Western University - Faculty of Engineering
Department of Civil and Environmental Engineering

CEE 4424b – Earth Structures Engineering
Course Outline 2025/26

Introduction:

This course has been developed to provide knowledge and understanding of the geotechnical, geological, and hydrological principles involved in the solution of earth structures engineering problems. Based on their knowledge of soil mechanics and geology, students will be introduced to the analysis, design and construction of slopes, dams and other structures made from soil and rocks.

The topics covered in this course include:

- Geotechnical site investigation
- Embankments and tunnels in soft ground
- Slopes, excavations and cuttings
- Earth dams

By the end of this course, students will be able to analyze laboratory and field tests data, to identify the appropriate analytical and design approaches for a range of earth structures, to recognize the complexities of construction materials, construction techniques and quality control, and to understand the methods available for the remediation and monitoring of geotechnical structures. Design problems and assignments will enable students to improve their problem-solving and communication skills, whilst working individually and in groups. Through studying and analyzing the outcomes of engineering cases, students will also be exposed to the complex and multidisciplinary challenges facing civil engineers. Where relevant, the students will use industry standard software packages in their designs.

Calendar Copy:

This course is intended to be a comprehensive introduction to the design of slopes, dams and other structures made from soil and rock materials. The material will cover the theory and analysis of a range of geotechnical problems involving natural slopes, cuttings, embankments, dams and waste facilities.

Pre-requisites: CEE3322a/b.

Anti-requisites: None.

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 Anti-requisite. 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 Anti-requisite conditions.

Contact Hours:

- *3 lecture hours/week* [redacted]
  Lectures will be delivered in class.

- *2 tutorial/design/case hours/week* [redacted]
  Tutorial/design/case sessions will be delivered in class. Tutorials are optional, but students seeking assistance with weekly assignments or clarification on lecture material are strongly encouraged to attend. The three design sessions and two case studies are *mandatory*.

Contingency plan for an in-person class pivoting to 100% online learning

In the event of a COVID-19 resurgence during the course that necessitates the course delivery moving away from face-to-face interaction, affected course content will be delivered entirely online, either synchronously (i.e., at the times indicated in the timetable) or asynchronously (e.g., posted on OWL for students to view at their convenience). The grading scheme will not change. Any remaining assessments will also be conducted online as determined by the course instructor.

Instructor:

[redacted]

Admin Support:, SEB 3005.

Teaching Assistants:

[redacted]

Textbook:

Prepared class notes should be brought to each class and may be downloaded from the course website (Brightspace).

Other References:

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

- Mitchell, R. (1983). *Earth Structures Engineering*. Springer (ISBN 9789401160018). p. 266.
- Clayton, C., Matthews, M. and Simons, N. (1995). *Site Investigation*. Wiley-Blackwell (ISBN 9780632029082). p. 592.
- Whitlow, R. (2000). *Basic Soil Mechanics*. Pearson International (ISBN 9780582381094). p. 592.
- Almeida, M. and Marques, M. (2013). *Design and Performance of Embankments on Very Soft Soils*. CRC Press (ISBN 9781138076938). p. 228.
- Atkinson, J. (2007). *The Mechanics of Soils and Foundations*. CRC Press (ISBN 9780415362566). p. 480.
- Fell, R., MacGregor, P., Stapledon, D., Bell, G. and Foster, M. (2015). *Geotechnical Engineering of Dams*. CRC Press (ISBN 9781138749344). p. 1382.

Laboratory:
None.

Units:
SI units will be used in teaching, assignments, design project, tutorials, cases and final exam.

Specific Learning Objectives [GA Indicator – **bold** denotes evaluated indicator]:

1) Geotechnical Site Investigation. At the end of this section and after completion of the Design Project the student should be able to:

   a) correctly use relevant terminology and understand the purpose of geotechnical site investigations [KB4]
   b) understand the planning of site investigations, identify the various phases of the investigation process and understand the relationships between the key components of each phase [**I1**]
   c) understand the links between the site materials, the proposed structure, the sampling process and the geotechnical testing for the best design outcomes [D1]
   d) understand and interpret advanced *in-situ* geotechnical site investigation tests (shear vane, cone penetrometer, pressuremeter and plate load test)
   e) describe the various geophysical tests available and their ability to characterize soil volumes [KB4].

