Spring 2022

CE 443-002: Foundation Design

Andrew Ciancia

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

NJIT New Jersey Institute of Technology

CE 443 Foundation Design **Spring 2022**
Section: 002

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TA: ALL HOMEWORK QUESTIONS, Jitendra Anil Kewalram, JAK93@NJIT.EDU
Required Text: Principles of Foundation Engineering 9th Ed. Das and Nagaratnam, 2019 Cengage Learning ISBN: 978-337-70502-8

Date 2022	**Lecture No. Foundation Design (CE 443-002)**	Subject	Homework Assignment
	TWO SESSIONS PER WEEK Tuesday - Thursday, 1 pm -220 pm		Re: Das and Nagaratnam, 9th Edition, "Foundation Engineering", 2019
	Prior to Class		Read Chapters 3 and 11, and PPt slides (Exclude 3.22 to 3.25)
1/18	1	Review of Geotechnical Investigations (Chapter 3) Factors of Safety (Chapter 11)	Lecture 1: Chapters 3 and 11 (Excluding 3.22 to 3.25) **HW**: See Canvas Read Chapter 2.1-2.11 and PPt Slides

1/20	2	Review of Soil Mechanics (Index Properties, Classifications and Seepage) (Chapter 2)	Review HW Lecture 2/Chapter 2.1-2.11 **HW**: See Canvas Read Chapter 2.12 -2.24, and PPt Slides
1/25	3	Review of Soil Mechanics (Effective Stress, Consolidation and Shear Strength) (Chapter 2)	Review HW Lecture 3/Chapter 2.12-2.24 **HW** See Canvas Read Chapter 6.1-6.2 and PPt Slides
1/27	4	Introduction to Foundation Types and Performance (Chapter 6)	Review HW Lecture 4/Chapter 6.1 – 6.2 **HW:** See Canvas Read Chapter 6.3 – 6.7 and PPt Slides (Exclude 6.5)
2/1	5	Introduction to Bearing Capacity Theory #1 for Shallow Foundations (Chapter 6)	Review HW Lecture 5/Chapter 6.3-6.7 (exclude 6.5) **HW**: See Canvas Read Chapter 6.5, 7.1- 7.4, 9-14 and 9.15, and PPt Slides
2/3	6	Introduction to Bearing Capacity #2 In-Situ Tests, Water Table Variations, Layered Soil (Chapter 6)	Review HW Lecture 6.5, 7.1- 7.4, 9-14 and 9-15 **HW:** See Canvas Read Chapter 7.11, 6.10 - 6.11 and PPt Slides

2/8	7	Bearing Capacity #3 Rock Bearing, Inclined Loadings (Chapter 7)	Review HW Lecture 7/Chapters 7.11, 6.10 - 6.11 **HW**: See Canvas Read Chapter 8.1- 8.14 and PPt Slides
2/10	8	Stress Distribution (Chapter 8)	Review HW Lecture 8/Chapter 8.1-8.14 **HW**: See Canvas Read Chapter 9.11 – 9.13 and PPt Slides
2/15	9	Introduction to Settlement, and Consolidation Settlement (Chapter 9)	Review HW Lecture 9/9.11 – 9.13 **HW** See Canvas Read Chapter 9.1 to 9.6 and PPt Slides
2/17	10	Settlement Analyses of Granular Soils (Chapter 9)	Review HW Lecture 10/9.1-9.6 **HW:** See Canvas Read Chapter 9.5 (Review) 9.15-9.17 and PPt Slides
2/22	11	Review Schmertmann, Settlement Criteria And Presumptive Bearing Values (Chapter 9)	Review HW Lecture 11/9.5, 9.15 - 9.17 **HW:** See Canvas Review Bearing Capacity Theories (Chapters 6 & 7) and Settlement Analyses (Chapter 9), and PPt Slides

2/24	12	Summary of Bearing Capacity and Settlement Analyses Shallow Foundation Design	Review HW Lecture 12/ Review Shallow Foundation Bearing Capacity and Settlement Analyses Theories (Chapters 6,7 and 9) **HW**: Study for Exam #1
3/1		**EXAM #1** **(Shallow Foundations, Chapters 2, 3 6, 7, 8 and 9)**	HW : Read Chapter 12.1 -12.4 and PPt Slides
3/3	13	Introduction to Deep Foundations (Chapter 12)	Review Exam Lecture 13/12.1-12.4 **HW** See Canvas Read Chapter12.5 to 12.6, 12.20 - 12.22, and PPt Slides
3/8	14	Pile Foundations-Types and Installations (Chapter 12)	Review HW Lecture 14 /12.5-12.6, 12.20-12.22 **HW**: See Canvas Read Chapter 12.7-12.9 and PPt Slides
3/10 SPRING BREAK 3/13-3/20	15	Pile Foundations-Types and Installations (Chapter 12)	Review HW Lecture 15/ 12.7-12.9 **HW***:* See Canvas Read Chapter 12.11-12.16 and PPt Slides

