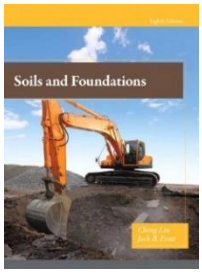
## CE 4339 – Geostructural Design




**Instructors:** Soheil Nazarian (nazarian@utep.edu)
Jose Carrasco (jccarrasco@miners.utep.edu)

**Lecture Time:** TR 12:00 -13:20

**Lecture Location**: Classroom Building C305

**Office Hours:** Students are always welcome. Contact us anytime.

**Textbook:** Soils and Foundations, 8th Edition, by Liu and Evett, Pearson

**Introduction** This course is concerned with Geostructural Design. The term "Geostructural Design" describes the design of foundations for buildings and other structures, such as retaining walls. It also includes the design of natural slopes and pavement design. Geostructural Design must be based on, and make use of, the principles of Soil Mechanics and Geotechnical Engineering. However, it also requires knowledge of geology and involves numerous considerations that might be called "practical." We will spend a significant part of our time on mechanistic types of problems. We will spend time discussing practical types of problems because they are the main problems of interest in engineering practice.

Most of the students interested in Geostructural Design are also interested in structural design. Structural designers generally have well-developed codes which they are expected to follow. No comparable codes exist in Geostructural Design. In structures, the properties of materials are reasonably well-defined because they are manufactured. In Geostructural Design, 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. Even if you choose not to engage in the practice of Geostructural Design, 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. This course is a mixture of theory and practice and is intended to help you make an easier transition from university classes to engineering practice.

**Topics covered** primarily include:

1. Calculating stability and design of retaining walls
2. Foundation design and bearing capacity for shallow and deep foundations
3. Consolidation and differential settlement of Foundations
4. Slope stability analysis of fills, embankments, cuts, dams
5. Pavement system design

Assuming that you already learned them in the Geotechnical Engineering course, we will also review the following items:

1. Index properties and soil classifications
2. Phase relations (air-water-solid)
3. Laboratory and field tests
4. Stresses in soils
5. Shear strength

**Schedule** A tentative lecture schedule is attached, and the reading assignments are indicated. *We recommend that you read the appropriate sections for each topic before the lecture.* For each topic, I will provide a broad lecture on the subject.

**Grading** Two mid-terms will count as 50%. A comprehensive final examination will count as 50%. Doing homework problems on time will earn you a 10% bonus toward your grade.

**Homework** All homework problems are assigned for the semester in the heading of each chapter in the Lecture Topic section. Homework is assigned to help you learn the material, not to generate grades. It is acceptable to work with others when discussing methods of attack, but your written work should always be your own.

The homework problems will be collected but not graded. Unless otherwise noted, homework problems are due at 8:00 a.m. on Monday the following week. Therefore, you usually have a weekend to work on your problems.

Experience clearly shows that a student's grade is strongly dependent on 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 most important factor that will affect your grade.

**Midterms** The problems will be similar to the homework problems or the examples in the textbook. There are no make-up or late midterm opportunities in this class.

**Examination** Final examination, which is comprehensive, will last 3 hours. Under university regulations, students who miss the examination will receive a grade of zero. Exceptions to this rule will be made only on a carefully considered individual basis and only if the student contacts the instructor before the exam. If you know in advance that you are going to miss an exam, it is your responsibility to inform the instructor before the exam.

**Neatness** You will present homework problems completed in a neat and orderly fashion. On examinations, your work must be easy to follow. However, if you use a calculator and put nothing down on a page but an equation and the answer, you will get no credit. Calculations spread all over an examination page, with an answer suddenly appearing out of nowhere, will also be graded down.

**Attendance** Students are expected to attend all class periods.

**Preparation for Semester** Ensure your UTEP e-mail account is working and that you have access to the Web and a stable web browser.

**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 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 to the University. Students requesting 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 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 one's solution 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 may be improved are particularly welcome.

**Lecture Topics**

**Lecture Topic 1. Soil Exploration (HW: 3-1 through 3-5)**

3-1 Introduction
3-2 Reconnaissance
3-3 Steps of Soil Exploration
3-4 Groundwater Table
3-5 Standard Penetration Test (ASTM D 1586)
3-6 Cone Penetration Test (ASTM D3441 AND D 5778)
3-7 Vane Test
3-11 Record of Soil Exploration

**Lecture Topic 2. Consolidation of Soil and Settlement of Structures (HW: 7-2, 7-4, 7-5, 7-7, 7-11)**

7-1 Introduction (different types of settlement)
7-3 Consolidation Test
7-4 Normally Consolidated Clay and Over Consolidated Clay
7-6 Settlement of Loads on Clay Due to Primary Consolidation
7-7 Time Rate of Settlement Due to Primary Consolidation
7-8 Settlement of Loads on Clay Due to Secondary Compression
7-9 Settlement of Loads on Sand