2) Embankments and Tunnels in Soft Ground. At the end of this section and after completion of the Design Project the student should be able to:

   a) describe the different forms and methods of embankment and tunnel construction [KB4]
   b) understand the stress changes that occur in the surrounding ground due to their construction and the influence of water in their design [KB4]
   c) analyze the stability, settlement and consolidation of embankments [PA1, PA2, D1, D4]
   d) analyze surface ground movements due to tunnel construction [PA1, PA2]
   e) describe remedial and ground improvement techniques for embankment construction [**D4**]
   f) describe the use of staged construction, monitoring and the observational method for embankments [KB4].

3) Slopes, Excavations and Cuttings. At the end of this section the student should be able to:

   a) describe the key slope failure mechanisms for natural and man-made slopes and excavations [KB4]
   b) analyze the stability of sloping earth surfaces using both analytical and graphical methods [**ET1, ET2**]
   c) understand the effects of crest loadings, dynamic loadings, submergence and drawdown processes on the stability of slopes [KB4]
   d) recommend appropriate factors of safety and construction procedures for various different scenarios [PA2]
   e) analyze the stability of excavations and cuttings using analytical and graphical methods [**I3, ET2**]
   f) describe appropriate remediation and monitoring methods for unstable slopes and excavations [**D4**].

4) Earth Dams. At the end of this section the student should be able to:

   a) describe the different types of earth dam structure [KB4]
   b) understand the major design considerations used in the construction of earth dams (including core and filter design) [D2]
   c) describe foundation treatments available for the most efficient dam designs [KB4]

d) analyze the stability, settlement/distortion and seepage behaviour of large earth dams and structures [**ET1, ET2**]

e) describe the risks associated with rapid drawdown and earthquakes for dams [KB4]

f) understand the construction of earth dams, their monitoring, performance and maintenance [PA2].

The instructor may expand or revise material presented in the course as appropriate.

General Learning Objectives:

E=Evaluate, T=Teach, I=Introduce; (I) = Introduction, (D) = Developing, (A) = Advanced level

Knowledge Base	T(A)	Engineering Tools	E(A)	Impact on Society	
Problem Analysis	T(A)	Teamwork		Ethics and Equity	
Investigation	E(A)	Communication		Economics and Project Management	
Design	E(A)	Professionalism		Life-Long Learning	

Accreditation Units:

Engineering Science = 50%; Engineering Design= 50%.

Evaluation:

The final course mark will be determined as follows:

Design assignments	15%
Case studies	15%
Design project	30%
Final examination	40%
Total	100%

1. 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.
2. Criteria for the various coursework submissions are described below.
3. 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.
4. 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.

a) Examination:

A three-hour closed book final examination will be held during the regular examination period. Only approved programmable calculators are permitted in the final exam. 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.

b) Design assignments:

Two *individual* design calculation assignments will be completed during the course. Each assignment must be submitted prior to the due date to OWL. Late assignments will be assessed a penalty of 10% per day, to a maximum of 3 days, after which they will receive a mark of zero.

c) Case studies:

Two *group* case assignments will be completed during the course. This requires written analysis of the case material prior to the class. The cases will be presented by practicing engineers who are experts in geotechnical engineering. Each assignment must be turned in to OWL by the group at the beginning of the case class. Group membership will be assigned by the instructor. Late assignments will be assessed a penalty of 10% per day, to a maximum of 3 days, after which they will receive a mark of zero.

d) Design Project:

The design project is a major component of the coursework. Students will tackle a design problem in groups that will be assigned by the instructor. The design project involves a site that has previously been considered for construction of a geotechnical structure. This assignment is in three parts: 1) *Planning and costing a suitable site investigation*, 2) *Interpreting the available site investigation and in-situ/laboratory data, and conducting an analysis on an embankment, slope or dam*, 3) *Producing an alternative design and interpretive geotechnical report with recommendations*. The submission should be sufficiently detailed such that it could be presented to a client for review and approval of the project. Your submission should clearly indicate the name of the individual who undertook prime responsibility for each aspect of the work and the name of the individual who reviewed that aspect of the work. All hand calculations are to be on squared paper and must be organized and presented in a neat, clear and professional manner. All pages of calculations must have the date, initials of the originator and initials of the checking engineer. All calculations are to be checked. All drawings are to be of professional quality with the name of originator and checking individual shown.

