

**The University of Western Ontario**  
**Department of Civil and Environmental Engineering**

**CEE 3326 - Soil Mechanics and Hydro-geologic Engineering**  
**Course Outline 2010/2011**

This is the first introductory course to the fundamentals of soil mechanics and hydro-geologic engineering for students enrolled in the Department of Civil and Environmental Engineering. The students are required to attend lectures, conduct laboratory experiments to measure the engineering properties of soil, interpret experimental data, and submit laboratory results in complete and concise reports. The course covers the following topics:

- Methodologies of soil classification and property testing, basics of clay mineralogy, site investigation and sampling procedures
- Concepts of pore water pressure, effective stress and capillarity and their implications on soil behaviour including swelling, shrinkage and frost action.
- One-dimensional settlement and consolidation
- One-dimensional and two-dimensional steady state groundwater flow
- Concept and measurement of soil shear strength
- Concept and general methods of slope stability analysis
- Design implications of consolidation, flow, settlement and shear strength and how the basic concepts can be applied in engineering practice.

**Prerequisites:**

CEE2202a/b, EarthSc2281b, AM2411 or former CEE202a/b, EarthSc281b, AM277 or former ES202a/b, Geol291b or AM270.

**Anti-requisites:**

Former CEE326, ES327a, ES366b, ES326

**Note:** It is students' **responsibility** to ensure that all Prerequisite conditions are met or that special permission to waive these requirements has been granted by the Faculty. Unless the student has either the requisites for this course or written special permission from the Associate Dean's Office to enrol in it, he/she will be removed from this course and it will be deleted from the student's record. It is also the student's **responsibility** to ensure that he/she has not taken a course listed as an Anti-requisite. The student may not be given credit if he/she violates the anti-requisite condition. The decisions regarding either prerequisite or anti-requisite may not be appealed. The student will receive no adjustment to tuition fees in the event that he/she is dropped from a course for failing to meet prerequisite and anti-requisite conditions.

**Contact Hours:**

2 lecture hrs/wk; 3 tutorial hrs or 3 laboratory hrs/wk; (recommended personal study – 4 hours/wk). Attendance at the tutorial/laboratory session is mandatory

**Instructor:**

Course coordinator: Dr. Julie Q. Shang, P.Eng. SEB3082, e-mail: [jqshang@uwo.ca](mailto:jqshang@uwo.ca)

Course instructors:

Fall 2009 Term: Dr. Julie Q. Shang

Winter 2009 Term: TBD

Administrative Assistant: SEB 3005, 519-661-2139; [civil@uwo.ca](mailto:civil@uwo.ca)

**Textbook:** Coduto, D. P., Yeung, M R, and Kitch, W A “Geotechnical Engineering, Principles and Practices”, Prentice-Hall, Inc., 2<sup>nd</sup> edition, 2011. Required.

Whitlow, R. “Basic soil mechanics”, Prentice-Hall, Inc. 4<sup>th</sup> Edition, 2001. Recommended.

**Lab manual:** Das B.M. “Soil Mechanics Laboratory Manual” 6<sup>th</sup> Edition, Oxford University Press. 2002. Required.

**Laboratory:**

Biweekly laboratory sessions are compulsory, and each lab must be written up and submitted in the manner specified.

**Tutorials:**

Biweekly tutorial sessions are compulsory and each assignment must be written up and submitted in the manner specified.

**Units:** SI units will be the primary units used in lectures and examinations.

**Specific Learning Objectives:**

1. Soil Characterisation.

- a) Identify basic soil groups
- b) Draw soil grain size distribution curves based on sieve and hydrometer analyses results
- c) Describe the basic structure and engineering properties of three clay minerals: kaolinite, illite, and montmorillonite and the general physical and chemical properties of soil-water systems.
- d) Measure soil Atterberg limits (PL, LL and PI)
- e) Classify soils based on the Unified Soil Classification System (USCS)
- f) Calculate soil properties using phase relations
- g) Describe principles of basic field soil sampling and groundwater monitoring methods

2. Soil Compaction

- a) Perform lab compaction tests
- b) Draw theoretical and experimental compaction curves
- c) Determine the optimal water content and maximum dry density of a soil
- d) Establish quality control criteria for field compaction works
- e) List typical engineering applications of soil compaction

