MERRIMACK COLLEGE
Department of Civil Engineering

CEN 5020: FOUNDATION 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 5020: Foundation Engineering (4 cr.)
Class meeting times and location: Tues. and Thurs., 10:00–11:50 a.m.; Mendel 140
Prerequisites: CEN 3020 (Geotechnical Engineering) and MTH 2220 (Differential Equations)
Course website: https://blackboard.merrimack.edu

Course description (catalog): An introduction to the geotechnical design aspects of foundations. Site investigation techniques and characterization of subsurface conditions. Analysis and design of shallow and deep foundations subjected to vertical and lateral loading, with an emphasis on bearing capacity and settlement. Evaluation and selection of foundation types and alternatives. Case studies and design problems.

Course learning objectives:
Upon successful completion of this course, the student will be able to:
1. Apply the fundamental principles of soil mechanics to the geotechnical design of foundations.
2. Explain the types of common subsurface exploration techniques, and assess their advantages and disadvantages.
3. Analyze laboratory and field data to determine appropriate soil parameters for foundation design.
4. Compare and contrast the different types of foundation systems, and recommend when various foundation systems are appropriate.
5. Compare and contrast common methods for the geotechnical design of foundations.
6. Analyze and design shallow foundations (footings and mats) for bearing capacity.
7. Analyze and design shallow foundations (footings and mats) for settlement.
8. Analyze and design deep foundations (piles and drilled shafts) for load capacity.
9. Exemplify enhanced communication and research skills by completing open-ended geotechnical design problems and reports.

Topical outline:	*Number of sessions:*
1. Soil mechanics review and applications	5 classes
2. Subsurface exploration and characterization	2 classes
3. Shallow foundations: Bearing capacity	4 classes
4. Shallow foundations: Settlement	4 classes
5. Shallow foundation design	3 classes
6. Deep foundations	8 classes

Required course materials:

- **Primary textbook:** *Principles of Foundation Engineering (Seventh Edition)*, by Braja M. Das (2011). Cengage Learning: Stamford, Connecticut. ISBN: 978-0495668107.
- **Secondary textbook** (same textbook as CEN 3020): *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:** On certain examinations in this course, only the following calculator models will be allowed:
  - 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/). On other examinations later in the semester, you may potentially be allowed to use calculators other than those listed, but you will need to reset the calculators (clearing all memory) prior to using them in the exam room.
- **Additional materials:** An engineer's scale (or ruler), compass, and protractor are required.

II. Policies

Attendance:
Attendance at all class meetings is strongly recommended and will be rewarded, but attendance at class meetings is not mandatory. When present in class, 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 class for any reason, you will be expected to confer with a classmate to obtain notes, announcements, and/or assignments that you miss.

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 sessions. Unless otherwise noted, classes 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 in class.
- Sleeping in class.

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 design project submissions 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 submission 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. Design project submissions 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 design projects and 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 assignments and design projects, 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:

66% Exams *
- 20% Midterm Examination 1
- 20% Midterm Examination 2
- 26% Final Examination

34% Assignments
- 20% Homework assignments (11)
- 14% Design project submissions (2)

* In order to pass this course, you must demonstrate mastery of the material presented in class. This means that your weighted exam average must be greater than 60%, regardless of your grades on other assignments. In addition, your final weighted course average (encompassing all exams 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. Graduate students (or undergraduate students seeking graduate credit for this course) will earn a grade of F for final course averages below 70; per College policy, grades in the D range cannot be assigned in graduate courses. To further distinguish between the undergraduate and graduate sections of this course, anyone seeking graduate credit for this course will have additional expectations for some of the design project submissions.

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 Wed., Dec. 19, from 8–11 a.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, homework, projects, 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 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; 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 prior to the beginning of class on the day preceding the due date 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.

Design Project: During the semester, you will be assigned a geotechnical design project using data from a real-world infrastructure project. The tasks of the design project will involve a review of geotechnical and geological literature, analysis of subsurface investigation data, evaluation of foundation alternatives, and geotechnical design of foundations. Two submissions will be associated with the project (as indicated in the schedule), and these submissions will be weighted equally when determining your final design project average. Students may work alone, with a partner, or in groups of three on these design projects (with one submission per group).

Reading: In the course schedule provided in this syllabus, reading assignments from the textbooks 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.