I. Missed/Late Accommodation Policy:

1. Students missing a test/assignment/lab or examination you will report the absence by submitting Academic Consideration Request form through STUDENT ABSENCE PORTAL.
2. Documentation must be provided as soon as possible.

II. Exam Accommodation:

1. If you are unable to write a final examination, report your absence using the Academic Consideration Request Form through STUDENT ABSENCE PORTAL.
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, headache, 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 submit an the Academic Consideration Request Form through STUDENT ABSENCE PORTAL.
   PLEASE NOTE: It is the student's responsibility to check the date, time and location of the Special Examination.

III. Late Assignments:

1. Students must advise the course instructor if they are having difficulty completing an assignment on time (prior to the due date of the assignment).

2. Students should be prepared to submit the Academic Consideration Request Form and provide documentation if requested to do so by the course instructor (see reverse side for information on documentation).
3. If granted an extension, a revised due date should be established with the course instructor. The approval of the Chair of your Department (or the Assistant Dean, First Year Studies, if you are in first year) is not required if assignments will be completed prior to the last day of classes.
4. This course employs flexible deadlines for assignments. The assignment deadlines can be found above in the course outline. For each assignment, students are expected to submit the assignment by the deadline listed. Should illness or extenuating circumstances arise, students are permitted to submit their assignment up to 72 hours past the deadline without academic penalty. Should students submit their assessment beyond 72 hours past the deadline, a late penalty of 10% per day will be subtracted from the assessed grade. As flexible deadlines are used in this course, requests for academic consideration will not be granted. If you have a long-term academic consideration or an accommodation for disability that allows greater flexibility than provided here, please reach out to your instructor at least one week prior to the posted deadline.
5. Extensions beyond the end of classes must have the consent of the instructor, the department Chair and the Associate Dean, Undergraduate Studies. Documentation is mandatory.

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

IV. Medical Accommodation:

1. Requests for Academic Consideration Request Form through STUDENT ABSENCE PORTAL.
2. Requests for academic consideration must include the following components:
    a. Self-attestation signed by the student (*This is only accepted for the first/one absence*)
    b. Medical note
    c. Indication of the course(s) and assessment(s) affected by the request
    d. Supporting documentation as relevant
3. Requests without supporting documentation are limited to one per term per course.
4. **Students must request academic consideration as soon as possible and no later than 48 hours after the missed assessment.**
5. Once the request and supporting documents have been received and reviewed, appropriate academic consideration, if granted, shall be determined by the instructor in consultation with the academic advisor, in a manner consistent with the course outline. Academic consideration may include extension of deadlines, waiver of attendance requirements for classes/labs/tutorials, or re-weighting of course requirements. Some forms of academic consideration, such as arranging Special Examinations, assigning a grade of Incomplete, or granting late withdrawals without academic penalty, may only be granted by the Academic Advising office of the Faculty of Engineering.

V. Religious Accommodation:

When scheduling unavoidably conflicts with religious holidays, which (a) require an absence from the University or (b) prohibit or require certain activities (i.e., activities that would make it impossible for the student to satisfy the academic requirements scheduled on the day(s) involved), no student will be penalized for absence because of religious reasons, and alternative means will be sought for satisfying the academic requirements involved. If a suitable arrangement cannot be worked out between the student and instructor involved, they should consult the appropriate Department Chair and, if necessary, the student's Dean.

It is the responsibility of such students to inform themselves concerning the work done in classes from which they are absent and to take appropriate action.

VI. Academic Integrity:

In the Faculty of Engineering, we encourage students to create a culture of honesty, trust, fairness, respect,

responsibility, and courage, befitting the professional degree you are pursuing.
Please visit Academic Integrity Western Engineering for more information

VII. Academic Offences:

Plagiarism means using another's work without giving credit. The university has rules against plagiarism and other scholastic offences. Western Engineering has a zero-tolerance policy on plagiarism. The minimum penalty is zero on the course work and a repeat offence will earn you zero on the course. A third offence may lead to expulsion from the university.
Scholastic Discipline for Undergraduate Students & Cheating, Plagiarism and Unauthorized Collaboration: What Students Need to Know

Students must write their reports, 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. University policy states that cheating, including plagiarism, 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.

