EOSC 434, Spring, 2015
Principles of Geological Engineering

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Learning goals of this course:

This course and its companion, EOSC 433 are meant to offer a transition between specialized courses such as Geomorphology, Hydrogeology, Soil Mechanics and Rock Mechanics and the range of knowledge the students will need in preparation for their entry into practice.

The course will aim to learn how to apply this knowledge at engineering sites in realistically complex geological environments.

As a senior level course, some of the material covered will be a review of knowledge obtained in earlier classes. New material will be introduced as necessary. My intent is to concentrate on those topics that are the most likely to be useful to a young professional at the start of a career and to present these topics in a way that is relevant to practice.

The course will emphasize engineering geology of unconsolidated deposits (“soils”) and weak rocks. The companion course (EOSC 433) will deal mainly with rock problems. However, there will be some intentional overlap between the two courses.
Topics:

• A brief overview of the history of geological engineering and engineering geology.
• Description of the roles of various professionals in an engineering project.
• A review of professional issues related to geological engineering such as ethics and liability.
• Definition and use of geotechnical facies, to establish a relationship between geological characteristics of a site and its likely engineering behaviour.
• A review of processes that modify soil characteristics.
• Problem soils - swelling, dispersive, collapsible soils. How to recognize and treat them.
• Review of site investigation techniques from the point of view of a geological engineer, ranging from simple surficial mapping and outcrop logging to image interpretation, subsurface and in situ techniques.
• Review of slope stability analysis methods and special issues such as pore-water pressure and selection of strength parameters. Presentation of example case histories.
• Excavations-feasibility, safety, support requirements, dewatering.
• Landslide stabilization methods.
• Soft ground tunnels- a brief overview of basic techniques.
• Engineering geology of foundations.
• Sanitary and mining waste disposal, geotechnical issues and case histories.
• Basics of landslide hazard and risk management.
• Methods of debris flows and rock fall hazard assessment and control.
Practicalities:

1. Time/place
2. Course web site Username: eosc434
3. Textbook, references
4. Labs/assignments
5. Oral presentations
6. Marking
7. Questions
8. Introductions
Laboratories:
There will be several exercises, each due one week after introduction of the assignment, unless indicated otherwise. Most of the “laboratory” time will be taken up by student presentations (10 minutes each).

Student presentations (laboratory):
Each student in the class will prepare and deliver a 10 minute oral technical presentation, supported by Powerpoint slides. The purpose of the presentations will be to give the graduating students a chance to present a professional lecture to peers and to conduct a discussion. The possible geotechnical or geoenvironmental topics for the presentation can include:
- Some technical experience gained during work terms
- A summary of a research or design project
- A geo- problem observed somewhere around Vancouver
- A geo- topic studied by the author in the literature and briefly summarized

Important note: The student presentations will be delivered during the lab period on Thursdays 16-18. All students are expected to attend the presentations and participate in discussions. Each student must submit a set of notes, summarizing each presentation, including the related class discussion in a paragraph of approximately 200 words. These notes will be marked pass/fail by the instructor.
Attention: Use of overheads and attendance in classes

All of my lectures will be delivered with the help of Powerpoint. All the presentations will be available on the course web site.

So, if all the material is on the web and in books, why attend classes?

Caution:
The presentations contain only essential notes and illustrative material. They should enrich the narrative, but cannot really replace it. If you are not in class, you may miss explanations, descriptions, discussion and other stuff that is supposed to make you understand the material. That is why we still have a physical university.

What should I do then?
1) Attend classes 2) keep your own notes 3) Ask questions, give comments, interact with classmates, participate

Oldrich Hungr, January, 2015
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<th>Component</th>
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<tbody>
<tr>
<td>Laboratories</td>
<td>10%</td>
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<tr>
<td>Oral presentation, participation in class</td>
<td>10%</td>
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<td>Midterm Quizz</td>
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What is Engineering?

A professional activity, involving design.

The word "design" is understood as the function of making specific and quantitative plans for construction, corrective actions or policy. Design may be concerned with civil or mining projects, as well as environmental protection and hazards management. According to Canadian law, persons engaged in engineering design should be registered Professional Engineers (P.Eng.)
What is Geological Engineering?

• **Geological Engineering** is the application of a combination of geology and engineering science to design, involving rock, soil, groundwater and mineral resources.

