**GE 487/687 - Geological Engineering Design - 4 Credits - 2014**

**Instructor:** Dr. Bob Watters, PE, PG  
**Office:** LMR 365, phone 784-6069, email watters@mines.unr.edu  
**Time:** Class LME 415, Tuesday/Thursday 11.00 – 12:15  
**Laboratory:** LMR 165, Wednesday 1.00 - 5.00pm  
**Office hours:** Monday/Wednesday 11.00 - noon

**Catalog Description:** Application of geological engineering design techniques to a present-day project. Emphasis on addressing scientific, technical, and societal challenges in creating an appropriate design solution.

**Prerequisites:** GE 385, GE 483, completion of CO 1 – 8, junior or senior standing

**Course objectives:**  
Core Objective 9 (Science, Technology & Society)  
- Students will be able to connect science and technology to real-world problems by explaining how science relates to problems of societal concern; be able to distinguish between sound and unsound interpretations of scientific information; employ cogent reasoning methods in their own examinations of problems and issues; and understand the applications of science and technology in societal context.

Core Objective 14 (Application):  
- Students will be able to demonstrate their knowledge and skills developed in previous Core and major classes by completing a project or structured experience of practical significance. More specifically, students will:
  - Apply the basics of mathematics, science, geology and engineering to an engineering design problem.  
  - Incorporate appropriate economic, legal, social, and ethical considerations in the final project design  
  - Assess the potential impact of existing and emerging technologies on the real-world project under consideration

**Student Learning Outcomes:**  
Core Objective 9 (Science, Technology & Society)  
SLO1. Students will be able to explain the scientific challenges involved in a major geological engineering project and describe the associated legal, social, and ethical implications of the project.  
SLO2. Students will be able to analyze different possible scientific and technological solutions to project challenges in terms of their benefits, costs, ethical considerations, and other societal challenges.

Core Objective 14 (Application):  
SLO3. Students will be able to describe the results of a geological engineering design project in technical report format appropriate to the geosciences and engineering.
Capstone Course: This course is a capstone course for geological engineering majors. The purpose of the course is to pull together junior and senior level classes you have had during your undergraduate education and use what you have learned on independent design projects. There are no 100% correct solutions for the design project as you will be employing field data and information from the literature, company engineering reports, testing, modeling studies, and the news media. However, remember, there are wrong solutions.

Prior to starting the project the necessary background will be reviewed to enable all students to assess what they know, and what you have to learn or review if you are deficient in technical knowledge. Lectures will encompass the first part of the semester reviewing the technical knowledge required for the project and addressing aspects which may not have been covered in other courses. The instructor will spend the first 2 - 3 weeks laying out the purpose of the project, the environmental impact, and a project’s effect on people and the changes which will be brought about during and after the project completion on impacted communities. A field trip will be made to the engineering site where the class can review the entire project, collect rock, soils and water samples if required, and talk to the engineers, planners, and environmental specialists. Field trip timing depends on weather, transportation and permission to access the site. The next 2 -3 weeks are spent on the appropriate technologies utilized in the design reflecting economics, sound scientific and engineering principles, and an understanding of required ongoing lifetime maintenance that can be efficiently and safely performed.

In the later part of the semester students are broken into small groups (3-4 people) with each group performing their own laboratory tests, calculations and running relevant computer software. The remainder of the semester the groups performing design calculations and report writing. The instructor will assist and lead each group during this period. A draft report is required from each student 3 weeks before the semester’s end which is edited and returned to the student for re-submittal as their final report.

The final report reflects your work and thoughts, though it will incorporate data etc. from the group. Group data must be clearly identified in your report.

Project Outline:

For the design project I assign projects(s) that are real, in other words have just been built, or are being constructed or they are at the feasibility stage but data is available. The project for 2014 is The Panama Canal Expansion. Full details will be distributed on both projects via lectures, handouts, web links, and posted on WebCampus.

One of the reasons for selecting the Panama Canal Project is that the MWH Global Company’s CEO is a Mackay graduate, Alan Krause, with an MS in Geological Engineering. Alan is Chairman and Chief Executive Officer (CEO), at MWH Global one of the leading companies in the world in wet water projects. Alan will be visiting UNR as the lecturer for the College of Science’s Discover series on the evening of February 6. All students will attend the presentation in the early evening; full details will be given later. It is anticipated that Alan will give a lecture to the class and be available for informal discussion with food!
The **Panama Canal** (Spanish: *Canal de Panamá*) is a 77.1-kilometre (48 mi) **ship canal** in **Panama** that connects the **Atlantic Ocean** (via the **Caribbean Sea**) to the **Pacific Ocean**. The canal cuts across the **Isthmus of Panama** and is a key conduit for international maritime trade. There are locks at each end to lift ships up to **Gatun Lake**, an artificial lake created to reduce the amount of excavation work required for the canal, 26 metres (85 ft) **above sea level**. The current locks are 33.5 meters (110 ft.) wide. A **third, wider lane of locks** is currently under construction and is due to open in 2015.

As background, France began work on the canal in 1881, but had to stop because of engineering problems and high mortality due to disease. The United States took over the project in 1904, and took a decade to complete the canal, which was officially opened on August 15, 1914. One of the largest and most difficult engineering projects ever undertaken, the Panama Canal shortcut greatly reduced the amount of time taken for ships to travel between the Atlantic and Pacific Oceans, enabling them to avoid the lengthy, hazardous **Cape Horn** route around the southernmost tip of **South America** via the **Drake Passage** or **Strait of Magellan**. The shorter, faster, and safer route to the U.S. West Coast and to nations in and around the Pacific Ocean allowed those places to become more integrated with the world economy. The approximate time to traverse the canal is between 20 and 30 hours.

