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CE 643-104: Advanced Foundation Design

Bruno Goncalves da Silva

JOHN A. REIF, JR. DEPARTMENT OF
CIVIL AND ENVIRONMENTAL ENGINEERING

NJIT New Jersey Institute of Technology

CE 643 – Advanced Foundation Design – Spring 2020
Section: 104

Instructor Dr. Bruno Gonçalves da Silva, Ph.D. Office Hours: Mondays, Tuesdays 4.30pm-6pm
Colton 233
E-Mail bmgsilva@NJIT.edu

Prerequisite: CE 642. Lateral and earth pressure computations for the design of retaining walls, bulkheads, cellular cofferdams, and sheetpiles. Also considers the design of internal bracing systems and anchors, soil nailing and reinforced earth. Slope stability of embankments and dams.

Required Textbooks

Terzaghi, K, Peck, R, Mesri, G (1996) Soil Mechanics in Engineering Practice, 3rd Edition, John Wiley and Sons, ISBN#: 978-0-471-08658-1

Das, BM, & Sobhan, K (2018) Principles of Geotechnical Engineering, 9th Edition, Cengage Learning, ISBN#: 978-1-305-97093-9

Other Highly Recommended Texts & Reading

Lambe, T, & Whitman, R (1969) Soil Mechanics (Series in Soil Engineering), 3rd Edition, John Wiley and Sons, ISBN#: 978-0-471-51192-2

Course Description

This course will describe methods of analysis, design and monitoring of earth retaining structures, including cantilever and propped walls, as well as braced excavations and testing of deep foundations. Initially, the course will give an overview of site investigation methods and emphasize the importance of soil parameter selection in geotechnical problems. The lectures will also cover soil-structure interaction, slope stability, techniques for ground improvement and mechanically-supported earth walls and slopes. Throughout the course the students will also be exposed to the modeling and analysis of geotechnical problems using the Finite Element code Plaxis.

Course Objectives (General)

By the end of this course, the student will be able to:

Estimate engineering properties of soils: Based on laboratory and/or in-situ tests and appropriate correlations, estimate strength and deformability parameters of cohesive and granular soils

Design braced excavations: Use field and laboratory data to determine earth and pore pressures, in order to design cantilever, propped and braced excavation walls, including tie-back design.

Evaluate slope stability: Identify failure mechanisms, determine safety of slopes and design measures to stabilize them.

Numerically model geotechnical engineering problems: Model excavation and slope stability problems using finite element analyses (software Plaxis will be used), including extracting and interpreting relevant outputs, such as deformation and stresses in soil and earth-retaining structures, as well as loads in tie-backs and struts.

Design mechanically-stabilized earth walls: Determine safety of MSE walls, as well as thickness and spacing between geo-membranes when using MSE walls.

POLICIES & PROCEDURES

Academic Integrity is the cornerstone of higher education and is central to the ideals of this course and the university. Cheating is strictly prohibited and devalues the degree that you are working on. As a member of the NJIT community, it is your responsibility to protect your educational investment by knowing and following the academic code of integrity policy that is found at: *http://www5.njit.edu/policies/sites/policies/files/academic-integrity-code.pdf*.
Please note that it is my professional obligation and responsibility to report any academic misconduct to the Dean of Students Office. Any student found in violation of the code by cheating, plagiarizing or using any online software inappropriately will result in disciplinary action. This may include a failing grade of F, and/or suspension or dismissal from the university. If you have any questions about the code of Academic Integrity, please contact the Dean of Students Office at dos@njit.edu"

Communication: All communications by the instructor will be during the class and via e-mail. It is your responsibility to check your e-mail regularly. If you prefer to use a private e-mail account, please inform the instructor.

Lectures/Class: Attendance to all lecture/class periods is expected. **Absence of 3 or more classes will result in a failing grade** for the course. During the class instructor will often ask you to work on a problem or brainstorm ideas with the people next to you and you will be called on to provide one or more of your answers. The goal of this in-class work is to get you started on a problem (not necessarily finish) that will then be discussed. Please turn off your cell phones during class.

Diagnostic test: A diagnostic test, which will not count for the final grade, will be given on the first day of classes. The test does aims to assess the required background knowledge for the students to be able to take the course. Based on the result of the test, the instructor will provide the students with individual feed-back and advice, encouraging or discouraging the students to take the course. The diagnostic test will consist of 15 multiple choice question that should be completed in 15 minutes. It will focus on basic soil mechanics, foundation design and strength of materials' concepts.

