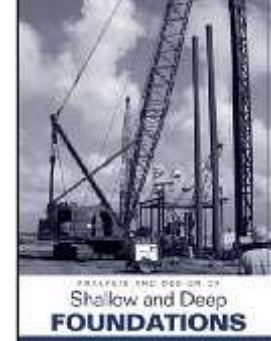
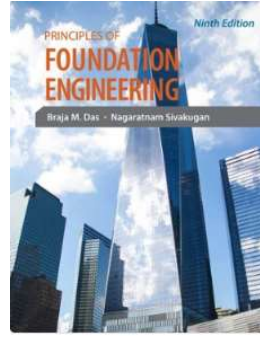


CE 5359 – Foundation Design I**Instructor:** Soheil Nazarian (nazarian@utep.edu)**Lecture Time:** TR 4:30 -6:00 PM**Office Hours:** Students are always welcome.**Textbook:** Principles of Foundation Engineering, 9th Edition, by Das and Sivakugan, Cengage Learning**Suggested Reference Book:** Analysis and Design of Shallow and Deep Foundations, by Reese, Isenhower and Wang, ENSOFT, Inc.

Introduction: This course is concerned with foundation engineering. The term “foundation engineering” is used to describe the design of foundations for buildings and other structures, such as retaining walls, tunnels, and coffer and earth dams. It also includes the design of natural slopes, the dewatering of soils, and stabilization of soils, mechanically and chemically.

Foundation design must be based on, and make use of, the principles of mechanics. However, it also requires knowledge of geology and involves numerous considerations that might be called “practical,” e.g., those based on the availability of suitable construction equipment and personnel. We will spend a part of our time on the mechanistic types of problems, in part because they lend themselves better to university-type instruction. But we will spend time discussing practical types of problems that do not lend themselves to homework problems, exams, and grading because they are the main problems of interest in engineering practice.

An important part of the material will be transmitted via lectures. Consequently, you are strongly advised to attend every class period and take extensive notes. Experience shows that students who miss class are likely to encounter questions on exams that they do not understand because the material was covered in their absence.

Some of the students interested in foundation engineering are also interested in structural design. Structural designers generally have well-developed codes which they are expected to follow. No comparable codes exist in the area of geotechnical engineering. In structures, the properties of materials are reasonably well defined because they are manufactured. In geotechnical engineering, a major problem exists with trying to define the properties of the soil materials at a site. Structural members are relatively simple in shape. Strata of soil are often discontinuous, and the success of a “design” may hinge on whether a soil exploration program results in the discovery of critical strata. For the range of stresses usually used, structural materials are subject to small strains, and may often be taken as linearly elastic. Soils are often stressed to large strains and are almost always inelastic and have nonlinear stress-strain curves. As a result of these conditions, students should realize that the term “design” carries with it different connotations in geotechnical engineering than in some other branches of civil engineering. Even if you choose not to engage in the practice of geotechnical engineering, there is a high probability that you will work with geotechnical engineers or read their reports in your work. Therefore, an understanding of how they work and think can be very beneficial.

Most undergraduate science, mathematics, and engineering courses taken by civil engineers involve problem solving. Problems are always well defined; little, if any, judgment is used in solving them; and there is a single correct answer. Students tend to become *dualistic* (the term intended to indicate that answers to problems are either right or wrong). In a dualistic system, it is assumed that the professor knows (or should know) the answer to every question and that the student is to act as a sponge, simply absorbing as

much knowledge as possible. The dualistic stage is an important one because it provides students with the tools of their trade.

Engineering practice, however, tends to be relativistic. In a relativistic system, the problems tend to be ill defined or the problem may be changing as the solution is developing. Important information may be missing or be known only approximately, and the engineer is not likely to possess all the technical skills needed for a refined solution. Despite such problems, the designer must develop an acceptable solution. For a relativistic problem, there is likely to be a range of solutions, some better than others, but none that can be considered “right”.