3. Steady-State Groundwater Flow

- a) Describe the concepts of steady-state groundwater seepage and pore water pressure
- b) Understand the nature of seepage flow in soil
- c) Define and apply Darcy’s law to calculate the steady-state groundwater flow
- d) Define and measure hydraulic conductivity of soil and know magnitudes of hydraulic conductivities of gravel, sand and clay soils
- e) Understand critical hydraulic gradient and its engineering significance
- f) Define the governing equation for 2D steady-state seepage flow in soil and solve the equation using the flow-net. Draw flow nets for engineering applications, including (1) calculate the seepage flow in isotropic and anisotropic soils, (2) calculate the pore water pressure in soil and (3) calculate the uplifting force due to seepage.

4. Effective Stress, Capillarity and Frost Action

- a) Calculate the total stress, pore pressure and effective stress in soil
- b) Define the coefficient of earth pressure at rest
- c) Calculate the capillary rise in soil and recognize its influence on soil behaviour.

- d) Understand the impact of frost action and identify frost susceptible soils.
5. Stresses and displacements
- Describe the soil stress-strain relationship
  - Calculate the stress distribution in soil due to surface loading based on the elastic theory
  - Calculate the stress distribution in soil due to surface loading based on the empirical method
  - Calculate the soil displacement due to surface loading based on the elastic theory
  - Describe the relationship between horizontal and vertical stresses in soil and calculate the horizontal stress in soil knowing the vertical stress
6. Settlement and consolidation.
- Describe the components of soil settlement
  - Describe the soil compressibility
  - Calculate immediate settlement of soil
  - Perform consolidation tests
  - Calculate the preconsolidation pressure, compressibility, coefficient of consolidation and stiffness of soils from consolidation test data
  - Perform design calculation for the final settlement of soils
  - Describe Terzaghi's one-dimensional consolidation theory, including assumptions made during the derivation
  - Calculate the degree of consolidation and degree of settlement of clay soils using analytical and finite difference solutions
  - Describe the concept of secondary consolidation
  - Describe the design implications of soil settlement.
7. Shear Strength of Soils.
- Define the soil shear strength for short and long term conditions
  - Use Mohr-Coulomb failure criterion to define failure in soil
  - Describe the shear strengths of sand and clay
  - Describe the peak and residual shear strengths of soils
  - Measure the shear strength of sands and clays in lab and in-situ
  - Describe the design implications of the soil shear strength.
8. Slope stability.
- Define the slope stability and factor of safety of slopes
  - Calculate the factor of safety of infinite slopes for long and short term analyses
  - Calculate the factor of safety for planar failure surfaces
  - Conduct short-term slope stability analysis using the stability chart
  - Describe the method of slices to calculate the factor of safety of earth slopes
  - Describe principles and procedures of using computer software for slope stability analysis
  - Describe the implications of slope stability with respect to the design of soil slopes

**General Learning Objectives**

Knowledge Base	x	Individual Work	x	Ethics and Equity	
Problem Analysis	x	Team Work	x	Economics and Project Management	
Investigation	x	Communication	x	Life-Long Learning	x
Design	x	Professionalism	x		
Engineering Tools	x	Impact on Society	x		

**Evaluation:**

Final examination	30%
Mid-year exam	30%
Laboratory Reports	16%
Tutorial Assignments	16%
Tutorial Quizzes (2)	8% = <b>Total 100%</b>

1. **Students must pass the weighted average of mid-year and final examinations to pass in this course.** Students who fail to achieve a passing grade in the weighted average will be assigned the aggregate mark, as determined above or 48% whichever is less.
2. **Students must submit all laboratory reports, and achieve a passing grade in all laboratory components, including lab attendance and lab reports, to pass this course.** Students who do not satisfy this requirement will be assigned the aggregate mark, as determined above or 48% whichever is less.
3. **Students who have failed an Engineering course (ie.<50%) must repeat all components of the course.** No special permissions will be granted enabling a student to retain laboratory, assignment or test marks from previous years. Previously completed assignments and laboratories cannot be resubmitted for grading by the student in subsequent years.

i. Examinations.