3/22	16	Pile Capacity and Settlements (Chapter 12)	Review HW Lecture 16/12.11-12.16 **HW**: See Canvas Read Chapters 12.18-12.19 and PPt Slides
3/24	17	Pile Capacity and Settlements (Chapter 12)	Review HW Lecture 17, Chapter 12.18-12.19 **HW:** See Canvas Read 12.17 and PPt Slides
3/29	18	Pile Load Tests (Chapter 12)	Review HW Lecture 18, Chapter 12.17 **HW**: See Canvas Read 12.24-12.29 and PPt Slides
3/31	19	Design/Construction of Pile Groups (Chapter 12)	Review Exam Lecture 19 , Chapter12.24-12.29 **HW** – See Canvas Read Chapter 13.1-13.7, 13.9, 13.13 and PPt Slides
4/5	20	Design/Construction of Drilled Shafts Chapter 13	Review HW Lecture 20 , Chapter 13.1-13.7, 13.9, and 13.13 **HW** – See Canvas Read Chapter 12.15-12.16 and PPt Slides

4/7	21	Other Drilled Piles Chapter 12	Review HW Lecture 21, Chapter 12.15-12.16 **HW** – Study for Exam #2 (Chapters 12 and 13)
4/12		**EXAM #2** **(Deep Foundations Chapters 12 and 13)**	**HW**: Read Chapter 16.1 and 16.2 and PPt Slides
4/14	22	Introduction to Earth Retaining Systems and Lateral Earth Pressures (At Rest) (Chapter 16)	Review exam Lecture 22, Chapter 16.1, 16.2 **HW** See Canvas Read Chapter 16.3,16.4,16.6 to 16.8, and PPt Slides
4/19	23	Lateral Earth Pressure (Active) (Chapter 16)	Review HW Lecture 23, Chapter 16.3, 16.4, 16.6 to 16.8 **HW** See Canvas Read Chapter 16.11 to 16.15, and PPt Slides
4/21	24	Lateral Earth Pressure (Passive) (Chapter16)	Review HW Lecture 24, Chapter 16.11 to 16.15 **HW** See Canvas Read Chapter 17.1 to 17.8, 17.11 to 17.13 and PPt Slides

4/26	25	Design of Retaining Walls (Chapter 17)	Review HW Lecture 25 , Chapter 17.1-17.8, and 17.11-17.13 **HW** See Canvas Read Chapter 18.1-18.3, and 19.1 to 19.5, and PPt Slides
4/28	26	Continue - Design of Retaining Walls, Sheeting/Shoring Loadings (Chapters 18 & 19)	Review HW Lecture 26, Chapters 18.1-18.3, and 19.1 to 19.5, and PPt Slides **HW**- Study for Final
(TBD)		**EXAM #3 (Lateral Earth Pressures and Retaining Walls, Sheeting/Shoring** **(Chapters 16 thru 19)**	Exam, Chapters 16 to 19

Description:

Site Investigations, selection of foundation types and basis for design, allowable loads, and estimated settlements of shallow and deep foundations.
Computations of earth pressures and design of retaining walls, and sheeting/shoring loadings

Prerequisites: CE 341 – Soil Mechanics
CE 341A – Soil Laboratory

Textbook(s)/Materials Required: Principles of Foundation Engineering 9th Ed. Das and Nagarathnam, 2019 Cengage Learning, ISBN: 978-337-70502-8

Course Objectives:

1. Learn subsurface exploration techniques and apply them to design of foundations and retaining walls.
2. Apply the principles of soil mechanics to design of shallow and deep foundations including bearing capacity and settlement calculations

3. Compute the lateral earth pressure, select size of retaining walls and verify safety against external forces and moments. Calculate earth loadings on sheeting/shoring.

Topics:

Review of Soil Mechanics and Subsurface Investigations
Shallow Foundations
Bearing Capacity and Settlement Calculations
Deep Foundations (Capacity and Settlement Calculation)
Individual Piles. Pile Groups, Caissons and Drilled Piers
Lateral Earth Pressure Theory
Design of Retaining Walls and Sheeting –Shoring Earth Loadings

Schedule: Lecture Recitation 2- 1-hr 20 min hour classes,
Laboratory - none

Professional Component: Engineering Topics (Design)

Week	Topic
1	Geotechnical Investigations and Review of Soil Mechanics
2	Shear Strength and Bearing Capacity Theory
3	Application of Bearing Capacity Theory
4	Bearing Stresses and Elastic Settlement
5	Consolidation Settlement
6	Design of Shallow Foundations
7	Examination #1, and Introduction to Deep Foundations
8	Pile Foundations- Types and Installations
9	Pile Capacity and Settlements
10	Design/Construction of Pile Groups
11	Design/Construction of Drilled Shafts
12	Examination #2, and Introduction to Lateral Earth Pressure
13	Lateral Earth Pressure and Design of Retaining Walls
14	Design of Retaining Walls, and Sheeting/Shoring Loadings
15	Examination #3

Attendance: Attendance and class participation are mandatory. It is your responsibility to obtain the materials presented and submit homework as assigned on the date due. All homework assignments will be posted on Canvas.

