper Saddle River, New Jersey. ISBN: 978-0132368681.
- **Calculator:** Only the following calculator models will be allowed on examinations in this course:
  - Casio: fx-115 or fx-991 (all models with fx-115 or fx-991 in their name)
  - Hewlett Packard: HP 33s or HP 35s (but no others)
  - Texas Instruments: TI-30X or TI-36X (all models with TI-30X or TI-36X in their name)

  These are the same types of calculators that are permitted on the Fundamentals of Engineering (FE) exam that you will complete at the end of your college career (https://ncees.org/exams/calculator/).
- **Additional materials:** An engineer's scale (or ruler), compass, and protractor are required.

Meeting structure of course:

- The class portion of CEN 3020 will meet twice a week (on Tuesdays and Thursdays) in a 1-hour 50-minute block. Each 1-hour 50-minute class session will be divided approximately into a 75-minute class, followed by a 30-minute workshop (on most Tuesdays) or lab orientation (on most Thursdays). Workshops will consist of case studies, applications, or problem sessions intended to highlight the course material. Lab orientations will consist of instruction pertinent to the laboratory activities to be performed during the subsequent lab block on Monday.
- The laboratory portion of CEN 3020 will meet once per week (on Mondays) in a 2-hour 50-minute block, with students subdivided into two sections (A and B). Most lab blocks will be devoted to performing the laboratory experiments associated with the course (of which there are 11), but on occasion some lab blocks will include class sessions.

II. Policies

Attendance:

- Attendance at all class meetings (including workshops and lab orientations) is strongly recommended and will be rewarded, but attendance at these meetings is not mandatory. When present in classes, you must arrive on time and behave in a professional manner (see the Professionalism section below); late arrivals and/or unprofessional behavior will result in a decreased course grade, as described in the Assessment section of the syllabus. If you miss a meeting for any reason, you will be expected to confer with a classmate to obtain notes, announcements, and/or assignments that you miss.
- Attendance at lab sessions, however, is mandatory. If you have more than two unexcused absences from lab sessions throughout the semester, you will receive an automatic F in the course. If a scheduling conflict arises for a given lab session (e.g., College-sponsored event, medical appointment, etc.), please seek my permission at least one week in advance to attend the other lab section, if space permits. To be excused from lab because of an extended illness or other emergency, please visit the Hamel Health and Counseling Center and have them send me a note directly.

Professionalism:

Professional behavior is expected in all aspects of this course, as professionalism is an essential characteristic of your future as a practicing engineer. Unprofessional behavior may negatively detract from the classroom environment and the learning experience of other students in the course, and will not be tolerated. Examples of unprofessional behavior may include, but are not limited to:

- Arriving late or leaving the classroom while class is in session (except for emergencies).
- Using mobile technology or personal electronic devices (e.g., cell phones, tablets, laptops, etc.) during class or lab sessions. Unless otherwise noted, classes and labs operate in an "unplugged" environment in order to minimize distractions and optimize your engagement and interaction. (Turn your electronic devices off and place them out of sight before the beginning of the session, unless you receive my prior consent due to an extenuating circumstance.)

- Using derogatory, vulgar, or insulting language.
- Unsolicited talking or disruptions during any session.
- Sleeping during any session.

Consequences for unprofessional behavior are described in the Assessment section of the syllabus. Remember that professional behavior extends to electronic communication as well. I will not reply to any emails that are unprofessional and/or lack a subject, salutation, body, and signature.

Late assignments:

- Homework submissions are due prior to the beginning of class on the due date; once class has begun, you will not be allowed to submit your work. Late homework submissions will not be accepted in this course, as they are usually not accepted in engineering practice. In the case of bids on contracts, late bids are rejected if even one minute late, resulting in the loss of employment opportunities for a firm and perhaps the subsequent loss of individual employment.
- The two major laboratory reports are the only course assignments that will be accepted after the due date, although I hope you plan your time and efforts to avoid this. A late penalty will be applied to your laboratory report grade according to the following schedule: 0-24 hours late = reduction of one letter grade; 24-48 hours late = reduction of two letter grades; 48-72 hours late = reduction of three letter grades. Laboratory reports will receive zero credit if submitted more than 72 hours after the original due date.
- All assignments must be submitted in hard copy; email submissions are not acceptable. In addition, selected written assignments (such as the two major laboratory reports portions of selected homework assignments) will also be submitted electronically on TurnItIn.com per the instructions of each assignment.