Mid-year and final examinations will be 3 hours, held in the examination period of the fall and winter terms, respectively. The examinations will be **LIMITED OPEN BOOK:** approved handheld programmable calculators and 3 pages (8 ½" x 11", double sided) data sheets prepared by the student may be brought to the examinations.

ii. Quizzes:

Two 60 minutes quizzes, one per term, will be scheduled during a tutorial period. At least 3 weeks notice will be given prior to the date of a quiz. The quizzes will be open book and approved handheld programmable calculators are allowed.

iii. Assignments:

Assignments will be distributed in the biweekly tutorial period. At the beginning of each tutorial session, up to five students may form a group. A tutorial group must submit the assignment problems specified by the TA by the end of the tutorial period. All members of a group must be present and work on the assignment during the tutorial. All group members whose names are on a submission will receive the same mark. The individual part of the assignments is due on following Monday at 11:00 a.m. in LOCKER #55, 2<sup>ND</sup> FLOOR, SEB. Late submissions will be deducted 0.2 (out of 1 mark) per day and not be accepted 7 days after the due date.

iv. Lab. Reports:

Due 1:30 PM Mondays to Locker #55 on the 2nd FLOOR, SEB. The due dates are the 1<sup>st</sup> Monday after the lab is completed. Late reports will be deducted 0.5 (out of 4 marks) per day and not be accepted 7 days after the due date.

v. Use of English

In accordance with Senate and Faculty Policy, students may be penalized up to 10% of the marks on all assignments, tests and examinations for the improper use of English. Additionally, poorly written work with the exception of final examinations may be returned without grading. If resubmission of the work is permitted, it may be graded with marks deducted for poor English and/or late submission.

**Cheating:**

University policy states that cheating is a scholastic offence. The commission of a scholastic offence is attended by academic penalties, which might include expulsion from the program. If you are caught cheating, there will be no second warning.

**Plagiarism:**

Students must write their essays and assignments in their own words. Whenever students take an idea, or a passage from another author, they must acknowledge their debt both by using quotation marks where appropriate and by proper referencing such as footnotes or citations. Plagiarism is a major academic offence (see Scholastic Offence Policy in the Western Academic Calendar).

**Attendance:**

Any student, who, in the opinion of the instructor, is absent too frequently from class or laboratory periods in any course, will be reported to the Dean (after due warning has been given). On the recommendation of the Department concerned, and with the permission of the Dean, the student will be debarred from taking the regular examination in the course.

**Accessibility:**

Please contact the course instructor if you require material in an alternate format or if any other arrangements can make this course more accessible to you. You may also wish to contact Services for Students with Disabilities (SSD) at 661-2111 x 82147 for any specific question regarding an accommodation.

**Conduct:**

Students are expected to arrive at lectures on time, and to conduct themselves during class in a professional and respectful manner that is not disruptive to others.

**Sickness and Other Problems:**

Students should immediately consult with the instructor or Department Chair if they have any problems that could affect their performance in the course. Where appropriate the problems should be documented (see attached). The student should seek advice from the instructor or Department Chair regarding how best to deal with the problem. Failure to notify the instructor or Department Chair immediately (or as soon as possible thereafter) will have a negative effect on any appeal.

**Consultation:**

Students are encouraged to discuss problems with their teaching assistants and/or course instructors in tutorial sessions. Other individual consultation can be arranged by appointment with the appropriate instructor. The instructor shall inform all students of their office hours for consultation during the first week of each term.

**Notice:**

Students are responsible for regularly checking their e-mail and notices posted outside the Civil and Environmental Engineering Departmental Office.

**Course breakdown:**

Engineering science = 60%, 55 AU's  
Engineering design = 40%, 36 AU's

The attached document "Instructions for Students Unable to Write Tests or Examinations or Submit Assignments as Scheduled" is part of this course outline.



