# GEOL 314
# Engineering Geology
**Winter 2013**

Dr. Robert Mitchell
ES234
650-3591
robert.mitchell@wwu.edu
http://kula.geol.wwu.edu/rjmitch/

Office Hours: MWF 2-3:00 pm or by arrangement

Text: Geotechnical Engineering Principles and Practice, D. P. Coduto

## Introduction

GEOL 314 focuses on the core activities of engineering geologists – site characterization and geologic hazard identification and mitigation. Through lectures, labs, and case study examination you will learn to couple your geologic expertise with the engineering properties of rock and unconsolidated materials in the characterization of geologic sites for civil work projects and the quantification of processes such as rock slides, soil-slope stability, settlement, and liquefaction.

Engineering geology is an applied geology discipline that involves the collection, analysis, and interpretation of geological data and information required for the safe development of civil works. Engineering geology also includes the assessment and mitigation of geologic hazards such earthquakes, landslides, flooding; the assessment of timber harvesting impacts; and groundwater remediation and resource evaluation. Engineering geologists are applied geoscientists with an awareness of engineering principles and practice—they are not engineers. In states that require professional licensing (e.g., Washington, Oregon, and California) these practitioners become Licensed Engineering Geologists (LEGs), not Professional Engineers (PEs) like geological engineers and geotechnical engineers

## Course Structure

My combined engineering and geoscience academic background enables me convey engineering fundamentals and how geology is applied to assess site vulnerabilities. I will focus on the mechanics of Earth materials and how they respond to forces and stresses. In the first half of the course I will discuss rock mechanics, and how to characterize the susceptibility of rock mass sites to failure. You will learn how to assess rock-mass quality, perform kinematic analyses, and analyze rock-slope stability (sliding and topples). In the second half of the course I cover the mechanics of unconsolidated materials (soils) as applied to processes such consolidation/settlement, subsidence, liquefaction, compaction, and soil slope stability. I will also introduce common methods used in geotechnical engineering such as the Unified Soil Classification System and the American Society for Testing Materials (ASTM) standards (e.g., Atterberg limits and Proctor tests). Please see the lecture topics below.

To convey these concepts I will employ a combination of lectures (3 hours per week) and labs (2 hours per week). The labs will emphasize material testing and analysis, employ ArcGIS techniques for site characterization, and utilize a software package called Rocscience for analyzing rock masses, rock slope stability, consolidation and settlement, and soil-slope stability. Two lab sessions will be allocated for discussions with practitioners, both engineering geologists and geotechnical engineers, who will visit campus to share their case study experiences. Please see the lab topics below.

My **course outcomes and learning objectives** for GEOL 314 outlined on the last page of the syllabus.

## Assessment

*Labs and Problem Sets*

There will be weekly two-hour labs that will include a mix of ArcGIS exercises, material testing and data analysis, software applications using Rocscience, and case studies presented by local professionals. The lab topics are listed below. In addition to the lab exercises you will be given problem sets that are very much like those encountered in physics, only they have geological meaning. The lab exercises and problem sets enforce the theory and develop problem solving skills and critical thinking. I do not require the memorization of equations; therefore, I provide an equation sheet that is updated throughout the quarter for exercises and exams. Labs and problem sets turned in after class on the due date will be deducted 5%, and 10% for each day they are late.

*Exams*

I give two exams during the quarter and a comprehensive final exam. The exams represent 75% of the grade. I expect you to understand a concept both conceptually and quantitatively, therefore, my exams tend to be a mix of concept description and problem solving using equation identification and manipulation. I provide an equation sheet with each exam, which is the same version of the one used for the problem sets, so your familiarity with the equation sheet becomes essential. I also provide a study guide prior to an exam summarizing the essential concepts I expect you to understand.

You will be required to take all exams at the scheduled times. Make-up exams will be given only in the case of official prearranged absences or emergencies. An excused absence form from the office of Student Affairs is required.

The grading break down will be as follows:

Lab and Problem Sets…25 %
Exam 1……..…..25%
Exam 2…….……..25%
Final Exam…….……25% (The final is scheduled for Thursday, March 21, 8-10 am)

A grading scale will be as follows (a curve is possible but not certain):
100-93 = A, 92-90 = A-, 89-88 = B+, 87-83 = B, 82-80 = B-, 79-78 = C+, 77-73 = C, 72-70 = C-, 69-68 = D+, 67-63 = D, 62-60 = D-, 60 or below = F

**Academic honesty** is an important part of every course at WWU. Please read the Academic Honesty Policy and Procedure in Appendix D of the WWU Course Catalog for details http://catalog.wwu.edu/

If you have a documented **disability** you must report to me during the first week of class to discuss your needs. If you need disability-related accommodations, please notify Student Support Services at 650-3083 (phone) or 650-3725 (TTY) or http://www.wwu.edu/depts/drs/

**Attendance** is not required but it is expected. It is your responsibility to get notes for the classes you miss. I encourage you to visit my office for help and clarification, but do not use my office hours to obtain lecture material that you miss (unless you have an excused absence).