Class honor code:

- Canon 6 of the American Society of Civil Engineers (ASCE) Code of Ethics states that "Engineers shall act in such a manner as to uphold and enhance the honor, integrity, and dignity of the engineering profession." This means that acts of academic dishonesty are unprofessional, unacceptable, and will not be tolerated whatsoever.
- It is unacceptable to copy the work of another student, whether on exams or assignments; such behavior will be grounds for academic disciplinary action, including, but not limited to: zero credit for the assessment in question, a failing grade for the course, suspension from the College, or dismissal from the College. It is also unacceptable to look at prior students' work or solutions to assignments or exams that have not been made directly available by the instructor. Now or in the future, you are not allowed to distribute any instructor-provided course materials to others.
- No electronic audio, video, or photographic recording is allowed in class without my prior written permission.
- Collaboration is allowed on homework and lab assignments, but all assignments must be written up independently by each student. If you consult with any of your classmates or anyone else, you must indicate their names at the end of the relevant problem(s).
- Students must carefully review the Merrimack College Academic Integrity Code (AIC) posted on Blackboard and available at https://www.merrimack.edu/live/files/279-academic-integrity-code. You will be required to sign an Academic Integrity Pledge during the first week of class, after you have reviewed the Academic Integrity Code and course policies.

Communication: Course announcements will be made in class and via email. Students are expected to be reachable through their Merrimack email address, and are responsible for receiving all course announcements, both inside and outside of class.

Americans with Disabilities (ADA) Policy: Merrimack College provides reasonable accommodations for students with documented disabilities. Students who have, or think they may have, a disability are invited to contact the Accessibility Services Office via the online request form: https://www.merrimack.edu/accessibility, email: accessibilityservices@merrimack.edu, or by visiting the third floor of McQuade Library. Students are encouraged to contact the office as soon as possible to ensure adequate time to meet and create a plan; accommodations cannot be made retroactively.

General comments: I look forward to working with you throughout the semester, and I encourage you to ask questions and be engaged in the course. Throughout the semester, please inform me of any personal circumstances or issues that I should know about. Please do not hesitate to drop by office hours, call me, or send me an email if you ever have any questions or concerns.

III. Assessment

Grading: To earn a grade in the C range, you will need to successfully memorize the basic material and correctly apply it to problems similar to those we have covered. To earn a grade in the B range, you will also need to show evidence of understanding the material well enough to explain the intuition behind the problems. To earn a grade in the A range, you will also need to be able to correctly apply the material to new problems and explain the intuition behind the underlying theory. Grades of D and F represent below-average and failing performance, respectively. Throughout the semester, students are responsible for being aware of their current course averages. The weights for your final course grade are as follows:

68% Exams and quizzes *
- 19% Midterm Examination 1
- 19% Midterm Examination 2
- 25% Final Examination
- 5% Quizzes (11)

32% Assignments
- 20% Homework assignments (12)
- 12% Laboratory reports (2) *

* In order to pass this course, you must demonstrate mastery of the material presented in class and lab. This means that (1) your weighted exam and quiz average must be greater than 60%, and (2) your laboratory report average (prior to any late penalties applied) must be greater than 60%, regardless of your grades on other assignments. In addition, your final weighted course average (encompassing all exams, quizzes, and assignments) must be greater than 60%.

Letter grades will be computed from your final numerical course average using the following scale:
A: 93 and above, A−: 90–92, B+: 87–89, B: 83–86, B−: 80–82, C+: 77–79, C: 73–76, C−: 70–72, D+: 67–69, D: 63–66, D−: 60–62, F: 0–59. Numerical averages will be rounded to the nearest whole number. Per Department policy, any student who matriculated at Merrimack College in or after Fall 2016 will be required to obtain a grade of C- or higher in CEN 3020 to enroll in any subsequent course for which CEN 3020 is a prerequisite.

Exams: There will be three (3) exams: (1) Midterm Examination 1, during class on Thurs., Oct. 18; (2) Midterm Examination 2, during class on Thurs., Nov. 15; and (3) a cumulative Final Examination, on Thurs., Dec. 13, from 11:30 a.m. – 2:30 p.m. (the date and time established by the Registrar). The format and coverage of each exam will be discussed in class, with sufficient notice. Exams will assess your understanding of concepts covered in class, lab, workshops, homework, and the assigned reading. No make-ups will be allowed for exams except in the case of a medical emergency with appropriate documentation.

