

Civil Engineering
CIVENG 3B03
Geotechnical Engineering II
Winter 2025



ENGINEERING

Instructor Information

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Upon Request

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Class Times

Lectures: Fr 12:30PM - 2:20PM

Lab 1: Th 2:30PM - 5:20PM

Lab 2: Mo 2:30PM - 5:20PM

Tutorial 1: Mo 12:30PM - 2:20PM

Tutorial 2: Tu 8:30AM - 10:20AM

Class Format

In Person

Course Dates: 01/06/2025 - 04/08/2025

Units: 3.00

Course Delivery Mode: In Person

Course Description: Shear strength characteristics and failure criteria for soils; direct shear, triaxial, plane strain and field tests; earth pressure theory; bearing capacity theory; slope stability and embankment analysis. Two lectures, one tutorial (two hours), one lab (three hours); second term Prerequisite(s): Credit or registration in CIVENG 3A03

Instructor-Specific Course Information

Soil and rock are still one of the most important construction materials used in the natural state. All civil engineering works (buildings, bridges, roads, airfields, tunnels, landfills, reservoirs, pumping stations, etc.) are founded on or built-in geomaterials (soil and/or rock). The stability and safety of engineering structures depend upon the characteristics and behavior of various types of soil and rock. A geotechnical engineer is normally involved in the analysis, design, and construction of foundations for structures, earth and rock dams, embankments, tunnels, and underground structures, highways, railways, airfields, bridge abutments, and pier foundations, etc.

The purpose of this course is to develop a good understanding of the current theories of soil mechanics and geotechnical engineering. This course focuses on the shear strength characteristics of soil elements, plane strain, earth pressure theories, earth retaining system, slope stability in embankment and excavation safety. After successfully completion of the course, student can be able to handle analysis parameters for the design of foundation for different type of structures, selection of earth retaining structure,

slope stability related problem and excavation construction safety. To complement the theoretical studies, students will be given the opportunity to carry out standard laboratory tests on various soils to explore strength.

Important Links

- [Mosaic](#)
- [Avenue to Learn](#)
- [Student Accessibility Services - Accommodations](#)
- [McMaster University Library](#)
- [eReserves](#)

Course Learning Outcomes

- Demonstrate a working knowledge of basic soil mechanics principles including: phase relationships, soil descriptions and classifications, and effective stress [CEAB 1.4]
- Understand the results of typical lab tests used to evaluate the shear strength of soil, including the direct shear test and the vacuum triaxial test, the unconfined compression test, and the unconsolidated-undrained triaxial test. [CEAB 1.4]
- Demonstrate an understanding of principal stresses, stress invariants, Mohr's circle, and the Mohr-Coulomb failure criteria as it relates to soils. [CEAB 1.4, 1.2]
- Understand how to calculate the bearing capacity and settlement (immediate and primary consolidation) of shallow foundations. [CEAB 2.2, 2.3]
- Understand both the allowable-stress and the Load Resistance Factor Design process for shallow foundations. [CEAB 4.1, 4.2]
- Understand how to apply the results from common field tests to the design of shallow foundations and earth retaining structures [CEAB 4.1, 4.2]

- Understand the concept of active and passive earth pressure and be able to apply it to the analysis and design of earth retaining structures [CEAB 2.3, 4.2]
- Understand how to calculate the stability of an embankment [CEAB 2.3]

Graduate Attributes

The Canadian Engineering Accreditation Board (CEAB) is a division of Engineers Canada and is responsible for accrediting undergraduate engineering programs across Canada. Accreditation by the CEAB ensures that the engineering programs meet a national standard of quality and cover essential educational requirements. Graduate Attributes are a set of qualities and skills that the CEAB expects engineering graduates to possess. These attributes are a benchmark for the learning outcomes of accredited engineering programs. This section lists the Graduate Attribute Indicators associated with the Learning Outcomes in this course.

CEAB (Canadian Engineering Accreditation Board) Attributes and Indicators. Through this course you will develop the following attributes and indicators:

- **Attribute 1. Knowledge**

- Indicator 1.4: Competence in specialized engineering knowledge

- **Attribute 2. Analysis**

- Indicator 2.3: Ability to obtain substantiated conclusions as a result of a problem solution including recognizing the limitations of the solutions

- **Attribute 4. Design**

- Indicator 4.1: Recognizes and follows an engineering design process
- Indicator 4.2: Recognizes and follows engineering design principles

Lab Information

List of Labs

Lab 1 – Direct Shear Test on sand

Lab 2 – Vacuum Triaxial Test on sand

Lab 3 – Unconfined Triaxial Compression on clay

Lab 4 – Unconsolidated Undrained Triaxial Compression on clay

Laboratory experiments

This is mandatory to pass this course. Everyone is required to participate in a total of 4 lab experiments (direct shear test, unconfined compression test, vacuum triaxial test, and unconsolidated-undrained triaxial test) during the term (Check your lab schedule posted on Avenue). The experiments are typically performed in groups of four in two lab sessions.

