

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

**CEE 9530 – Ground Anchoring Systems**

COURSE OUTLINE 2024-2025

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**DESCRIPTION**

Strengthening and stabilizing soil and rock masses, and resisting structural movements by anchoring them via prestressed reinforcement is achieved by anchoring. Also, to withstand lateral forces, temporary tie-backs in soil are necessary for construction of shallow foundations. This practical and informative course is aimed for graduate students interested in safe and economic methods for strengthening engineering structures. The objective of this course is to provide an in depth review of design, applications and installation methods for anchoring in rock and soil. This will include: 1) **understanding** the principles and procedures for designing anchors for soils and rocks; 2) **learning** how to select the right type of anchors and methods for installation, grouting and prestressing them; 3) **becoming** knowledgeable about the corrosion protection methods used; 4) **gaining** insight into the long term behavior of anchors in ground, and 5) **reviewing** applications of anchoring in excavation, rock and soil slopes, walled excavation, retaining walls, bridge structures, foundations, basins and water reservoirs, loading equipment in field tests and many other applications.

**ENROLLMENT RESTRICTIONS**

All course outlines must include one of the following two statements regarding enrollment restrictions:

Enrollment in this course is restricted to graduate students in Civil and Environmental Engineering.

**INSTRUCTOR CONTACT INFORMATION**

Course instructor: Abouzar Sadrekarimi, PhD, PEng  
Email address: asadrek@uwo.ca  
Office: 3010D SEB  
Office hours: Tuesdays 12:30 – 1:30 pm

**COURSE FORMAT**

The course will be conducted in-person.

**TOPICS**

Topic #	Description	Learning Activities	Tentative timeline
1	<b>Anchors in Specialty Geotechnical Engineering</b>	• Lectures	Week1
2	<b>Soil Anchors</b> <i>Types of soil anchors</i>	• Lectures	Week 2

	<i>Tendon material</i>	• Additional reading	
	<i>Anchored walls</i>		
	<i>Application of ground anchors</i>		Week 3
	<i>Failure mechanisms of anchors</i>		
3	<b>Rock Anchors</b>	• Lectures	Week 4
	<i>Types of rocks</i>		
	<i>Rock mass classification systems</i>		
	<i>Modes of failure of anchors in rock</i>		
	<i>Investigation and evaluation of rocks with regard to anchoring</i>		
	<i>Embedment and bond strength</i>		
4	<b>Anchor System Design</b>	• Lectures • Practice problems • Assignment	Week 5
	<i>Selection of Soil Shear Strength Parameters for Design</i>		
	<i>Evaluation of Earth Pressures for Wall Design</i>		
	<i>Ground Anchor Design</i>		Week 6
	<i>Anchored Slopes and Landslide Stabilization Systems</i>		
5	<b>Corrosion Considerations in Design</b>	• Lectures	Week 7
	<i>Monitoring concepts</i>		
	<i>Testing equipment</i>		
	<i>Types of test</i>		
	<i>Performance tests</i>		Week 8
	<i>Proof testing</i>		
	<i>Creep testing</i>		
	<i>Acceptance criteria</i>		
6	<b>Contracting Approaches</b>	• Lectures	Week 9
	<i>Method Contracting Approach</i>		
	<i>Performance Contracting Approach</i>		
	<i>Contractor Design/Build Approach</i>		
7	<b>Construction Inspection and Performance Monitoring</b>	• Lectures	Week 10

### SPECIFIC LEARNING OUTCOMES

Degree Level Expectation	Weight	Assessment Tools	Outcomes
<b>Depth and breadth of knowledge</b>	25%	<ul style="list-style-type: none"> <li>• Assignments</li> <li>• Project</li> </ul>	<ul style="list-style-type: none"> <li>• Understanding of advanced concepts and theories</li> <li>• Awareness of important current problems in reinforcing ground</li> <li>• Understanding of empirical methodologies to design ground anchoring systems</li> </ul>

<b>Research &amp; scholarship</b>	15%	<ul style="list-style-type: none"> <li>• Project</li> </ul>	<ul style="list-style-type: none"> <li>• Ability to conduct critical evaluation of current advancements in ground anchoring</li> <li>• Ability to conduct coherent and thorough analyses of complex problems using established techniques/principles and judgment</li> </ul>
<b>Application of knowledge</b>	30%	<ul style="list-style-type: none"> <li>• Assignments</li> <li>• Project</li> </ul>	<ul style="list-style-type: none"> <li>• Ability to apply knowledge in a rational way to analyze ground anchoring needs</li> <li>• Ability to use coherent approach to design a particular ground anchoring and reinforcing system</li> </ul>
<b>Professional capacity / autonomy</b>	5%	<ul style="list-style-type: none"> <li>• Project</li> </ul>	<ul style="list-style-type: none"> <li>• Awareness of academic integrity</li> <li>• Ability to implement established procedures and practices in the coursework</li> <li>• Defends own ideas and conclusions</li> <li>• Integrates reflection into his/her learning process</li> </ul>
<b>Communication skills</b>	15%	<ul style="list-style-type: none"> <li>• Project</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>	10%	<ul style="list-style-type: none"> <li>• Project</li> </ul>	<ul style="list-style-type: none"> <li>• Awareness of the need of assumptions in complex scientific 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 practical problems</li> </ul>

## ASSESSMENTS

<b>Assessment Type</b>	<b>Material Covered</b>	<b>Tentative Due Date</b>	<b>Weight</b>
Homework Assignments (two)	Topics 2 and 4	March 11 & 25, 2025	40%
Project report	To be decided later	April 8, 2025	40%
Project presentation (one)	To be decided later	April 1, 2025	20%

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

- Project report and presentation

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

- Assignments

## REQUIRED TEXTBOOK

Canadian Foundation Engineering Manual (2006). Canadian Geotechnical Society, 4<sup>th</sup> Edition, BiTech Publisher Ltd. 506 p.

Federal Highway Administration (1999). "Ground Anchors and Anchored Systems" Geotechnical Engineering Circular No. 4, U.S. Department of Transportation, FHWA-IF-99-015.

### **OPTIONAL COURSE READINGS**

Terzaghi, K., Peck, R., and Mesri, G. (1996). "Soil mechanics in engineering practice." John Wiley & Sons, 592 pages.

BA 80/99 (1999) "Design Manual for Roads and Bridges: Use of Rock Bolts" Volume 2, Highway Structures: Design, Section 1: Material Substructures, Part 7.

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

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