Homework:
- Homework assignments will assess material covered in class, lab, workshops, and the assigned reading. Many assignments will require written responses in addition to calculations. Homework problems provide you with practice using the methods covered in class and are essential for you to become proficient with these methods. Homework also provides an opportunity to assign more complex and/or thought-provoking

problems than those that may be assigned during a timed exam. Remember that the primary purpose of homework is to facilitate learning, not just to produce a solution as the end result.

- Assignment due dates are specified in the course schedule in this syllabus (generally on Tuesdays, and sometimes on Thursdays); submissions must be made prior to the start of class. Homework assignments must follow the prescribed format in the "Guidelines for Homework Submissions" section at the end of this syllabus. Unless otherwise noted, all homework assignments will be weighted equally when determining your final homework average, and your lowest homework grade will be dropped.
- Homework solutions will not be posted; the burden is on you to make sure you find out how to solve the problems by getting help before they are due, or asking about them after they have been handed in. In addition to office hours, time will be available during each lab session (either before or after the lab activity) for you to ask questions regarding the upcoming homework assignment.
- You will be able to earn 15 points on each homework assignment, based on two categories of review. First, all homework problems will be checked for completeness (10 points total); in order to receive full credit on a problem, the following conditions must be met: (a) all parts of the problem must be completed, (b) an honest attempt must have been made, and (c) your work must follow the prescribed format guidelines. Second, a subset of selected problems will be graded further for accuracy (5 points total); you will be assigned points based on the technical accuracy of your solution to these problems.
- On each homework submission, you will be allowed to earn 1 point of extra credit by submitting an outline or study guide of the assigned reading material. To receive full credit, an outline should not only be well-written and complete in its coverage, but it should also link the textbook to the material in your class notes. Note that each assignment will have 15 possible points, so a perfect score with extra credit would be 16/15.

Labs:

- Hands-on laboratory learning will be an integral component of this course, and experiments and/or activities will occur each week during your assigned lab section.
- Data analysis from laboratory experiments and activities will be submitted in one of two ways: (1) as problems submitted as part of the weekly homework assignments, or (2) as a formal laboratory report. Analyses for many lab activities will be incorporated into the homework assignments due each week. Beyond these weekly submissions, two formal laboratory reports will be required throughout the semester: one covering Labs 2-4 (Soil Composition and Classification), and the other covering Labs 8-9 (Consolidation). Expectations for these formal laboratory reports will be discussed during the relevant lab sessions. Students may work alone, with a partner, or in groups of three on these lab reports (with one submission per group).
- The two laboratory reports will be weighted equally when computing your final laboratory report average. Your grades for any laboratory data analyses submitted with your weekly homework assignments will be factored into the corresponding homework assignment.

Quizzes: A short, five-minute quiz will be administered at the beginning of each lab session that involves an experiment (11 quizzes throughout the semester). Each quiz will be related to the lab experiment to be performed that week, and will assess your understanding of: (1) fundamental course concepts related to the lab activity, and (2) the laboratory procedure. Before each lab, you are encouraged to review the relevant course material and the laboratory procedure in preparation for the quiz. Quizzes will only be administered to students who arrive to lab on time; if you are absent or arrive after the start of lab, you will receive a grade of zero. Make-up quizzes will not be administered for any reason; however, your lowest two quiz scores throughout the semester will be dropped, and your remaining nine (9) quiz scores will be weighted equally to determine your final quiz average.

Reading: In the course schedule provided in this syllabus, reading assignments from the textbook are listed for each class session. Reading assignments are to be done before the class for which they are listed, so that you may take an active role in the class and ask any questions to clarify the reading. Class sessions are intended to highlight or clarify concepts in the assigned reading, not to cover every concept for which you are responsible. If I do not cover a concept that needs clarification, please bring it up during class. Homework assignments and exam questions will be drawn heavily from the reading. For each textbook chapter, make sure to also read the chapter introduction and conclusion (summary).

Professionalism: Professional or unprofessional behavior will result in adjustments to your final course average: professional behavior throughout the term will result in a numerical increase, and unprofessional behavior will result in a numerical decrease.