The University of Western Ontario  
Faculty of Engineering  
2010-2011

**INSTRUCTIONS FOR STUDENTS UNABLE TO WRITE TESTS  
OR EXAMINATIONS OR SUBMIT ASSIGNMENTS AS SCHEDULED**

IF, ON MEDICAL OR COMPASSIONATE GROUNDS, YOU ARE UNABLE TO WRITE TERM TESTS OR FINAL EXAMINATIONS OR COMPLETE COURSE WORK BY THE DUE DATE, YOU SHOULD FOLLOW THE INSTRUCTIONS LISTED BELOW. YOU SHOULD UNDERSTAND THAT ACADEMIC ACCOMMODATION WILL NOT BE GRANTED AUTOMATICALLY ON REQUEST. YOU MUST DEMONSTRATE TO YOUR DEPARTMENT (OR THE UNDERGRADUATE SERVICES OFFICE IF YOU ARE IN FIRST YEAR) THAT THERE ARE COMPELLING MEDICAL OR COMPASSIONATE GROUNDS THAT CAN BE DOCUMENTED BEFORE ACADEMIC ACCOMMODATION WILL BE CONSIDERED. DIFFERENT REGULATIONS APPLY TO TERM TESTS, FINAL EXAMINATIONS AND LATE ASSIGNMENTS. READ THE INSTRUCTIONS CAREFULLY. (SEE THE 2009 UWO ACADEMIC CALENDAR).

**A. GENERAL REGULATIONS & PROCEDURES**

1. CHECK THE COURSE OUTLINE TO SEE IF THE INSTRUCTOR HAS A POLICY FOR MISSED TESTS, EXAMINATIONS, LATE ASSIGNMENTS OR ATTENDANCE.
2. BRING YOUR REQUEST FOR ACADEMIC ACCOMMODATION TO THE ATTENTION OF THE CHAIR OF YOUR DEPARTMENT (OR THE UNDERGRADUATE SERVICES OFFICE IF YOU ARE IN FIRST YEAR) PRIOR TO THE SCHEDULED TIME OF THE TEST OR FINAL EXAMINATION OR DUE DATE OF THE ASSIGNMENT. IF YOU ARE UNABLE TO CONTACT THE RELEVANT PERSON, LEAVE A MESSAGE WITH THE APPROPRIATE DEPARTMENT (OR WITH THE UNDERGRADUATE SERVICES OFFICE, IF YOU ARE IN FIRST YEAR). THE ADDRESSES, TELEPHONE AND FAX NUMBERS ARE GIVEN AT THE END OF THESE INSTRUCTIONS. DOCUMENTATION MUST BE PROVIDED AS SOON AS POSSIBLE.
3. IF YOU DECIDE TO WRITE A TEST OR AN EXAMINATION YOU SHOULD BE PREPARED TO ACCEPT THE MARK YOU EARN. REWRITING TESTS OR EXAMINATIONS OR HAVING THE VALUE OF A TEST OR EXAMINATION REWEIGHTED ON A RETROACTIVE BASIS IS NOT PERMITTED.

**B. TERM TESTS**

1. If you are unable to write a term test, inform your instructor and the Chair of your Department (or the Undergraduate Services Office if you are in first year) prior to the scheduled date of the test. If the instructor is not available, leave a message for him/her at the department office and inform the Chair of the Department (or the Undergraduate Services Office if you are in first year).
2. Be prepared to provide supporting documentation to the Chair and the Undergraduate Services Office (see next page for information on documentation).
3. Discuss with the instructor if and when the test can be rescheduled. **N.B.** The approval of the Chair (or the Undergraduate Services Office if you are in first year) is required when rescheduling term tests.

**C. FINAL EXAMINATIONS**

1. If you are unable to write a final examination, contact the Undergraduate Services Office **PRIOR TO THE SCHEDULED EXAMINATION TIME** to request permission to write a Special Final Examination. If no one is available in the Undergraduate Services Office, leave a message clearly stating your name & student number (please spell your full name).
2. Be prepared to provide the Undergraduate Services Office with supporting documentation (see next page for information on documentation) the next day, or as soon as possible (in cases where students are hospitalized). The following circumstances are not considered grounds for missing a final examination or requesting special examinations: common cold, sleeping in, misreading timetable and travel arrangements.
3. In order to receive permission to write a special examination, you must obtain the approval of the Chair of the Department **and** the Associate Dean and in order to apply you must sign a "Recommendation for a Special Examination Form" available in the Undergraduate Services Office. The Undergraduate Services Office will then notify the course instructor(s) and reschedule the examination on your behalf.

**N.B. It is the student's responsibility to check the date, time and location of the special examination.**

**D. LATE ASSIGNMENTS**

1. Advise the instructor if you are having problems completing the assignment on time (**prior** to the due date of the assignment).
2. Be prepared to provide documentation if requested by the instructor (see reverse side for information on documentation).
3. If you are granted an extension, establish a due date. The approval of the Chair of your Department (or the Associate Dean if you are in first year) is not required if assignments will be completed prior to the last day of classes.
4. i) Extensions beyond the end of classes must have the consent of the instructor, the department Chair and the Associate Dean. Documentation is mandatory.