**NOTE:** A requirement of the class in addition to the expansion project is to review and assess the geotechnical aspects of the original Panama Canal construction and the scientific, technical, and societal challenges that had to be addressed.
The **Panama Canal expansion project** (also called the Third Set of Locks Project) is intended to double the capacity of the **Panama Canal** by 2015 by creating a new lane of traffic and allowing more and larger ships to transit. The expansion project will: a) Build two new locks, one each on the Atlantic and Pacific sides. b) Each will have three chambers with water-saving basins. Excavate new channels to the new locks. c) Widen and deepen existing channels. d) Raise the maximum operating level of **Gatun Lake**.

Links:  
http://www.pancanal.com/eng/expansion/rpts/informes-de-avance/expansionreport-201210.pdf  
http://www.pancanal.com/eng/expansion/

The following topics must be researched, local conditions appraised, and calculations etc. performed.

Office:  

a) Historical, societal and legal context of the project  
b) Maps and photographs of the site location  
c) Previous technical and historical reports  
d) Design calculations for surface excavations  
e) Hydrology and groundwater
f) Model studies

g) Local geology and seismology

h) Geologic and geotechnical site cross-sections

i) Anticipated scientific, technical, and societal challenges

j) Excavation methods, design, and safety monitoring

Laboratory: a) testing

b) modeling

Course Grading:

1. Mid-term examination on topics required for the project (20%).

2. Written report, power point presentation, and model demonstration (60%). A draft copy of the report must be submitted to me 3 weeks before preparation day (by April 16). I will mark up and return the draft. The final report is due no later than Monday, May 12, 2014.

3. Final examination Thursday May 8, 8:00 – 10:00am. LME 415 (20%)

A > 94%
A – 90-93%
B + 87-89%
B 84-86%
B - 80-83%
C +75-79%
C 70-74%

Geological engineering majors must obtain a “C” or better to obtain course credit

C- 60-69%
D 50-59%
F <50%

UNR Policies:

1. Cheating, plagiarism or otherwise obtaining grades under “false pretenses” constitute academic dishonesty according to the code of this university. Academic dishonesty will not be tolerated and penalties can include canceling a student’s enrollment without a grade, giving an F for the course or for the assignment. For more details, see the UNR General Catalog.

2. If you have a disability and will be requiring assistance, please contact me or the Disability Resources Center (Thompson Building Suite 101) as soon as possible to arrange for appropriate accommodations.

3. Surreptitious or covert video-taping of class or unauthorized audio recording of class is prohibited by law and by Board of Regents policy. This class may be videotaped or audio recorded only with the written permission of the instructor.

In order to accommodate students with disabilities, some students may have been given permission to record class lectures and discussions. Therefore, students should understand that their comments during class may be recorded.
4. Any student missing classes, quizzes, examinations, or any other class or lab work because of observance of religious holy days will be given an opportunity during the semester to make up the missed work. The make-up will apply to the religious holy day absence only. It shall be the responsibility of the student to notify the instructor in advance in writing, if the student intends to participate in a religious holy day which does not fall on state holidays or periods of class recess.

**ABET Aligned Course Objectives:**

1. Comprehend the importance of accurate subsurface data collection from the global geologic picture.
2. Understand the mechanical behavior of soil and rock.
3. Show how geology affects surface failure mechanisms.
4. Calculate factors of safety for different failure modes and designs.
5. Perform computer stability analyses using numerical methods, and other RocScience programs.
6. Assess the importance of earthquake and water pressure on stability.
7. How appropriate design methods reflect economics, legal considerations, social issues and ethics.
8. Field visits to an active engineering project that illustrates failure processes, project design, mitigation, and effect on people and structures.
9. Apply the basics of mathematics, science, geology and engineering (gained from GE, CE, ME and MinE.classes) to an engineering design problem.
10. Work as a team member applying your knowledge to assist in solving the problem.
11. Prepare the collected data and engineering solutions in a technical report and produce a poster employing a software package.
12. Orally present your findings and design using a power point presentation.

**Student Learning Objectives:**

<table>
<thead>
<tr>
<th>Engineering programs must demonstrate that their graduates have:</th>
<th>Corresponding Course Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) an ability to apply knowledge of mathematics, science, and engineering</td>
<td>1.2.3</td>
</tr>
<tr>
<td>(b) an ability to design and conduct experiments, as well as to analyze and interpret data</td>
<td>1,2</td>
</tr>
<tr>
<td>(c) an ability to design a system, component, or process to meet desired needs</td>
<td>4,5</td>
</tr>
<tr>
<td>(d) an ability to function on multi-disciplinary teams</td>
<td>10,</td>
</tr>
<tr>
<td>(e) an ability to identify, formulate, and solve engineering problems</td>
<td>4,6</td>
</tr>
<tr>
<td>(f) an understanding of professional and ethical responsibility</td>
<td>7,</td>
</tr>
<tr>
<td>(g) an ability to communicate effectively</td>
<td>11, 12</td>
</tr>
<tr>
<td>(h) the broad education necessary to understand the impact of engineering solutions in a global and societal context</td>
<td>8</td>
</tr>
<tr>
<td>(i) a recognition of the need for, and an ability to engage in life-long learning</td>
<td>7,8</td>
</tr>
<tr>
<td>(j) a knowledge of contemporary issues</td>
<td>7</td>
</tr>
<tr>
<td>(k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice</td>
<td>4,5,6</td>
</tr>
<tr>
<td>(l) field skills competency will be achieved</td>
<td>1,8</td>
</tr>
</tbody>
</table>