In the context of a university course, relativism implies that there are ranges for answers to many exam questions, that answers depend on conditions of the specific problem (hence, the response “Well, it depends” to a question), and that there will not be “correct” answers to some problems. The problem, then, is to develop informed judgments and appropriate thought processes. Some students find interest and challenge in relativism. Others find relativism a great frustration and long for courses with unique answers. This course is a mixture of dualism and relativism and is intended to help students make an easier transition from deterministic university classes to engineering practice.

Schedule: We will use a self-guided approach in this course. A tentative lecture schedule is attached, and the reading assignments are indicated. For each topic, I will assign one or two videos to watch. I will then provide a broad lecture on the subject. We will then work problems as much as possible. You can also use MindTap (see last page of this syllabus) to improve your skills.

Grading: Completing homework problems will count a maximum of 20% toward your grade. Quizzes will count as 30% of your grade. The comprehensive final examination will count as 30%. Other class projects and participation will constitute 20% of your grade.

Homework: All homework problems are assigned in MindTap. Homework is assigned to help you learn the material, not to generate grades. The homework problems will be graded automatically. You can try as many times as you wish until you earn a perfect score.

Homework problems are due at 11:59 PM on Sunday the following week. Therefore, you will always have at least a weekend to work on your problems.

Experience clearly shows that a student's grade is strongly dependent upon the effort that is put into working and understanding the homework. Although the homework does not directly count towards your grade, in practice it is the single most important factor that will affect your grade.

Quizzes: A quiz will be assigned after the homework is handed in for a given topic. The quiz will be similar to either the homework problems from the previous week or the examples solved in the class or the examples in the textbook.

Examination: Final examination, which is comprehensive, will last three hours.

Class Attendance: Because this is an online class, we will not see each other in the ways you may be accustomed to: during class time. Course content is delivered via the Internet. The lectures will be live, but they will be recorded for your future reference. You can access the recordings in the class OneDrive.

Preparation for Semester: Ensure your UTEP e-mail account is working and that you have access to the Web and a stable web browser. You will need to have access to a computer/laptop, scanner, a webcam, and a microphone. You will need to download or update the following software: Microsoft Office, Adobe Acrobat Reader, Windows Media Player, QuickTime, and Java. Check that your computer hardware and software are up-to-date and able to access all parts of the course. If you do not have a word-processing

software, you can download Word and other Microsoft Office programs (including Excel, PowerPoint, Outlook and more) for free via UTEP's Microsoft Office Portal.

If you encounter technical difficulties beyond your scope of troubleshooting, please contact the UTEP Help Desk as they are trained specifically in assisting with technological needs of students. Please do not contact me for this type of assistance. The Help Desk is much better equipped than I am to assist you!

Netiquett. Sometimes communication online can be challenging. It is possible to miscommunicate what we mean or to misunderstand what our classmates mean given the lack of body language and immediate feedback. Therefore, please keep these netiquette (network etiquette) guidelines in mind.

- Always consider audience. This is a college-level course; therefore, all communication should reflect polite consideration of other's ideas.
- Respect and courtesy must always be provided to classmates and to the instructor. No harassment or inappropriate postings will be tolerated.
- When reacting to someone else's message, address the ideas, not the person. Post only what anyone would comfortably state in a face-to-face situation.
- Whatever is posted on online spaces is intended for classmates and professor only. Please do not copy documents and paste them to a publicly accessible website, blog, or other space.

Accommodations Policy. UTEP is committed to providing reasonable accommodations and auxiliary services to students, staff, faculty, job applicants, applicants for admissions, and other beneficiaries of University programs, services and activities with documented disabilities in order to provide them with equal opportunities to participate in programs, services, and activities in compliance with sections 503 and 504 of the Rehabilitation Act of 1973, as amended, and the Americans with Disabilities Act (ADA) of 1990 and the Americans with Disabilities Act Amendments Act (ADAAA) of 2008. Reasonable accommodations will be made unless it is determined that doing so would cause undue hardship on the University. Students requesting an accommodation based on a disability must register with the UTEP Center for Accommodations and Support Services (CASS). Contact the Center for Accommodations and Support Services at 915-747-5148, or email them at cass@utep.edu, or apply for accommodations online via the CASS portal.