- Students who exhibit exemplary attendance, punctuality, and participation will be rewarded. At the end of the semester, students who have no more than one unexcused absence, no more than one unexcused late arrival, do not engage in any unprofessional behavior (including usage of personal electronics), and who actively participate in class and lab throughout the semester, will receive one bonus point added to their final course average.
- Usage of personal electronics during any session, arriving to any session late (on more than two occasions), and/or engaging in other disruptive, disrespectful, or unprofessional behavior (examples of which are given in the course policies above) will result in automatic reductions of a student's final course average. On each instance that you engage in unprofessional behavior, I will immediately deduct one or more points off your final course average, no questions asked. Continued unprofessional and/or disruptive behavior may result in dismissal from the class, with readmission only allowed after a follow-up conversation with the instructor.

IV. Class and Laboratory Schedule (Tentative)

Notes:

- Abbreviations for session titles are: C = Class, L = Laboratory, W = Workshop, and LO = Lab Orientation.
- Due to the Columbus Day holiday, a Monday class schedule will be followed on Tuesday, Oct. 9.
- Note that some class sessions (marked with an asterisk, *) will be held during a lab block.

Mtg. No.	Session Title	Date	Textbook Reading	Assignment Due
Module 1: *Soil Composition and Classification*				
C1	Course Introduction; Overview of Geotechnical Engineering	Tue. Sept.4	1.1–1.5	
W1	Background Knowledge Probe			
C2	Engineering Geology	Thu. Sept. 6	2.1–2.3, 2.5–2.7	
C3	Soil Composition: Phase Diagrams *	Mon. Sept. 10	4.1–4.3	Quiz 1
LO-1	Lab Orientation 1			
L1	Lab 1: Water Content			
C4	Soil Composition: Grain Size and Plasticity	Tue. Sept. 11	4.4–4.8	HW 1
W2	Case Study: Hurricane Katrina			
C5	Soil Classification Systems	Thu. Sept. 13	5.1–5.3	
LO-2	Lab Orientation 2			
L2	Lab 2: Grain Size Distributions – Sieve and Hydrometer Analyses	Mon. Sept. 17		Quiz 2
C6	Soil Classification Applications	Tue. Sept. 18	5.4–5.6	HW 2
W3	Case Study: World Trade Center			

Mtg. No.	Session Title	Date	Textbook Reading	Assignment Due
Module 2: *Compaction*				
C7 LO-3	Compaction Concepts Lab Orientation 3	Thu. Sept. 20	6.1–6.3	
L3	Lab 3: Plasticity – Plastic and Liquid Limit Tests	Mon. Sept. 24		Quiz 3
C8 W4	Compaction Tests and Specifications Applications: Shallow Foundations	Tue. Sept. 25	6.4–6.9 14.1	HW 3
Module 3: *Groundwater*				
C9 LO-4	Groundwater Fundamentals Lab Orientation 4	Thu. Sept. 27	7.1–7.2	
L4	Lab 4: Soil Classification	Mon. Oct. 1		Quiz 4
C10 W5	One-Dimensional Flow and Darcy's Law Applications: Deep Foundations	Tue. Oct. 2	7.3–7.4 14.2	HW 4
C11	Two-Dimensional Flow; Flow Net Diagrams	Thu. Oct. 4	8.1–8.2	
Module 4: *Stress*				
C12 W6	Introduction to Stress; Stress Analysis Using the Mohr Circle * Case Study: Oso and Montecito Landslides	Tue. Oct. 9	9.1–9.3	HW 5
C13 LO-5	Geostatic and Effective Stresses Lab Orientation 5	Thu. Oct. 11	9.4–9.5, 9.8	
L5	Lab 5: Compaction	Mon. Oct. 15		Quiz 5
C14 LO-6	Effective Stress (Continued) Lab Orientation 6	Tue. Oct. 16	9.8–9.9	HW 6
C15	**Midterm Examination 1**	Thu. Oct. 18		Midterm 1
L6	Lab 6: Hydraulic Conductivity	Mon. Oct. 22		Quiz 6
C16 W7	Induced Stress Stress Workshop	Tue. Oct. 23	9.6–9.7	HW 7
Module 5: *Settlement*				
C17	Introduction to Settlement and Consolidation	Thu. Oct. 25	10.1–10.4	Lab Rpt. 1