- ii) A Recommendation of Incomplete Form must be filled out indicating the work to be completed and the date by which it is due. This form must be signed by the student, the instructor, the department Chair and the Associate Dean.

### SHORT ABSENCES

If you miss a class due to a minor illness or other problems, check your course outlines for information regarding attendance requirements and make sure you are not missing a test or assignment. Cover any readings and arrange to borrow notes from a classmate.

### EXTENDED ABSENCES

If you are absent more than one week or if you get too far behind to catch up, you should consider reducing your workload by dropping one or more courses. (Note drop deadlines listed below). You may want to seek advice from the academic counsellor in your Department or the counsellors in the Undergraduate Services Office if you are in first year.

### DOCUMENTATION

If you consulted Student Health Services regarding your illness or personal problem, you should complete a Records Release Form in your Departmental Office (or in the Undergraduate Services Office if you are in first year). This form will be forwarded to Student Health Services who in turn will provide confirmation of the problem to the Department or Associate Dean as requested. At your request the Department (or Undergraduate Services Office if you are in first year) will send confirmation to your instructor(s).

If you were seen by an off-campus doctor, you must provide the doctor with a Student Medical Certificate to complete and then bring it to the Department (or the Undergraduate Services Office if you are in first year). **This note must contain the following information: severity of illness, effect on academic studies and duration of absence.**

**In Case of Serious Illness of a Family Member:** Provide a Student Medical Certificate to your family member's physician to complete and bring it to the Department (or the Undergraduate Services Office if you are in first year).

**In Case of a Death:** Obtain a copy of the death certificate or the notice provided by the funeral director's office. You must include your relationship to the deceased and bring it to the Department (or the Undergraduate Services Office if you are in first year).

**For Other Extenuating Circumstances:** If you are not sure what documentation to provide, ask the Departmental Office (or the Undergraduate Services Office if you are in first year) for direction.

**Note:** Forged notes and certificates will be dealt with severely. To submit a forged document is a scholastic offence (see below).

### ACADEMIC CONCERNS

You need to know if your instructors have a policy on late penalties, missed tests, etc. This information may be included on the course outlines. If not, ask your instructor(s).

**You should also be aware of attendance requirements in some courses. You can be debarred from writing the final examination if your attendance is not satisfactory.**

If you are in academic difficulty, check out the minimum requirements for progression in the calendar. If in doubt, see your academic counsellor.

**Calendar References:** Check these regulations in your 2010 Western Academic Calendar available at [www.westerncalendar.uwo.ca](http://www.westerncalendar.uwo.ca).

Absences Due to Illness - page 22
Academic Accommodations for Disabled Students - page 20
Academic Accommodations for Religious or Holy Days - page 23
Course Withdrawals - pages 45
Debarred from Writing Examinations - page 39
Incomplete Standing - page 18
Scheduling of Term Assignments – page 40
Scholastic Offences - page 23-28
Special Examinations - page 38

**Note:** These instructions apply to all students registered in the Faculty of Engineering regardless of whether the courses are offered by the Faculty of Engineering or other faculties in the University.

<b><u>Drop Deadlines:</u></b>	First term half course (i.e. "A" or "F"):	October 15, 2010
	Full courses and full-year half courses (i.e. "E", "Y" or no suffix):	November 30, 2010
	Second term half or second term full course (i.e. "B" or "G"):	February 15, 2011

Undergraduate Services Office:	SEB 2097	telephone: (519) 661-2130	fax: (519) 661-3757
Dept. of Chemical and Biochemical Engineering:	TEB 477	telephone: (519) 661-2131	fax: (519) 661-3498
Dept. of Civil and Environmental Engineering:	SEB 3005	telephone: (519) 661-2139	fax: (519) 661-3779
Dept. of Electrical and Computer Engineering:	TEB 279	telephone: (519) 661-3758	fax: (519) 850-2436
Dept. of Mechanical and Materials Engineering:	SEB 3002	telephone: (519) 661-2136	fax: (519) 661-3020