Scholastic Integrity. Academic dishonesty is prohibited and is considered a violation of the UTEP Handbook of Operating Procedures It includes, but is not limited to, cheating, plagiarism, and collusion. Cheating may involve copying from or providing information to another student, possessing unauthorized materials during a test, or falsifying research data on laboratory reports. Plagiarism occurs when someone intentionally or knowingly represents the words or ideas of another as ones' own. Collusion involves collaborating with another person to commit any academically dishonest act. Any act of academic dishonesty attempted by a UTEP student is unacceptable and will not be tolerated. All suspected violations of academic integrity at The University of Texas at El Paso must be reported to the Office of Student Conduct and Conflict Resolution (OSCCR) for possible disciplinary action. To learn more, please visit HOOP: Student Conduct and Discipline.

Final Comment: Good luck to all of you in this course. Please do not hesitate to ask questions in class, or, if necessary, to see me outside of class. Any specific comments that students may have on how the course might be improved are particularly welcome.

Lecture Topics**Lecture Topic 1. Introduction and Review****1.1 Introduction (Handout)**

- 1.1.1 Types of Foundation
- 1.1.2 Performance Requirement
- 1.1.3 Design Loads
- 1.1.4 Strength Requirements
- 1.1.5 Serviceability Requirements
- 1.1.6 Constructability Requirements
- 1.1.7 Economic Requirements

1.2 Geotechnical Properties of Soil (Chapter 2)

- 1.2.1 Grain-Size Distribution
- 1.2.2 Size Limits for Soils
- 1.2.3 Weight-Volume Relationships
- 1.2.4 Relative Density
- 1.2.5 Atterberg Limits
- 1.2.6 Liquidity Index
- 1.2.7 Activity
- 1.2.8 Soil Classification Systems
- 1.2.9 Effective Stress
- 1.2.10 Consolidation
- 1.2.11 Calculation of Primary Consolidation Settlement
- 1.2.12 Time Rate of Consolidation
- 1.2.13 Shear Strength
- 1.2.14 Sensitivity

Lecture Topic 2. Natural Soil Deposits and Subsoil Exploration**2.1. Natural Soil Deposits (Chapter 3, no lecturer on this topic)**

- 2.1.1. Soil Origin
- 2.1.2. Residual Soil
- 2.1.3. Gravity Transported Soil
- 2.1.4. Alluvial Deposits
- 2.1.5. Lacustrine Deposits
- 2.1.6. Glacial Deposits
- 2.1.7. Aeolian Soil Deposits
- 2.1.8. Organic Soil
- 2.1.9. Some Local Terms for Soils

2.2. Subsurface Exploration (Chapter 3)

- 2.2.1. Purpose of Subsurface Exploration
- 2.2.2. Subsurface Exploration Program
- 2.2.3. Exploratory Borings in the Field
- 2.2.4. Procedures for Sampling Soil
- 2.2.5. Split-Spoon Sampling
- 2.2.6. Sampling with a Scraper Bucket
- 2.2.7. Sampling with Thin-Walled Tube
- 2.2.8. Sampling with a Piston Sampler
- 2.2.9. Observation of Water Tables
- 2.2.10. Vane Shear Test
- 2.2.11. Cone Penetration Test
- 2.2.12. Pressuremeter Test (PMT)
- 2.2.13. Dilatometer Test
- 2.2.14. Coring of Rocks

- 2.2.15. Preparation of Boring Logs
- 2.2.16. Geophysical Exploration
- 2.2.17. Subsoil Exploration Report

Lecture Topic 3. Shallow Foundations**3.1. Ultimate Bearing Capacity: General Concept (Chapter 6)**