Your overall grade will be based on the following:

15% - Quizzes/Class Participation, 10% - Homework, 75% - 3 Exams

Grading structure:
100 – 90: A; / 89 – 86: B+; / 85 – 80: B; / 79 – 74: C+; / 73 – 70: C; / 69 – 60: D; / 59 – 0: F

Surprise quizzes (assume 3 to 4) will be given based on material covered in the previous classes. A missed quiz (due to absence or tardiness to class) will be assigned a grade of zero. Quizzes may not be announced.

All exams/quizzes will be open book, open notes. No internet allowed

HOMEWORK: Written assignments are to be submitted via Canvas ON OR BEFORE one hour before the start of each class. Late homework submitted after the due time (one hour before each class start) will incur a 50% deduction; after the class day a 100% deduction will apply. All homework assignments shall be submitted with accompanying figures, tables, drawings, calculations, etc. The following information shall be included:
1. Your name
2. Date
3. Course Title and Number
4. Person to whom it is being submitted.
5. A brief statement of the assignment purpose (what was requested, who authorized it and what you did).
6. Reference to any drawings, figures, charts etc. – identify and important information that they contain.
7. Description of what information was obtained and used to solve the problem.
8. Important results clearly identified.
9. Appropriate conclusions and recommendations, if required.
10. All sources cited
11. If you assume soil property value you need provide a justification and cite your source.

ALL HOMEWORK QUESTIONS SHALL BE ADDRESSED TO THE TA.

Additional requirements and notices:
A. Bring your textbook and a calculator to each class.
B. There will be no extra credit available for this course.
C. Students should read the chapter related to the topic that will be covered in the class before the class
D. Students are encourage to ask questions about the material covered in the class. This will be used as feedback and can be on a topic that was not clearly comprehended.
E. Points deducted if engineering/graph paper are not used for your homework and tests.

Note: The NJIT Honor Code will be upheld, and that any violations will be brought to the immediate attention of the Dean of Students. Also, students will be consulted by the instructor and all must agree to any modifications or deviations from the syllabus throughout the course of the semester.

Academic Integrity

"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*

- **HW sent via Canvas. Any HW questions, comments, etc. shall be addressed to the TA.**
- Please keep a copy of all your work until you received a final grade.
- Please save a copy of your homework before submitting it to the instructor, since it may not be always possible for the instructor to return the corrected homework back in time for you to study for quizzes and examinations.
- All work should be done in a professional manner.
- Homework is due no later than one hour before the beginning of each class. Late homework will incur a 50% deduction if handed later than one hour before class starts, and 100% deduction if submitted after the day of class.
- The instructor may photocopy and save your assignments and tests, as part of the effort necessary to renew accreditation of our educational programs. The copies, which will be accessible only to faculty, administration, and external reviewers, will be destroyed afterwards.
- No make-up exams/quizzes will be administered, unless approved by the Dean's Office.
- Switch off laptops and cell phones during quizzes and examinations. Plan on bringing a watch to keep time during examinations.
- No recording devices shall be used during class or examinations. Take notes.

Strategies, Actions and Assignments	ABET Student Outcomes (1-7)	Program Educational Objectives	Assessment Measures
Student Learning Outcome 1: Identify the properties of soils and the basic principles of soil mechanics and develop the ability to apply these principles to solving problems in civil engineering.			
Introduce index properties of soils and subsurface investigations.	1	1	Homework, quizzes and exams.
Explore subsurface methods of investigation in design.	1	1, 2	Homework, quizzes, and problem solving in class.

Discuss professional design practice.	2, 7	1, 2	Class discussions and problem solving. Quizzes and exams.
Student Learning Outcome 2: Apply principles of seepage through porous media and effective stress.			
Introduce basic concepts and flow through soils.	1	1	Homework, quizzes and exams.
Apply these principles to problem solving.	1, 2	1	Homework, quizzes, and problem solving in class.
Discuss application of these principles to engineering problems.	2	1	Class discussions and problem solving. Quizzes and exams.
Student Learning Outcome 3: Apply principles of consolidation and shear strength.			
Introduce consolidation theory and shear strength principles	1	1	Homework, quizzes, and exams.
Discuss analytical methods to solve different types of settlement problems.	2	1	Homework, quizzes, and problem solving in class.
Discuss professional design practice.	2, 4	1, 2	Class discussions, problem analyses, and problem solving.

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: 12/26/2021