Mtg. No.	Session Title	Date	Textbook Reading	Assignment Due
LO-7	Lab Orientation 7			
L7	Lab 7: Geotechnical Engineering Software Lab in R	Mon. Oct. 29		Quiz 7
C18	Consolidation Testing	Tue. Oct. 30	10.5	HW 8
W8	Case Study: Christchurch Earthquake			
C19	Consolidation Settlement Predictions	Thu. Nov. 1	10.6, 10.8	
LO-8	Lab Orientation 8			
L8	Lab 8: Consolidation Test	Mon. Nov. 5		Quiz 8
C20	Secondary Compression; Consolidation Rate Theory	Tue. Nov. 6	10.7, 10.9–10.13, 11.1	
W9	Applications: Earth Retaining Structures I		16.1	
C21	Consolidation Rate Predictions	Thu. Nov. 8	11.2	HW 9
LO-9	Lab Orientation 9			
L9	Consolidation Data Analysis	Mon. Nov. 12		Quiz 9
C22	Coefficient of Consolidation	Tue. Nov. 13	11.3–11.4	
W10	Applications: Earth Retaining Structures II		16.2–16.3	
C23	**Midterm Examination 2**	Thu. Nov. 15		Midterm 2
Module 6: *Shear Strength*				
C24	Introduction to Shear Strength *	Mon. Nov. 19	12.1–12.3	
C25	Mohr-Coulomb Failure Law; Direct Shear Test *	Mon. Nov. 19	12.4, 12.9	
C26	Triaxial Test: Fundamentals	Tue. Nov. 20	12.9	HW 10
LO-10	Lab Orientation 10			
L10	Lab 10: Shear Strength – Direct Shear Test	Mon. Nov. 26		Quiz 10
C27	Triaxial Test: Soil Behavior	Tue. Nov. 27	12.5–12.9	
C28	Undrained Shear Strength; Unconfined Compression Test	Thu. Nov. 29	12.9	HW 11
LO-11	Lab Orientation 11			
L11	Lab 11: Shear Strength – Unconfined Compression Test	Mon. Dec. 3		Quiz 11

Mtg. No.	Session Title	Date	Textbook Reading	Assignment Due
W11	Shear Strength Workshop	Tue. Dec. 4		Lab Rpt. 2
C29	Course Conclusion	Thu. Dec. 6		HW 12
L12	Open Lab Block / Final Exam Review	Mon. Dec. 10		
—	**Final Examination**	Thu. Dec. 13, 11:30 a.m. – 2:30 p.m.		Final Exam

V. Guidelines for Homework Submissions

Format:

- Homework assignments should be neat, clear, and accurate. All work is to be done on 8½×11 paper and stapled together. The use of engineering paper is required for all assignments, except on problems that involve typed responses.
- On the first page of a homework assignment, please include your name, date, course number (CEN 3020), assignment number and name, and the total number of pages (e.g., "Page 1 of *n*"). On successive pages, include your name (or initials) and page number in the upper right corner.
- Use straightedges, protractors, and/or compasses for all diagrams, sketches and graphs; write legibly and unambiguously in a sequential format down the page.
- Leave an appreciable space (at least 1 inch) between problems or start each problem on a new page.
- Acknowledge collaboration with fellow students.

Problem-solving procedure:

- **Given** and **Find**: Restate the problem in your own words, including the information that is given and what is to be found. The reader should not have to refer to the textbook or problem assignment.
- **Sketch**: Include a sketch of the system, using straightedges where appropriate.
- **Solution**: Solve the problem (algebraically and/or numerically) to obtain your answer. Provide written explanations to help explain your thought process. State the fundamental equations and/or principles necessary to solve the problem, as well as any assumptions.
- **Answer**: Enclose your final answer with a box. Include units and remember the number of significant figures that are appropriate. If necessary, discuss your results and the assumptions used. Check your answer for reasonableness and confirm the consistency of your units.

General comments:

- Neatness and legibility is a requirement for an assignment to be graded. Homework that does not follow these guidelines or that is illegible may be returned with a grade of zero.
- Organization and neatness will be considered in grading, along with procedures and final answer. Show enough equations, sources of information, assumptions and intermediate steps so that your work can be followed both by a grader and by you when you later use the homework for review.
- Your homework submissions should reflect the diligence and thoroughness required in engineering. Consider your homework a professional submittal to your boss. What will happen if he/she cannot read or understand it?