• **Geotechnical Engineering** is the application of the science of soil mechanics, rock mechanics, engineering geology and other related disciplines to engineering and environmental projects (after Morgenstern, 2000).

• **Geo-environmental engineering** is the application of a combination of geology and engineering science to the solution of environmental problems.

• **Engineering Geology** is the application of geology to obtain information and understanding of geological structures, materials and processes, as needed for engineering analysis and design.

• **Environmental geology** is the application of geology to obtain information and understanding of geological structures, materials and processes, as needed for the solution of environmental problems.

*(Please read Hungr, 2000: handout)*
Who is a Geological Engineer?

Honours Degree + 4 years experience.

Types:
- Civil Engineer with geotechnical option (P.Eng.)
- Geological Engineer with geotechnical option (P.Eng., P.Geo.)
- Geologist with extra courses and experience (Engineering Geologist, P.Geo)

IMPORTANT: see http://www.apeg.bc.ca/
Division of tasks:

**Civil Engineer**
- designs structure

**Geotechnical/Geological, Geo-environmental Engineer**
- carries out site investigation
- evaluates soil/rock properties
- carries out analysis
- provides geotechnical/geoenvironmental design recommendations

**Engineering Geologist**
- carries out site investigation and evaluates geological factors
- provides geological input for analysis
- assesses hazards and impact of geological processes
- prospects for materials
Geological Engineering: Other tasks:

- Environmental studies
- Groundwater exploration and development
- Aquifer protection
- Environmental cleanup
- Exploration and evaluation of mineral resources
- Mining production
- Geophysical exploration
...
Who employs geological engineers?

**Owner**
- Site Engineer
- Site Geotechnical Engineer / Engineering Geologist

**Designer**
- Civil Engineers

**Geotechnical Consultant**
- Civil Engineers
- Geotechnical Engineers
- Engineering Geologists

**Site Investigation Contractor (UK)**
- Geotechnical Engineers
- Engineering Geologists

**Contractor**
- Civil Engineers

**Government Agency**
- Civil Engineers
- Geotechnical Engineers
- Engineering Geologists

**Specialist Consultant**
- Geotechnical Engineer / Engineering Geologist
What does a geological engineer do?

• Determines distribution of geological materials, structures and groundwater (X-ray picture)

• Estimates or measures properties of materials

• Provides a quantitative or qualitative assessment of geological processes

• Uses all the above information to give advice regarding planning, design of projects and environmental management
Which industries are served by geological engineering?
Code of Ethics (in plain English)

1) Safety and environment is #1
2) Do only what you are qualified to do
3) Say only what you believe is true
4) Avoid conflict of interest
5) Insist on fair compensation
6) Keep up your expertise
7) Be honest, fair and courteous
8) Point out potential problems
9) Report bad things when you see them
10) Promote the profession

(APEGBC Guidelines for Professional Excellence, 1994)
Legal issues:

See “Ten Commandments of Good Practice”
(pdf on web site)

1. Do not raise unrealistic expectations about your ability or the merits of a project.
2. Inform client that you are not a guarantor of the work.
3. Have a good, written contract.
4. Do not play lawyer.
5. Check design and calculations. Enforce inspections.
6. Keep client advised: you are the consultant.
8. Maintain written records.
9. Do not certify what you have not seen.
10. Take caution before initiating a lawsuit.
Contracts:

Terms of Engagement
(Please read handout by Singleton Urquhart, Scott, 1997)

Important points:
Termination – with 30 days notice
Environmental – will not deal with (also vice/versa)
Standard of service – customary
Limitations on liability
  – exclude things out of your control
  – limit to the amount of insurance available
  – 2 year statute of limitation
Documents – not to be used for another project
Field services – as recommended by the Consultant (you)
Basic Principles:
The Burland Triangle

Basic Principles:
The Burland Triangle, generalized

Geological model

Field and lab observations

Analysis

Common misconceptions:

1) A result backed by analysis is always superior to that based on subjective judgment
2) A theory is reliable if all the mathematics is correct
3) A theory that is more complicated is always superior to that which is simple
4) A theoretical (statistical) analysis can replace missing data
5) Complex field or remote sensing measurements are always more reliable than simple observations
6) A good theory needs no calibration against field observations
7) “Unreliability” is caused only by the variation of the ground (i.e. we are reliable, the ground is not)

“Quality control applied to an inappropriate analytical model merely guarantees that we will not get the right result by accident”

(P. Vaughan, Imperial College)