All required papers may be subject to submission for textual similarity review to commercial plagiarism detection software under license to the University for the detection of plagiarism. All papers submitted will be included as source documents on the reference database for the purpose of detecting plagiarism of papers subsequently submitted to the system. Use of the service is subject to the licensing agreement, currently between the University of Western Ontario and Turnitin.com (http://www.turnitin.com). Scholastic offences are taken seriously and students are directed to read the appropriate policy, specifically, the definition of what constitutes a Scholastic Offence, in the relevant section of the Academic Handbook: http://www.uwo.ca/univsec/pdf/academic_policies/appeals/scholastic_discipline_undergrad.pdf

VIII. Faculty of Engineering AI Policy:

The use of generative Artificial intelligence (GenAI) tools won't be discouraged in the Faculty of Engineering. As we pride ourselves on building the future we can't hide from the use of GenAI tools to contribute to the understanding of the course materials. However, the use of GenAI tools in any assignment or contribution during the course will have to be disclosed, as a resource.
GenAI tools use won't be permitted in any type of examination or other assessments where the faculty have prohibited their use. If use of GenAI tools is detected by the instructor in these instances, academic offences penalties might be imposed against the student.

IX. Use of English Policy:

In accordance with Senate and Faculty Policy, students may be penalized up to 10% of the marks on all assignments, tests, and examinations for improper use of English. Additionally, poorly written work except for the final examination 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.

X. Accessibility:

Western is committed to achieving barrier free accessibility for persons with disabilities studying, visiting and working at Western. As part of this commitment, there are a variety of services, groups and committees on campus devoted to promoting accessibility and to ensuring that individuals have equitable access to services and facilities. To help provide the best experience to all members of the campus community, please visit the Accessibility Western University for information on accessibility-related resources available at Western.

Students with disabilities may arrange for academic accommodation at Western. For a more detailed explanation, please visit Academic Support & Engagement -Academic Accommodation.

XI. Inclusivity, Diversity, and Respect:

The Faculty of Engineering at Western University is committed to creating equitable and inclusive learning environments that value diverse perspectives and experiences. We recognize that university courses often marginalize students based on social identity characteristics such as, but not limited to, Indigeneity, race, ethnicity, nationality, ability, gender identity, gender expression, sexuality, age, language, religion, and socioeconomic status. Understanding this, we strive to facilitate equitable experiences and inclusion within the classroom by respecting and integrating multiple ways of knowing, being, and doing. Please visit the Office of Equity, Diversity and Inclusion.

XII. Health and Well-Being:

- Health & Wellness Services – Students - Offers appointment-based medical clinic for all registered part-time and full-time students.
- Mental Health Support - Provides professional and confidential services, free of charge, to students needing assistance to meet their personal, social and academic goals. Services include consultation, referral, groups and workshops, as well as brief, change-oriented psychotherapy.
- Crisis Support - For immediate assistant, please visit Thames Hall Room 2170 or call 519-661-3030. The crisis clinic operates between 11:00 am - 4:30 pm. For after-hours crisis support, click here.
- Gender-Based Violence and Survivor Support - Western is committed to reducing incidents of gender-based and sexual violence and providing compassionate support to anyone who has gone through these traumatic events. If you have experienced gender-based or sexual violence (either recently or in the past), you will find information about support services for survivors, including emergency contacts, here. To connect with a case manager or set up an appointment, please contact support@uwo.ca.

Important Contacts:

Engineering Undergraduate Services	SEB 2097	519-661-2130	engugrad@uwo.ca
Civil & Environmental Engineering	SEB 3005	519-661-2139	civil@uwo.ca
Office of the Registrar/Student Central	WSSB 1120	519-661-2100	

Important Links:

- WESTERN ACADEMIC CALENDAR
- ACADEMIC RIGHTS AND RESPONSIBILITIES