

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

**CEE 9523 – Environmental Geotechnique**

**COURSE OUTLINE (Summer 2025)**

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**DESCRIPTION**

The course focuses on how humans use land and resources in relation to the geology, mineralogy, and geotechnical properties of soils and rocks. It also includes the application of geophysical, geochemical, and hydrogeological scientific principles to solve engineering problems in the ground or subsurface environment. It covers a number of topics such as cation exchange reactions and effects of contaminants on soil properties; theory of the double layer; principles of sorption of contaminants in soils; formation and mitigation of acid rock drainage; contaminant fate and transport modeling and applications to barrier design; soil erosion, mineralogy, clay mineral-water interactions; solutions equilibria and geochemical modeling; and sustainable remediation of contaminated sites, etc.

**ENROLLMENT RESTRICTIONS**

Enrollment in this course is restricted to graduate students in Environmental Geotechnique, as well as any student that has obtained special permission to enroll in this course from the course instructor as well as the Graduate Chair (or equivalent) from the student's home program.

**PREREQUISITES**

CEE 3322b, CEE 2217a or equivalent

**CONTACT INFORMATION**

Course instructor: Mohammad Oyarhossein

Email address: [moyarhos@uwo.ca](mailto:moyarhos@uwo.ca)

Office hours: By appointment

Administrative Support: PhD and MEng students: [ceeresearch@uwo.ca](mailto:ceeresearch@uwo.ca)

MEng students: [ceeprofessional@uwo.ca](mailto:ceeprofessional@uwo.ca)

**COURSE FORMAT**

Face-to-face (in person).

**CONTACT POLICY:**

- Contact instructor via email (above) or through messages in OWL
- Weekly Office hours are held via Zoom or briefly after the class
- A general FAQ section on the 'forums' section of OWL will be used for students to pose course-related questions so that they all have the same information

## TOPICS

Topic #	Description	Learning Activities	Tentative timeline
1	<b>Introduction to Environmental Geotechnique</b>		
	Lesson 1 & 2: Background Historical background of the geotechnique and geo-environmental field; practical and field applications; challenges and opportunities. (Review of hydrogeology; groundwater flow; contamination in soil and groundwater; environmental concerns)	Two lectures Additional reading material Quiz (2 <sup>nd</sup> week)	<u>Week 1</u>
2	<b>Properties of soils and rocks</b>		
	Lesson 3 & 4: Background information: Clay mineralogy-structural components; abbreviated classification of clay minerals;	Two lectures Additional reading materials	<u>Week 2</u>
	clay physico-chemistry; cation exchange capacity; theory of double layer; GouyChapman and Stern theories of potential.	• <b>Project-1</b>	
3	<b>Principles of sorption</b>		
	Lesson 5: Discuss sorption theories: Freundlich isotherm and Langmuir isotherm. Lesson 6: Problem solving	• • Lecture • Additional reading materials • Practice problems set Help session <b>Assignment 1</b>	<u>Week 3</u>
4	<b>Contaminant fate and transport</b>		
	Lesson 7 & 8: Chemicals of concern in the subsurface environment and important properties; sorption/attenuation of contaminants; introduction to principles of contaminant transport; Governing equations for 1-D transport through laboratory columns and clay liners; contaminant effects on clay hydraulic conductivity.	• • Lectures • Additional reading material • Part of the lecture will be used as a help session Practice problems set Quiz (during class hours)	<u>Week 3-4</u>

5	<b>Containment technologies</b>		
	Lesson 9 & 10: Introduction to barrier systems for landfills; compacted clay liner; geomembrane and geosynthetic clay liner; Hydraulic flow through compacted clay liner.	<ul style="list-style-type: none"> <li>• Two lectures</li> <li>• Additional reading material</li> </ul> <b>Assignment 2</b>	<u>Week 4-5</u>
6	<b>Acid rock drainage</b>		
	Lesson 11 & 12: Introduction to formation and mitigation of acid rock drainage; chemical properties environmental impact; prevention and containment technologies.	<ul style="list-style-type: none"> <li>• Two lectures</li> <li>• Additional reading material</li> </ul> Part of the lecture will be used as a help session	<u>Week 5</u>
7	<b>Remediation of contaminated sites</b>		
	Lesson 13 & 14: Introduction to remediation of contaminated sites: ex situ and in situ methods. Case studies  <ul style="list-style-type: none"> <li>• Lessons' Revision</li> </ul>	<ul style="list-style-type: none"> <li>• Lectures</li> <li>• Additional reading material</li> <li>• Practice problems set</li> <li>• Final Project</li> <li>• Presentations</li> <li>• Final Project Report</li> </ul>	<u>Week 6-7</u>

