

The University of Western Ontario
Department of Civil and Environmental Engineering

CEE4426a - Geotechnical Engineering Design
Course Outline –2016/17

Introduction

This course is intended to extend the core knowledge and understanding of the mechanics of soils that were developed in courses CEE3321/3322. Students will be introduced to commonly encountered geotechnical engineering systems (pure soil and composite) and the approaches required for their design. The concepts and methodology of site investigation and post-construction monitoring will be introduced. The students will be able to analyze and interpret the laboratory test, field test and borehole data presented in geotechnical reports to select appropriate design parameters. They will be able to select suitable analytical methods to predict the behaviour of a range of geotechnical structures, interpret the results of these predictions and make rational design decisions based on the results. They will improve their communication skills by documenting design decisions in coherent and legible design calculations. The students will develop problem-solving skills while working individually or as members in a group. The students will employ relevant software packages in their designs. They will develop an understanding of the impact of engineering on non-technical issues.

Calendar Copy

Application of shear strength, effective stress, and earth pressure theories to the design of embankments and slopes, shallow and deep foundations, braced cuts, and retaining structures and related safety issues.

Prerequisites

CEE3322/21 or the former CEE3326

Corequisites

None.

Antirequisites

The former ES426a

Note: It is the **student's responsibility** to ensure that all Prerequisite and Corequisite conditions are met or that special permission to waive these requirements has been granted by the Faculty. It is also the **student's responsibility** to ensure that they have not taken a course listed as an Antirequisite. The student may be dropped from the course or not given credit for the course towards their degree if they violate the Prerequisite, Corequisite or Antirequisite conditions.

Contact Hours

3 lecture hours/week: Monday from 9:30 am to 10:30 am in SSC 3024;
 Tuesday from 5:30 pm to 6:30 pm in SH 2355;
 Wednesday from 2:30 pm to 3:30 pm in TC 203.

2 design/tutorial hours/week: Wednesday from 3:30 pm to 5:30 pm in TC 203.

Instructor

Associate Prof. Tim Newson, SEB 3084.
e-mail: tnewson@eng.uwo.ca .
Admin Support: Sandra McKay, SEB 3005.

Textbook

Prepared class notes should be brought to each class, and may be downloaded from the course website (<http://owl.uwo.ca>).

Other References

The following books form a useful additional source of reference material:

1. Canadian Foundation Engineering Manual, 4th Edition prepared by Canadian Geotechnical Society, 2006, BiTech Publishing. (Purchase Optional)
2. Foundation Design and Construction, M.J. Tomlinson, 6th Edition, 1995, Longman (Purchase Optional)
3. An Introduction to Geotechnical Engineering, R.D. Holtz and W.D. Kovacs, 1981, Prentice Hall. (Purchase Optional)
4. Basic Soil Mechanics, R. Whitlow, 4th Edition, 2001, Prentice Hall. (Purchase Optional)

Laboratory

None.

Computing

The students will use the software package SlopeW, installed on the computers in the Computer lab SEB1004, to solve assigned problems and the design project.

Units

SI units will be used in teaching, design project, tutorials and final exam.

General Learning Objectives

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|-------------------|---|-------------------|---|----------------------------------|---|
| Problem Analysis | E | Team Work | E | Ethics and Equity | |
| Investigation | E | Communication | I | Economics and Project Management | |
| Design | E | Professionalism | I | Life-Long Learning | I |
| Engineering Tools | T | Impact on Society | | | |

Specific Learning Objectives

The specific objectives of the course are:

1. Site Investigation:

By the end of this section, the students will be able to:

- i) Describe the purpose and structure of typical geotechnical site investigations.
- ii) Describe the methods available and objectives for monitoring of geotechnical structures.

- iii) Describe a range of techniques for ground exploration and understand the quality and use of samples for laboratory testing.
- iv) Describe the different forms of *in situ* field test and the determination of parameters for design.
- v) Design a suitable site investigation for a given geotechnical structure.

2. *Shallow Foundations:*

By the end of this section, the students will be able to:

- i) Describe the difference between ultimate and allowable bearing capacity, and reasons for the different approaches to apply factors of safety.
- ii) Describe the factors considered in the general bearing capacity equation and use it to calculate the bearing capacity.
- iii) Identify the cases where the assumptions of the general bearing capacity equation are not valid and apply proper correction factors for these cases.
- iv) Design shallow foundations on clay or sand that satisfy the allowable bearing capacity requirements based on soil properties interpreted from laboratory tests or field investigations.
- v) Determine the distribution of stress increase underneath the foundation due to its load.
- vi) Design shallow foundations that satisfy the short and long term settlement requirements.

3. *Deep Foundations:*

By the end of this section, the students will be able to:

- i) Describe the load-carrying mechanisms for piles.
- ii) Describe different types of piles and installation methods.
- iii) Design single piles and pile groups that satisfy the bearing capacity requirements.
- iv) Calculate the settlement of single piles.
- v) Design pile groups that satisfy the settlement requirements.

4. *Slope Stability:*

By the end of this section, the students will be able to:

- i) Describe the reasons for slope failure, understand the terminology and notation typically used and define the critical failure surface and factor of safety.
- ii) Identify the short term and long term stability conditions and the effect of the pore water pressure.
- iii) Design slopes and analyze their stability using tabular methods and a range of limit equilibrium solutions.
- iv) Use the computer program SlopeW to analyze and design slopes and embankments.

