JOHN A. REIF, JR. DEPARTMENT OF
CIVIL AND ENVIRONMENTAL ENGINEERING
NJIT New Jersey Institute of Technology

CEE 643 – 01: Advance Foundation Engineering

(3 credits)

Lectures Thursdays 6:00pm – 8:50pm
GITC-1100 and CE Computer Lab

Instructor **Asif Arshid, Ph.D., P.E.**
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Office Hours: Mon & Fri 5:00-6:30pm (Online)

Prerequisite Approved undergraduate or graduate course in foundation designs (CE 443 or CE 642) within the last five years is required.

Required Textbook

1. Principles of Foundation Engineering, 10th Edition, Das, 2024

Other Recommended Texts & Reading

1. **Plaxis 2D Manuals** – Tutorial Manual, Reference Manual, and Material-Models Manual
2. **DeepEx Manuals** – DeepEx User Manual
3. **FHWA NHI-06-088 –** FHWA Soils and Foundations Reference Manual – Volume I, 2006 https://highways.dot.gov/sites/fhwa.dot.gov/files/FHWA%20NHI-06-088.pdf
4. **FHWA NHI-06-089 –** FHWA Soils and Foundations Reference Manual – Volume II, 2006 https://highways.dot.gov/sites/fhwa.dot.gov/files/FHWA-NHI-06-089.pdf
5. **NAVFAC DM-7.02** – Foundations & Earth Structures, Design Manual 7.02, 1986, U.S. Army Corps of Engineers, Naval Facilities Engineering Command https://web.mst.edu/~rogersda/umrcourses/ge441/dm7_02.pdf

Course Description

Computer applications in the design of shallow and deep foundations. Lateral and earth pressure computations for the design of retaining walls, bulkheads, cellular cofferdams, and sheet piles. Also considers the design of internal bracing systems and anchors, soil nailing and reinforced earth.

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 excavations & earth-retaining structures: 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 deep excavations, slope stability problems, and deep foundation elements using finite element analyses (software Plaxis and DeepEx), including extraction and interpretation of relevant outputs, such as deformation and stresses in soil and earth-retaining structures, as well as loads in tie-backs and struts.

POLICIES & PROCEDURES

Academic Integrity: It is expected that NJIT's University Code on Academic Integrity will be followed in all matters related to this course. Refer to NJIT's Dean of Students website to become familiar with the Code on Academic Integrity and how to avoid Code violations.

https://www.njit.edu/policies/sites/policies/files/academic-integrity-code.pdf

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.

Handouts: All handouts will be uploaded to the course's online portal (Canvas). You can download and view them at your convenience. Important handouts will also be distributed as printed copies during class sessions. This will include key lecture notes, important announcements, and any other critical materials.

Diagnostic Test: A diagnostic test, which will not count for the final grade, will be given on the first day of class. 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. 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.

Homework Format: Homework assignments are to be electronically submitted to the instructor in pdf file format via Canvas email before the beginning of class on the day it is due. Each homework assignment will be graded on a ten-point scheme, with points assigned to format, concept, and execution. Points distribution varies by homework assignment and will be provided.

Late Homework: Homework will be due before the beginning of class on the date it is due. Late Homework will only be accepted if excuse from Dean's office and up to two days after the due date. After that time, they will not be accepted.

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.

Term Projects/Presentations: There will be two term projects that should be completed in groups of two students. Each project will require a report and/or presentation. The instructor will provide two real-life problems that need to be solved using the concepts and tools taught in the class. These problems will be explained during class sessions.

The primary purposes of the term projects are to a) provide students with the opportunity to apply the knowledge and skills learned in class to solve real-life problems and to present their work in a clear, understandable, and technically well-founded manner, b) give students the chance to integrate their knowledge from several areas/topics, c) help students develop teamwork skills.