- 3.1.1. General Concept
- 3.1.2. Terzaghi's Bearing Capacity Theory
- 3.1.3. Factor of Safety
- 3.1.4. Modification of Bearing Capacity Equations for Water Table
- 3.1.5. General Bearing Capacity Equation
- 3.1.6. Effect of Soil Compressibility
- 3.1.7. Eccentrically Loaded Foundations
- 3.1.8. Ultimate Bearing Capacity under Eccentric Loading - One-Way Eccentricity
- 3.1.9. Bearing Capacity with Two-Way Eccentricity
- 3.1.10. Bearing Capacity of a Continuous Foundation Subjected to Eccentric Inclined Loading

3.2. Ultimate Bearing Capacity: Special Cases (Chapter 7)

- 3.2.1. Foundation Supported by a Soil with a Rigid Base at Shallow Depth
- 3.2.2. Bearing Capacity of Layered Soils: Stronger Soil Underlain by Weaker Soil
- 3.2.3. Bearing Capacity of Layered Soil: Weaker Soil Underlain by Stronger Soil
- 3.2.4. Closely Spaced Foundations - Effect on Ultimate Bearing Capacity
- 3.2.5. Bearing Capacity of Foundations on Top of a Slope
- 3.2.6. Bearing Capacity of Foundations on a Slope
- 3.2.7. Foundations on a Rock
- 3.2.8. Uplift Capacity Foundations

Lecture Topic 4. Allowable Bearing Capacity and Settlement**4.1. Vertical Stress Increase in a Soil Mass Caused by Foundation Load (Chapter 8)**

- 4.1.1. Stress Due to a Concentrated Load
- 4.1.2. Stress Due to a Circularly Loaded Area
- 4.1.3. Stress below a Rectangular Area
- 4.1.4. Average Vertical Stress Increase Due to a Rectangular Loaded Area
- 4.1.5. Stress Increase under an Embankment
- 4.1.6. Westergaard's Solution for Vertical Stress Due to a Point Load
- 4.1.7. Stress Distribution for Westergaard Material

4.2. Elastic Settlement (Chapter 9):

- 4.2.1. Elastic Settlement of Foundations on Saturated Clay
- 4.2.2. Settlement Based on the Theory of Elasticity
- 4.2.3. Improved Equation for Elastic Settlement
- 4.2.4. Settlement of Sandy Soil: Use of Strain Influence Factor
- 4.2.5. Settlement of Foundation on Sand Based on Standard Penetration Resistance
- 4.2.6. Settlement in Granular Soil Based on Pressuremeter Test (PMT)

4.3. Consolidation Settlement (Chapter 9):

- 4.3.1. Primary Consolidation Settlement Relationships
- 4.3.2. Three-Dimensional Effect on Primary Consolidation Settlement

Lecture Topic 5. Mat Foundations (Chapter 10)

- 5.1. Combined Footings**
- 5.2. Common Types of Mat Foundations**
 - 5.2.1. Bearing Capacity of Mat Foundations
 - 5.2.2. Differential Settlement of Mats
- 5.3. Field Settlement Observations for Mat Foundations**
- 5.4. Compensated Foundation**

Lecture Topic 6. Pile Foundations (Chapter 12)

- 6.1. Types of Piles and Their Structural Characteristics**
- 6.2. Estimating Pile Length**
- 6.3. Installation of Piles**
- 6.4. Load Transfer Mechanism**
- 6.5. Equations for Estimating Pile Capacity**
 - 6.5.1. Meyerhof's Method for Estimating Q_p
 - 6.5.2. Vesic's Method for Estimating Q_p
 - 6.5.3. Coyle and Castello's Method for Estimating Q_p in Sand
 - 6.5.4. Correlations for Calculating Q_p with SPT and CPT Results
 - 6.5.5. Frictional Resistance (Q_p) in Sand
 - 6.5.6. Frictional (Skin) Resistance in Clay
 - 6.5.7. Point-Bearing Capacity of Piles Resting on Rock
- 6.6. Pile Load Tests**
- 6.7. Elastic Settlement of Piles**
- 6.8. Laterally Loaded Piles**
- 6.9. Pile-Driving Formulas**
- 6.10. Negative Skin Friction**
- 6.11. Group Piles**
 - 6.11.1. Group Efficiency
 - 6.11.2. Ultimate Capacity of Group Piles in Saturated Clay
 - 6.11.3. Elastic Settlement of Group Piles
 - 6.11.4. Consolidation Settlement of Group Piles