Homework: It is expected that all homework be presented in an organized manner; use green, yellow or white engineering paper, one side of each page (clear side, not grid side); begin each problem on a new page and number all pages; staple all homework pages together and have your name written clearly on the front page.

Homework Format: Homework questions will be graded in terms of a ten point scheme based on three categories of format, concept, and execution. All homework questions will be equally weighted in determining your final homework grade.

Format

One (1) point will be awarded if the solution is formatted with a problem statement and a statement on what is required in the solution

One (1) additional point will be awarded if the engineering solution is presented in an organized and neat fashion that is easy to follow along.

One (1) additional point will be awarded if the solution is completed with a boxed-in answer, including a properly formatted drawing if it is requested in the problem statement.

Concept

One (1) point will be awarded if the solution has major errors in the conceptual basis of the solution.
Two (2) points will be awarded if the solution has minor errors in the conceptual basis of the solution.
Three (3) points will be awarded if the solution has no errors in the conceptual basis of the solution.

Execution

One (1) point will be awarded if the solution has two or more math or execution errors.
Three (3) points will be awarded if the solution has one math or execution error.
Four (4) points will be awarded if the solution has zero math or execution errors.

Late Homework: Homework will be due at the beginning of class on the date it is due. Late Homework will be accepted up to two days after the due date with a 10% reduction for each day that it is late. After that time they will not be accepted. The late homework should be turned in to the Instructor by 5pm.

Homework Solutions: Engineering problems are typically open-ended. The homework assignments will reflect this fundamental aspect of engineering, hence they will admit multiple solutions, as long as they are well explained and theoretically founded. As such, homework solutions will not be provided to students; instead, feedback on the homework assignment and interactive discussion will take place when the assignment is returned to the students. It is the students' responsibility to make sure they understand how to solve the problems by attending office hours with the instructor and/or asking questions in class.

Exams: There will be one midterm exam held during class time and one comprehensive final exam as scheduled by the University Registrar.

Term Paper: There will be a term paper that should be done in groups of two students, and should have 12-15 pages, in addition to the reference list. Figures must be used to clarify written concepts and explanations. The term paper must discuss an engineering topic related to the topics covered in class (e.g. failure of deep excavations, design strategies followed in a major excavation, measures to stabilize a prominent slope), as will be further explained in class. The purpose of the term paper is to 1) provide the students with the opportunity to treat thoroughly a limited subject and to present their work in a clearly understandable and technically well-founded manner, 2) give the students the opportunity and experience in integrating their knowledge of several areas, 3) develop the ability of the student in critically judging source material and 4) supplement the general information provided by the lectures with detailed information on a related subject.

Calculation of Course Grade: A weighted average grade will be calculated as follows:

25% - Homework
20% - Term paper
10% - Class Participation
20% - Midterm
25% - Final

The minimum requirements for final letter grades are as follows:

A = 90.0%, B+ = 85.0%, B = 80.0%, C+ = 75.0%, C = 70.0%, D = 65.0%, F < 60.0%

Grades are not curved in computing the final grade.

Instructor Commitment: You can expect the Instructor to be courteous, punctual, organized, and prepared for lecture and other class activities; to answer questions clearly; to be available during office hours or to notify you beforehand if office hours are moved; to provide a suitable guest lecturer or pre-recorded lecture when they are traveling or unavailable; and to grade uniformly and consistently.

Students with Documented Disabilities: NJIT is committed to providing students with documented disabilities equal access to programs and activities. If you have, or believe that you may have, a physical, medical, psychological, or learning disability that may require accommodations, please contact the Coordinator of Student Disability Services located in the Center for Counseling and Psychological Services, in Campbell Hall, Room 205, (973) 596-3414. Further information on disability services related to the self-identification,

documentation and accommodation processes can be found on the webpage. at: (http://www.njit.edu/counseling/services/disabilities.php)

Estimated Course Schedule:

CE 643 - Advanced Foundation Engineering Estimated schedule		
Week	**Topic**	**Assignments**
1	Introduction Soil classification Site investigation: - Drilling and soil sampling methods	
2	Soil properties based on in-situ testing Geotechnical design: - Emphasis on the selection of soil parameters for ultimate and serviceability limit state calculations	
3	Earth retaining structures - Introduction Earth pressures - Review	
4	Gravity and cantilever retaining walls Propped walls Sheet-pile walls	Assignment 1
5	Design of anchors and tiebacks Braced excavations	Term project: Outline and references Assignment 2
6	Braced excavations	Due Assignment 1
7	Introduction to Finite Element modeling Modeling of an excavation problem in Plaxis	Due Assignment 2
8	**Midterm**	
9	Soil-structure interaction Piles subject to horizontal loads	Term project: Due Initial draft Assignment 3 – Plaxis modeling
10	Pile testing	
11	Slope stability	Assignment 4 Due Assignment 3
12	Drained and Undrained behavior of soils Modeling of a slope stability problem in Plaxis	
13	Mechanically stabilized earth walls and slopes: - Reinforced soil - Nailed soil	Due Term project Due Assignment 4
14	Ground improvement Term project: Presentations	
15	**Final**	

CE 643 – Advanced Foundation Design

Strategies, Actions, Assignments	Assessment Measures	ABET Student Outcomes (1-7)	Program Educational Objectives
Student Learning Outcome 1: Interpret laboratory and in-situ tests to estimate soil strength and deformability properties			
Students will learn how to use in-situ and laboratory test data to estimate engineering properties of soils	Class/group discussions, homework and examinations.	1, 6, 7	1, 2
Students will learn basic soil behavior, including drained and undrained stress-strain behavior	Class/group discussions, homework and examinations.	1, 7	1
Student Learning Outcome 2: Use laboratory and in-situ data to design excavation walls, including cantilever, propped and braced excavation walls			
Students will learn how to use earth pressure theory and statics to design cantilever and propped walls	Homework, term paper and examinations.	1, 2, 3, 4	1, 2
Students will learn how to use apparent earth pressures and finite element methods to calculate earth pressures in braced excavations	Homework, term paper and examinations.	1, 2, 3, 4, 5, 6, 7	1,2
Students will learn how to determine loads in tie-backs and struts and how to design tie-backs	Homework, term paper and examinations.	1, 2, 3, 4	1,2
Student Learning Outcome 3: Evaluate the safety of slopes in soil and design methods to stabilize them			
Students will learn methods (e.g. Fellenius, Simplified Bishop, Taylor) to analyze the safety of possible failure mechanisms	Class discussion, homework, term paper and examinations.	1, 2, 3, 4	1
Students will learn how to design slope stabilization measures	Class discussion, homework, term paper and examinations.	1, 2, 3, 4, 5, 6	1,2
Students will learn how to use finite element analysis to evaluate the safety of a slope	Class discussion, homework, term paper	1, 2, 3, 4, 5, 7	1,2

CEE Mission, Program Educational Objectives and Student Outcomes

The mission of the Department of Civil and Environmental Engineering is:

- to educate a diverse student body to be employed in the engineering profession
- to encourage research and scholarship among our faculty and students
- to promote service to the engineering profession and society

Our program educational objectives are reflected in the achievements of our recent alumni:

1 – Engineering Practice: Alumni will successfully engage in the practice of civil engineering within industry, government, and private practice, working toward sustainable solutions in a wide array of technical specialties including construction, environmental, geotechnical, structural, transportation, and water resources.

2 – Professional Growth: Alumni will advance their skills through professional growth and development activities such as graduate study in engineering, research and development, professional registration and continuing education; some graduates will transition into other professional fields such as business and law through further education.

3 – Service: Alumni will perform service to society and the engineering profession through membership and participation in professional societies, government, educational institutions, civic organizations, charitable giving and other humanitarian endeavors.

Our Student Outcomes are what students are expected to know and be able to do by the time of their graduation:

1. an ability to identify, formulate and solve complex engineering problems by applying principles of engineering, science and mathematics
2. an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety and welfare, as well as global, cultural, social, environmental and economic factors
3. an ability to communicate effectively with a range of audiences
4. an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental and societal contexts
5. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks and meet objectives
6. an ability to develop and conduct appropriate experimentation, analyze and interpret data and use engineering judgment to draw conclusions
7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies

Revised: 2/13/18