Classroom and CE Lab: Classes will be held either in GITC-1100 and/or the Colton CE Computer Lab. Some classes will start in GITC-1100 and then finish in the CE Computer Lab. Students are encouraged to spend non-class hours in the CE Computer Lab using the class provided software to practice and/or solve geotechnical problems**.**

Exams: There will be one midterm exam held during class time and one comprehensive final exam as scheduled by the University Registrar. The use of student notes, handouts, and textbooks is allowed in the exams. However, the use of AI tools and online sources are strictly prohibited. Use of computers, lap-tops, phones, etc. are prohibited during exams and unless use of DeepEx of Plaxis as allowed by the instructor.

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

Homework	15%
Term Project/Presentation	30%
Midterm Exam	25%
Final Exam	30%

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.

AI statement: The use of artificial intelligence (AI) is permitted in this course only when explicitly stated in assignments. If students use AI for any course-related work, they must cite it according to the guidelines provided on the **NJIT Library AI Citation page**. If you have any questions about AI use in this course, please contact the course instructor before submitting any assignments. In cases where AI use is not allowed, students are expected to complete work without AI assistance to develop their skills in this subject area.

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)

Course Schedule:

CE 643 – Advance Foundation Design		
Week # (Date)	**Topic** {C = GITC-1100……. L = Colton CE Computer Lab}	**Assessments**
1 (1/23/2025) (C)	Introduction Soil classification; Site investigation	Reading Assignment
2 (1/30/2025) (C)	Engineering properties based on in-situ and lab testing of soils and their correlations. Geotechnical design: Ultimate & Serviceability Limit State	Reading Assignment
3 (2/06/2025) (C)	Review of earth pressures Introduction to earth retaining structures Introduction to DeepEx User Manual	Reading Assignment
4 (2/13/2025) (L)	Unbraced Excavations - Design of Gravity and Cantilever retaining walls - Modeling of a cantilever wall in DeepEx	Assignment 1 Term Project-1
5 (2/20/2025) (L)	Braced Excavations (external) - Design of anchors and tiebacks - Modeling of braced excavation in DeepEx	
6 (2/27/2025) (L)	Braced excavations (internal) - Modeling of braced excavation in DeepEx	Due Assignment 1 Assignment 2
7 (3/06/2025) (L)	Introduction to Finite Element modeling - Modeling of excavation problems in Plaxis	
8 (3/13/2025) (C)	Term Project-1 Presentations **Midterm Exam (in-class)**	Due Assignment 2 & Term Project-1
9 (3/20/2025)	**Spring Recess**	
10 (3/27/2025) (C)	Soil-Structure interaction Deep Foundations – Introduction; selection guidelines; construction techniques and challenges	Assignment 3 Term Project-2
11 (4/03/2025) (L)	Deep Foundation – Design guidelines and requirements - Modeling of piles in Plaxis	
12 (4/10/2025) (L)	Deep Foundation – Group effect & load testing - Modeling of piles in Plaxis	Due Assignment 3 Assignment 4
13 (4/17/2025) (L)	Slope stability (Limit Equilibrium Method) - Modeling of a slope stability problem in Plaxis	
14 (4/24/2025) (L)	Continuation of Slope stability - Modeling of a slope stability problem in Plaxis	Due Assignment 4
15 (5/01/2025) (C)	Term Project-2 Presentations	Due Term Project-2
16 (5/08/2025) (C)	**Final Exam**	

Course Objectives Matrix – CE 643 – 01

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

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

Program Educational Objectives
Our **Program Educational Objectives** are reflected in the achievements of our recent alumni:

- **Engineering Practice:** Alumni will successfully engage in the ethical practice of civil engineering within industry, government, and private practice, working towards safe, practical, resilient and sustainable solutions in a wide array of technical specialties including construction, environmental, geotechnical, structural, transportation, and water resources.
- **Professional Growth:** Alumni will advance their technical and interpersonal 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 academia, business, and law through further education.
- **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.

Student Outcomes

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

- an ability to identify, formulate and solve complex engineering problems by applying principles of engineering, science and mathematics
- 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
- an ability to communicate effectively with a range of audiences
- 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
- 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
- an ability to develop and conduct appropriate experimentation, analyze and interpret data and use engineering judgment to draw conclusion
- an ability to acquire and apply new knowledge as needed, using appropriate learning strategies

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