## SPECIFIC LEARNING OUTCOMES

Degree Level Expectation	Weight	Assessment Tools	Outcomes
<b>Depth and breadth of knowledge</b>	30%	Assignments Examinations	Discuss important concepts and theories related to environmental geo technique Awareness of important current problems in the field of geotechnical engineering Discuss computational and/or empirical methodologies to solve related problems
<b>Application of knowledge</b>	35%	Assignments Examinations	Ability to apply knowledge in a rational way to analyze sorption and transport of contaminants Ability to use a coherent approach to evaluate the effectiveness of barrier systems.
<b>Communication skills</b>	15%	• Projects	• Ability to communicate (oral and/or written) ideas, issues, results and conclusions clearly and effectively
<b>Awareness of limits of knowledge</b>	20%	Projects Discussion/Debate Class activities	Awareness of the need for assumptions in complex and heterogenous soil conditions analyses and their consequences Understanding of the difference between theoretical and empirical approaches Ability to acknowledge analytical limitation due to complexity of geoenvironmental practical problems

## ASSESSMENTS <sup>1</sup>

Assessment Type	Material Covered	Tentative Due Date	Weight
Assignments (two)	Topics 1-3, 4 and 5	Week 4 & 6	15%
Quiz (two)	Topics 1 and 4	Week 2 & 4	10%
Projects (two)	Topics 1, 2, 5, 6 and 7	Week 3 & 7	25%
Participation in class activities and discussion/debate “forums section of OWL”	All the topics	Week 1- 6	10%
Final exam	All the topics	August 2025	40%

### **Activities in which collaboration is permitted:**

Projects (Discussion is allowed). Whether the project is done in groups or individually depends on the number of students and will be finalized at the class.

### **Activities in which students must work alone (collaboration is not permitted):**

Assignments, Quizzes, and Final Exam

## REQUIRED TEXTBOOK

**No Textbook** is required, but it highly recommended to read from the following Textbooks:

- Sharma, Hari D. and Krishna R. Reddy, “Geoenvironmental Engineering-Site Remediation, Waste Contaminant, and Emerging Waste Management Technologies”, 2004, Wiley.
- James K. Mitchell and Kenichi Soga “Fundamentals of Soil Behavior”, 3<sup>rd</sup> Edition, 2005. John Wiley & Sons.
- Donald L. Sparks, “Soil Physical Chemistry, 2<sup>nd</sup> Edition”, 1998. CRC Press.
- Hillel, D. “Fundamental of Soil Physics”, 1980, Academic Press.
- Qian, X., R.M. Koerner and D.H. Gray. “Geotechnical Aspects of Landfill Design and Construction”, 2001, Prentice Hall.

## OPTIONAL COURSE READINGS

Nielsen, David M., editor. “Practice Handbook of Environmental Site Characterization and Ground-Water Monitoring, 2nd Edition” (2006), Boca Raton, FL: CRC/Taylor & Francis. 2- Fang, H. Y. “Introduction to Environmental Geotechnology” (1997), CRC Press.

## COURSE CONTENT

The lecture notes are copyrighted to the instructor and legally protected. Do not post these lecture notes on any other website or online forums. The recording of the lectures of the course without the permission from the instructor is prohibited. The illegal posting and sharing of the copyrighted course content could be subjected to legal actions.

## STATEMENT ON THE USE OF GENERATIVE ARTIFICIAL INTELLIGENCE (AI)

The use of AI in the preparation of the project and assignments must be acknowledged

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<sup>1</sup> This section will be finalized during the class. Weights and assignment types are subject to change.

in the submission. Please refer to the published [Provisional Guidance for the Use of Generative AI in Graduate Studies](#) at Western University.