**Lecture Topic 3. Shallow Foundations (HW: 9-2, 9-4, 9-6, 9-8, 9-10, 9-12)**

9-1 Introduction
9-2 Loads on Foundations
9-4 Bearing Capacity Analysis
9-5 Size of Footings

**Lecture Topic 4. Deep Foundations (HW: 10-1, 10-4, 10-6, 10-8, 10-14, 10-16)**

10-1 Introduction
10-3 Types of Piles
10-5 Pile Capacity
10-8 Negative Skin Friction (Down Drag)
10-9 Pile Groups and Spacing of Piles
10-10 Efficiency of Pile Groups
10-12 Settlement of Pile Foundations
10-14 Introduction to Drilled Shaft Foundations
10-15 Bearing Capacity of Drilled Shafts
10-16 Settlement of Drilled Shafts

**Lecture Topic 5. Lateral Earth Pressure (HW: 11-1, 11-4, 11-5, 11-8)**

11-1 Introduction
11-2 Earth Pressure at Rest
11-3 Rankine Earth Pressures
11-5 Effects of a Surcharge Load

**Lecture Topic 6. Retaining Structures (HW: 12-1, 12-4, 12-5)**

12-1 Introduction
12-2 Retaining Walls
12-3 Design Considerations for Retaining Walls
12-4 Stability Analysis
12-7 Reinforced Earth Walls
12-9 Anchored Bulkheads

**Lecture Topic 7. Stability Analysis of Slopes (HW: 13-2, 13-4, 13-6, 13-8)**

13-1 Introduction
13-2 Analysis of a Mass Resting on an Inclined Layer of Impermeable Soil
13-3 Slopes in Homogeneous Cohesionless Soils ($c = 0$, $\phi > 0$)
13-4 Slopes in Homogeneous Soils Possessing Cohesion ($c > 0$, $\phi = 0$, and $c > 0$, $\phi > 0$)
13-5 Method of Slices

**Lecture Topic 8. Pavement Design (Homework problems and Lecture notes will be provided)**

Introduction
Pavement Types
Pavement System Design: Principles for Flexible Pavements
Traditional AASHTO Flexible-Pavement Design Procedure
Traditional AASHTO Rigid-Pavement Design Procedure

**Review Topics**

**Review Topic a. Engineering Properties of Soils (HW: 2-2,2-4,2-6,2-9,2-11,2-13,2-17,2-19,2-21)**

2-1 Soil Types
2-2 Grain-Size Analysis
2-3 Soil Consistency-Atterberg Limits
2-4 Soil Classification Systems
2-5 Components of Soils
2-6 Weight/Mass and Volume Relationships

**Review Topic b. Subsurface Stresses in Soils (HW: 6-1, 6-3, 6-5, 6-7, 6-9, 6-11)**

6-1 Introduction
6-2 Subsurface Stresses Caused by Overlying Soil Masses
6-3 Subsurface Stresses Caused by Surface Loadings
6-4 Vertical Pressure below a Concentrated Load
6-5 Vertical Pressure below a Loaded Surface Area (Uniform Load)

**Review Topic c. Shear Strength of Soil (HW: 8-2, 8-4, 8-5, 8-8, 8-10)**

8-1 Introduction
8-2 Methods of Investigating Shear Strength
8-3 Characteristics of the Failure Plane
8-4 Shear Strength of Cohesionless Soils
8-5 Shear Strength of Cohesive Soils

**Tentative Lecture Schedule**

| Week of | Tuesday | Thursday |
|---|---|---|
| 8/28 | Introduction | Lecture Topic 1 |
| 9/4 | Review Topic a* | Review Topic b |
| 9/11 | Lecture Topic 2 | Lecture Topic 2 |
| 9/18 | Lecture Topic 2 | Review Topic c |
| 9/25 | Review Topic c | Lecture Topic 3 |
| 10/2 | Lecture Topic 3 | Lecture Topic 4 |
| 10/9 | Lecture Topic 4 | Lecture Topic 4 |
| 10/16 | Lecture Topic 5 | Lecture Topic 5 |
| 10/23 | Lecture Topic 6 | Midterm 1 (up to Lecture Topic 4) |
| 10/30 | Lecture Topic 6 | Lecture Topic 6 |
| 11/6 | Lecture Topic 6 | Lecture Topic 7 |
| 11/13 | Lecture Topic 7 | Lecture Topic 7 |
| 11/20 | Lecture Topic 8 | Thanksgiving |
| 11/27 | Lecture Topic 8 | Midterm 2 (Lecture Topics 5-7) |
| 12/3 | Lecture Topic 8 | Review |

* Review Topics are shaded in yellow. You have already studied them in Geotechnical Engineering.