Civil Engineering 743
Fundamental of soil behaviour
Course Outline

1. Course Description

An understanding of soil behaviour is a fundamental requisite to a wide variety of geotechnical engineering applications, such as foundation design, soil-structure interaction and geotechnical earthquake engineering. Appropriate numerical modelling also highly depends on a better understanding of soil behaviour. This course, which focuses on the behaviour of soils under various conditions, their theoretical descriptions and laboratory testing, will provide students the knowledge and understanding of fundamental soil behaviour and of the underlying scientific principles.

2. Course Contents

(1) Stress/ Strain in Soils and the principles of effective stress

- Review on stresses in soil
  - States of stress and strain
  - Mohr's circle and its application
  - Principal stresses and stress invariants
- Principle of effective stress

(2) Stress-Strain-Strength Characteristics of dry and saturated soils

- Stress conditions and laboratory tests: plane strain, triaxial, simple shear
- Typical stress-strain behaviour of soil
- Primary factors affecting soil behaviour
- Review: shear strength of soil and Mohr-Coulomb failure criterion
- Strength and failure
  - Mohr-coulomb failure criteria
  - Failure criteria under three-dimensional stress conditions
  - Effects of confining stress, intermediate principal stress, bedding plane, stress paths on Strength and dilatancy
- Fabric and anisotropy
- Micromecahnics of granular soil: An introduction

(3) Constitutive Models for Soils

- Critical State Soil Mechanics
  - Drained/ undrained conditions and stress paths
  - Volume change characteristic of soil
    - ✓ Consolidation and dilatancy
    - ✓ Stress-dilatancy relationships
  - Framework of critical state soil mechanics
    - ✓ Cam-Clay and Modified Cam-Clay Models
    - ✓ Critical-state based models of granular soils
- Elasto-plasticity models
- Hypoplasticity model

(4) Coupled flow phenomena in porous medium

- Theory of consolidation
  - Review: Terzaghi 1D consolidation theory
  - 3D consolidation theory
  - Finite strain consolidation
- Thermal-mechanical processes: An introduction

(5) Behaviour of unsaturated soils: an introduction

3. Assignments

Problem assignments will be assigned periodically and are designed to assist the students to retain the theoretical materials presented in lecture.

4. Course Textbook

The course content does not allow to use a specific book. Instead, the course text will be developed from some references and the class notes.

5. Grading

The following percentages are tentative.

Assignments	30%
Final exam	30%
Term project	40%

6. Major References

Cambou, B., Jean, M. and Radjai, F. (2009). Micromechanics of Granular Materials, Wiley.
Lambe, T. and Whitman, R. V. (1979) Soil Mechanics, John Wiley.
Mitchell, J.K. and Kenichi Soga (2005), Fundamentals of Soil Behavior, 3rd Ed., John Wiley.
Murray, E. J. and Sivakumar, V. (2010) Unsaturated Soils: a Fundamental Interpretation of Soil Behaviour, Wiley-Balckwell.
Wood, D.M. (1990), Soil Behavior and Critical State Soil Mechanics, Cambridge University Press.

7. Additional References/Readings Materials

Additional references /reading materials will be given during the lectures.

This lecture schedule is based upon current university and public health guidelines and may be subject to changes during the term. Any changes to the schedule or course delivery will be communicated on the course announcements section on Avenue to Learn. Please check the announcements prior to attending class.

NOTES CONCERNING PROJECT REPORTS

1 INTRODUCTION

The introduction section sets the stage as to why we are doing this research as well as the problem statement.
Example: (1) What is the effect of stress path on the friction angle of sand? (2) What is the effect of sample preparation method on the strength and deformation features of soil?

2 PURPOSE AND SCOPE

This section states objectives and "what was done to achieve the objectives".
Example: The purpose of this permeability test was to determine values for *k*, and evaluate the effects of fabric on *k* values (or the directional dependency of *k*). These objectives were achieved by performing tests according to ASTM D???? using various gradients and flow directions. The introduction, purpose and scope, should tell the reader WHY (problem), objective, and WHAT/HOW experiment was done.

3 LITERATURE REVIEW

For this section, present a brief review of those references that you will refer to in data analysis, or background you feel the reader should have to understand the report. However, omit BASICS!
Example: Carpenter and Stephenson (1885) observed that *k* decreased as *i* increased, which is contrary to Darcy's Law (You do not need to explain Darcy's Law).

4 MATERIAL (SOIL), TEST EQUIPMENT, AND PROCEDURE

- A brief description on soil type, i.e., classification, visual description, grain-size curves;
- Specimen preparation- Compacted, undisturbed, sand rain (in air or in water), initial void ratios, etc. ;
- Test equipment & Procedure - Refer to ASTM specifications wherever possible, and just note exceptions.

5 APPROACH TO COMPLETE YOUR STUDY (EXPALE: PRESENTATION AND ANALYSIS OF DATA)

Make use of summary tables and graphs to present results and make "points" that will be in analysis of data. Place raw data in appendix (if there is any).

6 CONCLUSIONS

- Be concise
- Each conclusion should be backed-up in data analysis section
- For every purpose, there must be a conclusion

7 REFERENCES