Students have one week to write lab reports, which must be submitted by 5:00 pm, the same day of the week following the completion of the experiments. Extensions on due dates for labs will be granted only under exceptional circumstances.

Information on Lab Component:

Each group is to submit a lab report for each Lab Experiment, within ONE WEEK from the date of the lab. (Which is different to different groups, according to the schedule above). Each group Report should be submitted Once by a single member of the group. Below is a set of instructions and framework to follow for the lab reports.

Geotechnical Engineering II - Lab Report(s)

1. Experimental Work

Experiments are to be carried out in a manner described in your laboratory manual, except as noted in the supplemental material that is provided in the Lab information document. Test procedures have been outlined in detail in these supplemental sheets in order to suit the available test apparatus, which are in general not similar to those described in the laboratory information manual.

2. Reports

Each group will prepare a report on each experiment actually performed. These reports should be submitted via A2L within one week.

More details will be posted on A2L, including lab schedule, groups, and additional details.

Lab Safety

The Faculty of Engineering is committed to McMaster University's Workplace and Environmental Health and Safety Policy which states: "Students are required by University policy to comply with all University health, safety and environmental programs". It is your responsibility to understand McMaster University Workplace and Environmental Health and Safety programs and policies. For information on these programs and policies please refer to [McMaster University Health and Safety](#). The Lab Safety Handbook is available [here](#), as well as on A2L.

It is also your responsibility to follow any specific Standard Operating Procedures (SOPs) provided for some of the experiments and the laboratory equipment. A laboratory-specific set of rules can also be added to ensure that students fully understand laboratory safety rules that are in place prior to their first session.

The safety requirements for JHE 114 are listed below. Students not abiding by these safety requirements will be given one warning. Second offences will result in the student being asked to vacate the laboratory and receiving a grade of zero for that particular lab.

- Glasses or safety glasses/goggles must be worn in the lab at all times.
- No short (i.e., above the knee) pants or skirts are permitted in the lab – lab coats must be worn over top of your clothing in these instances.
- Closed-toe shoes must be worn at all times.
- No loose clothing is allowed.
- Long hair must be tied back.
- Disposable latex or nitrile gloves must be worn when working with hazardous chemicals.
- Heat resistant gloves must be worn when removing hot items from the drying oven (as indicated by the laboratory instructor).
- Dust masks must be worn (as indicated by the laboratory instructor).
- Hearing protection must be worn (as indicated by the laboratory instructor).

Course Schedule

This schedule is provided as a rough guide and may change slightly depending upon the pace of lectures. The class will be notified via A2L of any changes to the schedule

A weekly breakdown of the course schedule

Week	Topic	Assessment
1	Introduction to soil mechanics and foundation engineering; Review of basic soil properties.	
2	Stresses in soil; Mohr-circle	Budhu Ch. 7, 8
3	Failure and shear strength of soil; Failure criterion; Laboratory tests for shear strength parameters	Budhu Ch.10
4	Concept of stress path and invariants; Field tests and empirical relations for shear strengths	Budhu Ch. 8, 10
5	Midterm Exam [To be Confirmed]	
Midterm Break		
6	Bearing capacity of soils for shallow foundations	Budhu Ch.12
7	Settlement of shallow foundations	Budhu Ch.12
8	Introduction to earth pressure – Rankin Theory, Coulomb theory	Budhu Ch.15
9	Excavation Hazards and safety (OHSA. of Ontario and lecture notes), Introduction to Canadian Building Code and Foundation Manuals	
10	Retaining structures – design considerations and selection (CFEM ch.26 and lecture notes)	Budhu Ch.15
11	Slope stability analysis - I	Budhu Ch.16
12	Slope stability analysis - II	Budhu Ch.16
13	Review	

Required Materials and Texts

Textbook Listing: <https://textbooks.mcmaster.ca>

Budhu, M. 2010. Soil Mechanics and Foundations, 3rd edition, John Wiley & Sons.