*I reserve the right to change the syllabus as required throughout the term to better meet the instructional needs of the class.*

## GEOL 314 - Engineering Geology Lecture Topics

The assigned readings are from the assigned textbook (Coduto)

1. Introduction—definition of engineering geology (pp. 1-14).
2. Site Characterization (pp. 46-84)
3. Bulk properties of rock—porosity, bulk density, unit weight, moist density (pp. 97-103)
4. 1-D stress and strain—compression and tension (pp. 314-320)
5. Geostatic stress and Bulk Modulus (pp. 321-323)
6. Mining room and pillar analysis—introduction of the factor of safety
7. Shear stress and strain
8. Translational slides—in terms of forces & factor of safety equation (pp. 518-523)
9. Translational slide—in terms of stresses & factor of safety equation
10. Translational slides—engineered slopes (bolts)
11. Translational slides—road cuts
12. Topples—moments
13. Exam 1
14. Soils introduction (pp. 33-43)
15. Soil classification—coarse fraction & the Unified Classification System (pp. 136-155)
16. Engineering properties of clays (sensitivity—quick clays) (pp. 125-127 & 494-495)
17. Soil classification—fine fraction, plasticity & Atterberg Limits (pp. 128-131 & 143-146)
18. Induced Stress (pp. 323-336)
19. Effective Stress (pp. 336-345)
20. Consolidation—settlement and compression index ($C_c$) (Chapter 11)
21. Consolidation—rates (permeability) and Liquifaction (Chapter 12)
22. Compaction (Chapter 6)
23. Soil shear strength—triaxial test and Mohr's circles (Chapter 13)
24. Exam 2
25. Rotational slides—moments (Chapter 14)
26. Rotational slides—method of slices
27. Rotational Slides—vegetation and triggers
28. Rotational Slides—mitigation
29. Earthquake groundshaking and NEHRP data (Chapter 20)

# GEOL 314 - Engineering Geology Lab Topics

1. ArcGIS exercise: introduction to site characterization and geologic hazards in Whatcom County, WA.

2. I-90 Design Sector VI rock mass quality analysis using intact rock, core recovery, and rock quality designation (RQD) data.

3. I-90 Design Sector VI stereographic projection of discontinuity data using Rocscience software.

4. I-90 Design Sector VI kinematic analysis using discontinuity data and slope face orientations and Rocscience software.

5. Soil classification and the Unified Soil Classification System –determining the group symbol and group name of the course fraction resulting from sieve analyses.

6. Soil classification and the Unified Soil Classification System – determining the plastic and liquid limit (Atterberg Limits) of the fine fraction of a soil – demo by Troy Baggerman, Material Testing & Consulting, Inc.

7. Consolidation and Settlement – case study examples presented by Sean Cool, PE, geotechnical engineer, Geoengineers, Inc. Bellingham, WA.

8. ArcGIS exercise: using model builder in ArcGIS to examine infinite slope landslide susceptibility in the Smith Creek basin in the Lake Whatcom watershed.

9. Analysis of the Jones Creek deep-seated rotational Landslide in Whatcom County using SLIDE a tool in Rocscience.

# GEOL 314 - Engineering Geology Course Outcomes and Objectives

| Course Outcomes | Course Objectives |
|---|---|
| Students will understand:<br><br>1. Site characterization and how to collect, analyze, and report geologic data using standards in engineering practice (e.g., ASTM methods).<br><br>2. The fundamentals of the engineering properties of Earth materials and fluids.<br><br>3. Rock mass characterization and the mechanics of planar rock slides and topples.<br><br>4. Soil characterization and the Unified Soil Classification System.<br><br>5. The mechanics of soils and fluids and their influence on settlement, liquefaction, and soil slope stability. | Students will be able to:<br><br>1.1 Use ArcGIS to examine geology, soil, geologic hazard, and NEHRP data to characterize a geologic site.<br><br>2.1 Calculate the bulk properties of rocks and unconsolidated sediments such as density, void ratio, water contents, and unit weights.<br><br>3.1 Evaluate rock-mass quality and perform a kinematic analysis.<br><br>3.2 Apply the factor of safety equation to solve planar rock slide and toppling problems.<br><br>4.1 Perform a grain-size analysis, determine plastic and liquid limits, and classify soils using the Unified Soil Classification System.<br><br>5.1 Calculate soil consolidation magnitudes and rates under induced stress conditions.<br><br>5.2 Determine soil strength parameters from in situ tests.<br><br>5.3 Apply the method of slices and factor of safety equation to solve rotational slide problems. |