

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

**CEE 9523L – Environmental Geotechnique**

**COURSE OUTLINE 2021-2022**

**DESCRIPTION**

The course deals with land and resource utilization by humans in relation to geology, mineralogy, physico-chemistry and geotechnical properties of component soils and rocks. It discusses a number of topics including: cation exchange reactions and effects of pollutants 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 modelling and applications to barrier design; erodibility of soils in relation to moisture content, mineralogy, climate and attack by moving water; mineral-water interactions; solutions equilibria and geochemical modelling.

**PREREQUISITES**

List prerequisites for the course, if any  
CCE 3322b, CCE 2217a or equivalent

**TOPICS**

<b>Topic #</b>	<b>Description</b>	<b>Learning Activities</b>	<b>Tentative timeline</b>
<b>1</b>	<b>Introduction to geoenvironmental engineering</b>		
	Lesson 1 & 2: Background Historical background of the geoenvironmental field; practical and field applications; challenges and opportunities. (Review of hydraulic flow; groundwater flow; contamination in soil and groundwater; environmental concerns)	<ul style="list-style-type: none"><li>• Two lectures</li><li>• Additional reading material</li><li>• <b>Mini Project 1 (Due on July 14, 2022)</b></li></ul>	Week 1  July 4, 2022  July 7, 2022
<b>2</b>	<b>Properties of soils and rocks</b>		
	Lesson 3 & 4: Background information: Clay mineralogy-structural components; abbreviated classification of clay minerals; clay physico-chemistry; cation exchange capacity; theory of double layer; Gouy-Chapman and Stern theories of potential.	<ul style="list-style-type: none"><li>• Two lectures</li><li>• Additional reading materials</li><li>• <b>Mini Project 2 (Due on July 21, 2022)</b></li></ul>	Week 2  July 11, 2022  July 14, 2022

3	<b>Principles of sorption</b>		
	Lesson 5: Discuss sorption theories: Freundlich isotherm and Langmuir isotherm. Lesson 6: Problem solving	<ul style="list-style-type: none"> <li>• Lecture</li> <li>• Additional reading materials</li> <li>• Practice problems set</li> <li>• Help session</li> <li>• <b>Assignment 1 (Due on July 28, 2022)</b></li> </ul>	Week 3  July 18, 2022  July 21, 2022
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.	<ul style="list-style-type: none"> <li>• Two lectures</li> <li>• Additional reading material</li> <li>• Part of the lecture will be used as a help session</li> <li>• Practice problems set</li> <li>• <b>Assignment 2 (Due on August 4, 2022)</b></li> </ul>	Week 4  July 25, 2022  July 28, 2022
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> <li>• <b>Assignment 3 (Due on August 11, 2022)</b></li> </ul>	Weeks 5  August 1, 2022  August 4, 2022
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> <li>• Part of the lecture will be used as a help session</li> <li>• <b>Mini Project 3 (Due on August 18, 2022)</b></li> </ul>	Week 6  August 8, 2022  August 11, 2022
7	<b>Remediation of contaminated sites</b>		
	Lesson 13 & 14: Introduction to remediation of contaminated sites: Ex situ and in situ methods.	<ul style="list-style-type: none"> <li>• Lecture</li> <li>• Additional reading material</li> <li>• Practice problems set</li> <li>• Mini Project 3 Presentations</li> </ul>	Week 7  August 15, 2022  August 18, 2022

## SPECIFIC LEARNING OUTCOMES

Degree Level Expectation	Weight	Assessment Tools	Outcomes
<b>Depth and breadth of knowledge</b>	30%	<ul style="list-style-type: none"> <li>• Assignments</li> <li>• Examinations</li> </ul>	<ul style="list-style-type: none"> <li>• Discuss important concepts and theories related to environmental geo technique</li> <li>• Awareness of important current problems in the field of geotechnical engineering</li> <li>• Discuss computational and/or empirical methodologies to solve related problems</li> </ul>
<b>Application of knowledge</b>	35%	<ul style="list-style-type: none"> <li>• Assignments</li> <li>• Examinations</li> </ul>	<ul style="list-style-type: none"> <li>• Ability to apply knowledge in a rational way to analyze sorption and transport of contaminants</li> <li>• Ability to use a coherent approach to evaluate the effectiveness of barrier systems.</li> </ul>
<b>Communication skills</b>	15%	<ul style="list-style-type: none"> <li>• Mini Projects</li> </ul>	<ul style="list-style-type: none"> <li>• Ability to communicate (oral and/or written) ideas, issues, results and conclusions clearly and effectively</li> </ul>
<b>Awareness of limits of knowledge</b>	20%	<ul style="list-style-type: none"> <li>• Mini Projects</li> <li>• Discussion/Debate</li> </ul>	<ul style="list-style-type: none"> <li>• Awareness of the need for assumptions in complex and heterogenous soil conditions analyses and their consequences</li> <li>• Understanding of the difference between theoretical and empirical approaches</li> <li>• Ability to acknowledge analytical limitation due to complexity of geoenvironmental practical problems</li> </ul>

## ASSESSMENTS

Assessment Type	Material Covered	Tentative Due Date	Weight
Assignments (three)	Topics 3, 4 and 5	Week* 4, 5 &6	25%
Mini Projects (three)	Topics 1, 2, 6 and 7	Week* 2, 3 & 7	25%
Discussion/Debate “forums section of OWL”	All the topics	Week 1- 6	10%
Final exam	All the topics	August 22, 2022	40%

\*Before the class on Thursday of the shown weeks.

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

- Mini Projects (Discussion is allowed)

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

- Assignments
- Final Exam

### **CONTACT INFORMATION**

Course instructor: Ikrema Hassan

Email address: imohame5@uwo.ca

### **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 all have the same information

### **REQUIRED TEXTBOOK**

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

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

### **OPTIONAL COURSE READINGS**

- 1- 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.

### **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 under “Assessments” and ask 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 (see Western's scholastic discipline regulations for graduate students).

## **CONDUCT**

Students are expected to follow proper etiquette during the classes and all activities to maintain an appropriate and respectful academic environment. Any student who, in the opinion of the instructor, is not appropriately participating in the learning activities and/or is not following the rules and responsibilities associated with the learning 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**

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 (remotely accessible) 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. Campus mental health resources may be found at [http://www.health.uwo.ca/mental\\_health/resources.html](http://www.health.uwo.ca/mental_health/resources.html)  
<https://www.uwo.ca/health/psych/index.html>

## **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.

## **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 Accessible Education at 661-2111 x 82147 or [http://academicsupport.uwo.ca/accessible\\_education/index.html](http://academicsupport.uwo.ca/accessible_education/index.html), for any specific question regarding an accommodation.