5. *Retaining walls:*

By the end of this section, the students will be able to:

- i) Calculate the distribution of lateral earth pressure at rest.
- ii) Describe the different theories of lateral earth pressure and their assumptions, and use Rankine and Coulomb theories to calculate the distribution of lateral earth pressure acting on retaining walls.
- iii) Design concrete retaining walls including consideration of different failure modes such as over turning, sliding, bearing capacity and general stability; and determine the factor of safety of the wall against each of these failure modes.
- iv) Design sheet pile walls including cantilever and anchored types.

Evaluation

The final grade is computed as follows:

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|---------------------------|-------------|
| Assignment Problems | 20% |
| Design Project and Report | 30% |
| Final Examination | <u>50%</u> |
| TOTAL | 100% |

- 1. Students must pass the final examination to pass this course. Students who fail the final examination will be assigned the aggregate mark, as determined above or 48%, whichever is less.
- 2. Students who do not achieve a passing grade on each of the three design project components shall not pass the course. They shall be assigned a mark of 48% or the aggregate mark whichever is less.
- 3. The mark for the design project shall be multiplied by the number of group members and the product allocated to the members in proportion to each member's contribution to the work. At the end of the course, group members must individually recommend (in the appropriate form), a suitable allocation to be used. A summary of the work done by each member (with reference to the three design project reports) must be attached to the final report submission.
- 4. Criteria for the various coursework submissions are described later in this document.
- 5. The penalty for late submission of coursework shall be 10% per day; thus, if any submission is more than 5 days late it cannot receive a passing grade.
- 6. Students who have failed this course previously must repeat all components of the course. No special permissions will be granted enabling a student to retain design project, assignment or test marks from previous years. Previously completed assignments and design project reports cannot be resubmitted.

Examinations

1 x 3 hour, Closed Book - Final Examination

Only approved programmable calculators are permitted in the final exam and in the quizzes. Students should consult the list of approved calculators outside the Departmental Office. To get approval to use a calculator not on the list you must consult with Dr. Newson at least three weeks prior to the quiz/exam where you wish to use the calculator.

Coursework

There will be a group geotechnical design project that is sub-divided into three parts. Groups will be assigned by the instructor at the start of the project. The overall solution to the design and the report is worth 30% of the final assessment mark.

Tutorial question sheets will be given out during the course. These will *not be assessed*, but have the aim of familiarizing students with the topics covered during the lectures and preparing them for the end of year examination. Four short design assignments (5% each) will be assessed and individual submissions are required.

Assignments and components of the design project are to be placed submitted in class or to the locker provided (to be advised) by the due date. Assessed coursework will be marked and returned as soon as possible.

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.

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.

Cheating

University policy states that cheating, including plagiarism, is a scholastic offence. The commission of a scholastic offence is attended by academic penalties that might include expulsion from the program. If you are caught cheating, there will be no second warning (see Scholastic Offence Policy in the Western Academic Calendar). **For more information on scholastic offenses, please see:** http://www.uwo.ca/univsec/handbook/appeals/scholastic_discipline_undergrad.pdf

Attendance

Any student who, in the opinion of instructor, is absent too frequently from class, laboratory, or tutorial periods 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 regular final examination in the course.

Conduct

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

On the premises of the University or at a University-sponsored program, students must abide by the Student Code of Conduct: <http://www.uwo.ca/univsec/board/code.pdf>

Sickness or 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.

For more information concerning medical accommodations, please see:
http://www.uwo.ca/univsec/handbook/appeals/accommodation_medical.pdf

Notice

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

Consultation

Students are encouraged to discuss problems with their teaching assistant and/or instructor in tutorial sessions. Other individual consultation can be arranged by appointment with the instructor.

Course Breakdown

Total = 44.11 AU's

Engineering Science = 25% or 11.03 AU's; Engineering Design = 75% or 33.08 AU's

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

***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 2016 Western [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 the 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 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 exam 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 an off-campus doctor or Student Health Services regarding your illness or personal problem, you must provide the doctor with a Student Medical Certificate to complete at the time of your visit 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 2016 Western Academic Calendar available at www.westerncalendar.uwo.ca.

[Absences Due to Illness](#) - page 117

[Academic Accommodations for Students with Disabilities](#) - page 118

[Academic Accommodations for Religious Holidays](#) - page 119

[Incomplete Standing](#) - page 104

[Scheduling of Term Assignments](#) - page 97

[Scholastic Offences](#) - page 113

[Special Examinations](#) - page 132

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.

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|-------------------------------|---|-------------------|
| <u>Drop Deadlines:</u> | First term half course (i.e. "A" or "F"): | November 5, 2016 |
| | Full courses and full-year half courses (i.e. "E", "Y" or no suffix): | November 30, 2016 |
| | Second term half or second term full course (i.e. "B" or "G"): | March 7, 2017 |

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| 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, Software Engineering Mechatronics Engineering | TEB 279 | telephone: (519) 661-3758 | fax: (519) 850-2436 |
| Dept. of Mechanical and Materials Engineering: | SEB 3002 | telephone: (519) 661-4122 | fax: (519) 661-3020 |