### **CHEATING, PLAGIARISM/ACADEMIC OFFENCES**

Academic integrity is an essential component of learning activities. Students must have a clear understanding of the course activities in which they are expected to work alone (and what working alone implies) and the activities in which they can collaborate or seek help; see information above and ask the instructor for clarification if needed. Any unauthorized forms of help-seeking or collaboration will be considered an academic offense. University policy states that cheating is an academic offence. If you are caught cheating, there will be no second warning. Students must write their essays and assignments in their own words. Whenever students take an idea or a passage of text 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. Academic offences are taken seriously and attended by academic penalties which may include expulsion from the program. Students are directed to read the appropriate policy, specifically, the definition of what constitutes a Scholastic Offence at the following website: [https://www.uwo.ca/univsec/pdf/academic\\_policies/appeals/scholastic\\_discipline\\_grad.pdf](https://www.uwo.ca/univsec/pdf/academic_policies/appeals/scholastic_discipline_grad.pdf)

All required papers may be subject to submission for textual similarity review to the commercial plagiarism-detection software under license to the University for the detection of plagiarism. All papers submitted for such checking will be included as source documents in 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>).

### **CONDUCT**

Students are expected to follow proper etiquette to maintain an appropriate and respectful academic environment. Any student who, in the opinion of the instructor, is not appropriately participating in course activities and/or is not following the rules and responsibilities associated with the course activities, will be reported to the Associate Dean (Graduate) (after due warning has been given). On the recommendation of the Department concerned, and with the permission of the Associate Dean (Graduate), the student could be debarred from completing the assessment activities in the course as appropriate.

### **HEALTH/WELLNESS SERVICES**

As part of a successful graduate student experience at Western, we encourage students to make their health and wellness a priority. Western provides several health and wellness related services to help you achieve optimum health and engage in healthy living while pursuing your graduate degree. Information regarding health- and wellness-related services available to students may be found at <http://www.health.uwo.ca/>.

Students seeking help regarding mental health concerns are advised to speak to someone they feel comfortable confiding in, such as their faculty supervisor, their program director (graduate chair), or other relevant administrators in their unit. Faculty of Engineering has a Student Wellness Counsellor. Information on how to schedule an appointment with the counsellor is available at:

<https://www.eng.uwo.ca/undergraduate/academic-support-and-accommodations/Student-Wellness-Counselling.html>.

Students who are in emotional/mental distress should refer to Mental Health@Western: <http://www.uwo.ca/uwocom/mentalhealth/> for a complete list of options about how to obtain help.

### **STATEMENT ON GENDER-BASED AND SEXUAL VIOLENCE**

Western is committed to reducing incidents of gender-based and sexual violence (GBSV) and providing compassionate support to anyone who is going through or has gone through these traumatic events. If you are experiencing or have experienced GBSV (either recently or in the past), you will find information about support services for survivors, including emergency contacts at the following website: [https://www.uwo.ca/health/student\\_support/survivor\\_support/get-help.html](https://www.uwo.ca/health/student_support/survivor_support/get-help.html). To connect with a case manager or set up an appointment, please contact [support@uwo.ca](mailto:support@uwo.ca).

### **SICKNESS**

Students should immediately consult with the instructor (for a particular course) or Associate Chair (Graduate) (for a range of courses) if they have problems that could affect their performance. The student should seek advice from the Instructor or Associate Chair (Graduate) regarding how best to deal with the problem. Failure to notify the Instructor or the Associate Chair (Graduate) immediately (or as soon as possible thereafter) will have a negative effect on any appeal. Obtaining appropriate documentation (e.g., a note from the doctor) is valuable when asking for accommodation due to illness.

Students who are not able to meet certain academic responsibilities due to medical, compassionate or other legitimate reason(s), could request for academic consideration. The Graduate Academic Accommodation Policy and Procedure details are available at:

<https://www.eng.uwo.ca/graduate/current-students/academic-support-and-accommodations/index.html>

### **ACCESSIBLE EDUCATION WESTERN (AEW)**

Western is committed to achieving barrier-free accessibility for all its members, including graduate students. As part of this commitment, Western provides a variety of services devoted to promoting, advocating, and accommodating persons with disabilities in their respective graduate program. Graduate students with disabilities (for example, chronic illnesses, mental health conditions, mobility impairments) are strongly encouraged to register with Accessible Education Western (AEW): [http://academicsupport.uwo.ca/accessible\\_education/index.html](http://academicsupport.uwo.ca/accessible_education/index.html)

AEW is a confidential service designed to support graduate and undergraduate students through their academic program. With the appropriate documentation, the student will work with both AEW and their graduate programs (normally their Graduate Chair and/or Course instructor) to ensure that appropriate academic accommodations to program requirements are arranged. These accommodations include individual counselling, alternative formatted literature, accessible campus transportation, learning strategy instruction, writing exams and assistive technology instruction.