J. Knappett and R.F. Craig, 2012, Craig's Soil Mechanics (9th Edition), CRC Press
Optional

Canadian Geotechnical Society, 2006, Canadian Foundation Engineering Manual (CFEM). 4th Ed.
Optional

Course Evaluation

Assessment of Learning	Weight %
Assignments (4)	25%
Midterm Test	20%
Labs (4)	25%
Final Exam	30%

Note: that this structure represents a plan and is subject to adjustment. The instructor and the University reserve the right to modify elements of the course during the term. The University may change the dates and deadlines for any or all courses in extreme circumstances. If either type of modification becomes necessary, reasonable notice and communication with the students will be given with explanation and the opportunity to comment on changes

Grading Scale

The McMaster 12 Point Grading Scale

Grade	Equivalent Grade Point	Equivalent Percentages
A+	12	90-100
A	11	85-89
A-	10	80-84

Grade	Equivalent Grade Point	Equivalent Percentages
B+	9	77-79
B	8	73-76
B-	7	70-72
C+	6	67-69
C	5	63-66
C-	4	60-62
D+	3	57-59
D	2	53-56
D-	1	50-52
F	0	0-49

Late Assignments

Due dates will be indicated on the assignment sheets. Late assignments will be penalized by 10% If an MSAF is Submitted and is accepted

Minimum standards of neatness will be expected for all assignments. These standards include neat, legible printing, use of a straight edge for straight lines, and use of an eraser to correct mistakes. Assignments will be returned UNMARKED if these standards are not met.

Absences, Missed Work, Illness

Assignments:

- Assignment must be submitted electronically on AVENUE Drop Box. Assignments sent via email will not be marked.
- Due dates will be indicated on the assignment sheets. Late assignments will be penalized by 10%. If an MSAF is Submitted and is accepted
- Minimum standards of neatness will be expected for all assignments. These standards include neat, legible printing, use of a straight edge for straight lines, and use of an eraser to correct mistakes. Assignments will be returned UNMARKED if these standards are not met.

- Assignments are to be individual effort. Excessive collaboration on an assignment may constitute a violation of the McMaster Academic Integrity Policy (Section 7)

Laboratory experiments

This is mandatory to pass this course. Everyone is required to participate in a total of 4 lab experiments (direct shear test, unconfined compression test, vacuum triaxial test, and unconsolidated-undrained triaxial test) during the term (Check your lab schedule posted on Avenue). The experiments are typically performed in groups of four in two lab sessions.

Students have one week to write lab reports, which must be submitted by 5:00 pm, the same day of the week following the completion of the experiments. Extensions on due dates for labs will be granted only under exceptional circumstances.

Midterm:

- There will be One Midterm.
- It is your responsibility to make yourself available during the Midterm (it will be during Lecture Time). There will be no alternative times to write a Midterm. The Midterms are not MSAF-able (Section 7).
- If a Midterm is missed due to illness, Speak directly to the course instructor, to decide on whether it is appropriate to move forward and request accommodation from the Associate Dean's office.

Generative AI: Use Prohibited

Students are not permitted to use generative AI in this course. In alignment with [McMaster academic integrity policy](#), it “shall be an offence knowingly to ... submit academic work for assessment that was purchased or acquired from another source”. This includes work created by generative AI tools. Also state in the policy is the following, “Contract Cheating is the act of “outsourcing of student work to third parties” (Lancaster & Clarke, 2016, p. 639) with or without payment.” Using Generative AI tools is a form of contract cheating. Charges of academic dishonesty will be brought forward to the Office of Academic Integrity.

APPROVED ADVISORY STATEMENTS

Academic Integrity

You are expected to exhibit honesty and use ethical behaviour in all aspects of the learning process. Academic credentials you earn are rooted in principles of honesty and academic integrity. **It is your responsibility to understand what constitutes academic dishonesty.**

Academic dishonesty is to knowingly act or fail to act in a way that results or could result in unearned academic credit or advantage. This behaviour can result in serious consequences, e.g. the grade of zero on an assignment, loss of credit with a notation on the transcript (notation reads: "Grade of F assigned for academic dishonesty"), and/or suspension or expulsion from the university. For information on the various types of academic dishonesty please refer to the [Academic Integrity Policy](https://secretariat.mcmaster.ca/university-policies-proceduresguidelines/), located at <https://secretariat.mcmaster.ca/university-policies-proceduresguidelines/>

The following illustrates only three forms of academic dishonesty:

- plagiarism, e.g. the submission of work that is not one's own or for which other credit has been obtained.
- improper collaboration in group work.
- copying or using unauthorized aids in tests and examinations.