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 throughout the semester, will receive one bonus point added to their final course average.
- Usage of personal electronics during class, arriving to class 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 Schedule (Tentative)

Notes:

- Readings refer to sections from the textbook by Das and the textbook by Coduto, Yeung, and Kitch (abbreviated "CYK").
- Due to the Columbus Day holiday, a Monday class schedule will be followed on Tuesday, Oct. 9.

Class No.	Class Title	Date	Textbook Reading	Assignment Due
Module 1: *Soil Mechanics Review and Applications*				
1	Overview of Foundation Engineering; Soil Composition and Classification	Tue. Sept. 4	CYK 1.1–1.5, 14.1–14.2; Das 1.1–1.11, 2.1–2.10	
2	Stress	Thu. Sept. 6	CYK 9.1–9.5, 9.8; Das 1.12, 5.2–5.4, 5.7–5.8	
3	Consolidation	Tue. Sept. 11	CYK 10.1–10.4, 10.8; Das 1.13–1.15	HW 1
4	Shear Strength	Thu. Sept. 13	CYK 12.1–12.4; Das 1.17–1.21	
5	Slope Stability and Lateral Earth Pressures	Tue. Sept. 18	CYK 13.1–13.7, 17.1–17.2 (pp. 720-730); Das 7.1–7.3, 7.10	HW 2
Module 2: *Subsurface Exploration and Characterization*				
6	Subsurface Exploration Programs; Standard Penetration Test	Thu. Sept. 20	CYK 3.1–3.9 (to p. 96); Das 2.11–2.19, 2.24–2.25	
7	Additional In-Situ Tests	Tue. Sept. 25	CYK 3.9 (pp. 96–106), 3.10–3.13; Das 2.20–2.23, 2.26–2.27	HW 3
Module 3: *Shallow Foundations: Bearing Capacity*				
8	Shallow Foundations: Footings and Mats	Thu. Sept. 27	CYK 14.1; Das 6.3	
9	Bearing Capacity: Introduction; Terzaghi's Bearing Capacity Theory	Tue. Oct. 2	Das 3.1–3.4	HW 4
10	The General Bearing Capacity Equation	Thu. Oct. 4	Das 3.5–3.6	
11	Additional Topics in Bearing Capacity	Thu. Oct. 11	Das 3.7, 3.9, 3.10 (p. 159, 163), 3.11 (p. 165), 5.19, 6.4	HW 5
Module 4: *Shallow Foundations: Settlement*				
12	Settlement: Introduction; Elastic Settlement from Theory	Tue. Oct. 16	CYK 10.1–10.3; Das 5.1, 5.9–5.10	HW 6
13	**Midterm Examination 1**	Thu. Oct. 18		Midterm 1
14	Empirical Relations for Elastic Settlement; Consolidation Settlement	Tue. Oct. 23	Das 5.13 (pp. 263–264), 5.15–5.17, 6.6	Design Project 1
15	Allowable Settlement	Thu. Oct. 25	Das 5.20	HW 7

Class No.	Class Title	Date	Textbook Reading	Assignment Due
Module 5: *Shallow Foundation Design*				
16	Foundation Design Methodologies	Tue. Oct. 30	Handouts	
17	Shallow Foundation Design	Thu. Nov. 1	Handouts	HW 8
18	Shallow Foundation Design	Tue. Nov. 6	Handouts; Das 6.7	
Module 6: *Deep Foundations*				
19	Deep Foundations: Piles and Drilled Shafts	Thu. Nov. 8	CYK 14.2; Das 11.1–11.4, 12.1–12.4	HW 9
20	Static Analysis of Piles: Point Resistance	Tue. Nov. 13	Das 11.5–11.7	
21	**Midterm Examination 2**	Thu. Nov. 15		Midterm 2
22	Static Analysis of Piles: Side Resistance	Tue. Nov. 20	Das 11.10–11.12	Design Project 2
23	Pile Load Tests; Dynamic Analysis of Piles	Tue. Nov. 27	Das 11.14, 11.17	HW 10
24	Settlement; Pile Group Effects	Thu. Nov. 29	Das 11.15, 11.20–11.23	
25	Capacity of Drilled Shafts	Tue. Dec. 4	Das 12.5–12.11	HW 11
26	Course Conclusion	Thu. Dec. 6		
—	**Final Examination**	Wed. Dec. 19, 8–11 a.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 5020), 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?