Lecture Topic 7. Drilled-Shaft Foundations (Chapter 13)

- 7.1. Types of Drilled Shafts**
- 7.2. Construction Procedures**
- 7.3. Other Design Considerations**
- 7.4. Load Transfer Mechanism**
- 7.5. Estimation of Load-Bearing Capacity**
 - 7.5.1. Drilled Shafts in Granular Soil: Load-Bearing Capacity
 - 7.5.2. Load-Bearing Capacity Based on Settlement
 - 7.5.3. Drilled Shafts in Clay: Load-Bearing Capacity
 - 7.5.4. Load-Bearing Capacity Based on Settlement
- 7.6. Settlement of Drilled Shafts at Working Load**
- 7.7. Lateral Load-Carrying Capacity - Characteristic Load and Moment Method**

Lecture Topic 8. Foundations on Difficult Soils (Chapter 15)**8.1. Collapsible Soils**

- 8.1.1. Definition and Types of Collapsible Soil
- 8.1.2. Physical Parameters for Identification
- 8.1.3. Procedure for Calculating Collapse Settlement
- 8.1.4. Foundation Design in Soils Not Susceptible to Wetting
- 8.1.5. Foundation Design in Soils Susceptible to Wetting

8.2. Expansive Soils

- 8.2.1. General Nature of Expansive Soils
- 8.2.2. Unrestrained Swell Test Swelling Pressure Test
- 8.2.3. Classification of Expansive Soil based on Index Tests
- 8.2.4. Foundation Considerations for Expansive Soils
- 8.2.5. Construction on Expansive Soils

Lecture Topic 9. Soil Improvement and Ground Modification (Chapter 5 time permits)**9.1. General Principles of Compaction****9.2. Field Compaction**

- 9.2.1. Compaction Control for Clay Hydraulic Barriers
- 9.2.2. Vibroflotation
- 9.2.3. Blasting
- 9.2.4. Precompression
- 9.2.5. Sand Drains
- 9.2.6. Prefabricated Vertical Drains
- 9.2.7. Lime Stabilization
- 9.2.8. Cement Stabilization
- 9.2.9. Fly-Ash Stabilization
- 9.2.10. Stone Columns
- 9.2.11. Sand Compaction Piles
- 9.2.12. Dynamic Compaction
- 9.2.13. Jet Grouting

Tentative Lecture Schedule

Week of	Tuesday	Thursday
8/25	Topic 1.1	Topic 1.1
9/1	Topic 1.2	Topics 2.2
9/8	Topic 2.2	Topic 3.1
9/15	Topic 3.1	Topic 3.2
9/22	Topic 3.2	Topic 4.1
9/29	Topic 4.2	Topic 4.3
10/6	Topic 4.3	Topics 5.1-5.2
10/13	Topics 5.3-5.4	Topics 6.1-6.2
10/20	Topics 6.3-6.4	Topic 6.5
10/27	Topics 6.6-6.8	Topics 6.9-6.10
11/3	Topic 6.11-6.12	Topics 7.1-7.2
11/10	Topics 7.3-7.4	Topic 7.5-7.6
11/17	Topic 7.7	Topic 8.1
11/24	Topic 8.2	Thanksgiving
12/1	Topic 9	Topic 9

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CE 5359 Fall 2020

Instructor : Soheil Nazarian

Start Date : 08/25/2020

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