Courses with an On-line Element

Some courses may use on-line elements (e.g. e-mail, Avenue to Learn, LearnLink, web pages, capa, Moodle, ThinkingCap, etc.). Students should be aware that, when they access the electronic components of a course using these elements, private information such as first and last names, user names for the McMaster e-mail accounts, and program affiliation may become apparent to all other students in the same course. The available information is dependent on the technology used. Continuation in a course that uses on-line elements will be deemed consent to this disclosure. If you have any questions or concerns about such disclosure please discuss this with the course instructor.

Online Proctoring

Some courses may use online proctoring software for tests and exams. This software may require students to turn on their video camera, present identification, monitor and record their computer activities, and/or lock/restrict their browser or other applications/software during tests or exams. This software may be required to be installed before the test/exam begins.

Conduct Expectations

As a McMaster student, you have the right to experience, and the responsibility to demonstrate, respectful and dignified interactions within all of our living, learning and working communities. These expectations are described in the [Code of Student Rights & Responsibilities](#) (the “Code”). All students share the responsibility of maintaining a positive environment for the academic and personal growth of all McMaster community members, **whether in person or online.**

It is essential that students be mindful of their interactions online, as the Code remains in effect in virtual learning environments. The Code applies to any interactions that adversely affect, disrupt, or interfere with reasonable participation in University activities. Student disruptions or behaviours that interfere with university functions on online platforms (e.g. use of Avenue 2 Learn, WebEx or Zoom for delivery), will be taken very seriously and will be investigated. Outcomes may include restriction or removal of the involved students’ access to these platforms.

Equity, Diversity, and Inclusion

The Faculty of Engineering is committed to creating an environment in which students of all genders, cultures, ethnicities, races, sexual orientations, abilities, and socioeconomic backgrounds have equal access to education and are welcomed and treated fairly. If you have any concerns regarding inclusion in our Faculty, in particular if you or one of your peers is experiencing harassment or discrimination, you are encouraged to contact the Chair, Associate Undergraduate Chair, Academic Advisor or to contact the [Equity and Inclusion Office](#).

Academic Accommodation of Students with Disabilities

Students with disabilities who require academic accommodation must contact [Student Accessibility Services](#) (SAS) at 905-525-9140 ext. 28652 or sas@mcmaster.ca to make arrangements with a Program Coordinator. For further information, consult McMaster University's [Academic Accommodation of Students with Disabilities](#) policy.

Academic Advising

For any academic inquires please reach out to the Office of the Associate Dean (Academic) in Engineering located in JHE-Hatch 301.

Details on academic supports and contact information are available from:

<https://www.eng.mcmaster.ca/programs/academic-advising>

Requests for Relief for Missed Academic Term Work

In the event of an absence for medical or other reasons, students should review and follow the [Policy on Requests for Relief for Missed Academic Term Work](#).

Academic Accommodation for Religious, Indigenous, or Spiritual Observances (RISO)

Students requiring academic accommodation based on religious, indigenous or spiritual observances should follow the procedures set out in the [RISO](#) policy. Students should submit their request to their Faculty Office *normally within 10 working days* of the beginning of term in which they anticipate a need for accommodation or to the Registrar's Office prior to their examinations. Students should also contact their instructors as soon as possible to make alternative arrangements for classes, assignments, and tests.

Copyright and Recording

Students are advised that lectures, demonstrations, performances, and any other course material provided by an instructor include copyright protected works. The Copyright Act and copyright law protect every original literary, dramatic, musical and artistic work, **including lectures** by University instructors.

The recording of lectures, tutorials, or other methods of instruction may occur during a course. Recording may be done by either the instructor for the purpose of authorized distribution, or by a student for the purpose of personal study. Students should be aware that their voice and/or image may be recorded by others during the class. Please speak with the instructor if this is a concern for you.

Extreme Circumstances

The University reserves the right to change the dates and deadlines for any or all courses in extreme circumstances (e.g., severe weather, labour disruptions, etc.). Changes will be communicated through regular McMaster communication channels, such as McMaster Daily News, Avenue to Learn and/or McMaster email.

Turnitin.com

Some courses may use a web-based service (Turnitin.com) to reveal authenticity and ownership of student submitted work. For courses using such software, students will be expected to submit their work electronically either directly to Turnitin.com or via an online learning platform (e.g. A2L, etc.) using plagiarism detection (a service supported by Turnitin.com) so it can be checked for academic dishonesty.

Students who do not wish their work to be submitted through the plagiarism detection software must inform the Instructor before the assignment is due. No penalty will be assigned to a student who does not submit work to the plagiarism detection software. All submitted work is subject to normal verification that standards of academic integrity have been upheld (e.g., on-line search, other software, etc.). For more details about McMaster's use of Turnitin.com please go to www.mcmaster.ca/academicintegrity.