

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

## CEE 9529 – Foundation Design

### COURSE OUTLINE 2022-2023

#### DESCRIPTION

This course develops understanding of the concepts, theories and procedures of design for different types of foundations. The students will learn to calculate the capacity of shallow and deep foundations. Also, they will learn how to evaluate the performance of these foundations under static loads.

#### PREREQUISITES

This course is intended for graduate students enrolled in Civil and Environmental Engineering. It is expected that students will have basic understanding of soil mechanics and geotechnical engineering obtained by taking suitable courses at either the undergraduate or graduate level. Students without a suitable background in soil mechanics should discuss this with the instructor prior to registering for the course.

#### TOPICS

Topic #	Description	Learning Activities	Tentative timeline
1	Basic Principles		
1.1 Basic Principles in Geotechnical and Foundation Engineering	1.1.1 Effective stress 1.1.2 Stress distribution 1.1.3 Shear strength and bearing capacity 1.1.4 Compressibility and settlement	<ul style="list-style-type: none"> <li>• One lecture</li> </ul>	Week 1
	Site/Soil Investigation		
1.2 Soil Investigation	1.2.1 Field Tests 1.2.2 Laboratory Tests	<ul style="list-style-type: none"> <li>• One lecture</li> </ul>	Week 1
2	Shallow Foundations		
2.1. Ultimate Bearing Capacity	2.1.1 Terzaghi's Bearing Capacity Theory 2.1.2 General Bearing Capacity Theory 2.1.2.1 Footing shape 2.1.2.2. Footing depth 2.1.2.3 Inclined load 2.1.2.4 Base inclination 2.1.2.4. Ground inclination 2.1.2.5 Ground water table 2.1.2.6 Eccentric/moment loading	<ul style="list-style-type: none"> <li>• Two lectures</li> </ul> <p style="text-align: center;">In-class problem solving</p>	Week 2

	2.1.2.7 Layered soils 2.1.3 Bearing Capacity from SPT/CPT 2.1.4 Safety Factors / Limit states design		
2.2. Foundation Settlement	2.2.1 Types of Foundation Settlement 2.2.1.1 Immediate (elastic) settlement 2.2.1.2 Consolidation settlement 2.2.1.3 Reliability of settlement calculations 2.2.1.4 Structural tolerance to total and differential Settlements	<ul style="list-style-type: none"> <li>• Two lectures</li> <li>• In-class problem solving</li> </ul>	Weeks 3
2.3 Mat Foundation	2.3.1 Types of Mat Foundation 2.3.2 Bearing Capacity of Mat Foundation 2.3.3 Settlement of Mat Foundation	<ul style="list-style-type: none"> <li>• One lecture</li> </ul>	Week 4
3	Deep Foundations		
3.1 Introduction	3.1.1 Load transfer mechanism 3.1.2 Effect of method of installation on pile performance 3.1.3. Group effect in piles 3.1.4 Load test on piles 3.1.5 Pile types and pile materials 3.1.6 Piling Equipment and Installation	<ul style="list-style-type: none"> <li>• One lecture</li> </ul>	Week 4
3.2 Analysis and Design of Pile Foundations for Vertical Loads	3.2.1 Capacity of single and grouped piles 3.2.2 Settlement of single and grouped piles 3.2.3 Pullout capacity of piles 3.2.3 Design procedure	<ul style="list-style-type: none"> <li>• Two lectures</li> <li>• In-class problem solving</li> </ul>	Week 5
3.3. Analysis and Design of Pile Foundations for Lateral Loads	3.3.1 Ultimate lateral resistance of single piles and pile groups 3.3.2 Lateral deflection of single piles and pile groups 3.3.3 Design procedure for piles 3.3.3 Limit state design for piles	<ul style="list-style-type: none"> <li>• One lecture</li> <li>• In-class problem solving</li> </ul>	Week 6

### SPECIFIC LEARNING OUTCOMES

Degree Level Expectation	Weight	Assessment Tools	Outcomes
<b>Depth and breadth of knowledge</b>	15%	<ul style="list-style-type: none"> <li>• Assignments</li> <li>• Exam</li> </ul>	<ul style="list-style-type: none"> <li>• Understanding of advanced concepts and theories</li> <li>• Awareness of important current problems in the field of study</li> <li>• Understanding of computational and/or empirical methodologies to solve related problems</li> </ul>

<b>Research &amp; scholarship</b>	20%	<ul style="list-style-type: none"> <li>• Assignments</li> </ul>	<ul style="list-style-type: none"> <li>• Ability to conduct critical evaluation of current advancements in the field of specialization</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>• Exam</li> </ul>	<ul style="list-style-type: none"> <li>• Ability to apply knowledge in a rational way to analyze a particular problem</li> <li>• Ability to use coherent approach to design a particular engineering system using existing design tools</li> </ul>
<b>Professional capacity / autonomy</b>	10%	<ul style="list-style-type: none"> <li>• Assignments</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>• Assignments</li> <li>• Exam</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>• Assignments</li> <li>• Exam</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

Assessment Type	Material Covered	Tentative Due Date	Weight
Homework Assignments (Five)	Topic 1-3		50%
<b>Final Exam: June 20</b>	Topics 1-3		50%

### Activities in which collaboration is permitted:

- Analysis/calculations of assignments

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

- Writing reports of assignments

## CONTACT INFORMATION

Course instructor: Prof. M. Hesham El Naggar, P.Eng.

Email address: naggar@uwo.ca

### Contact policy:

- Contact instructor via email (above) or through messages in OWL
- Weekly Office hours (TBD) are held via Zoom

## REQUIRED TEXTBOOK

None

## **OPTIONAL COURSE READINGS**

Any relevant books and scientific papers

## **COURSE CONTENT**

The lecture notes and online lecture videos are copyrighted to the instructor and legally protected. Do not post these videos and lecture notes on any other website or online forums. The recording of the live/synchronous sessions 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).

## **SYNCHRONOUS LEARNING ACTIVITIES**

Students are expected to participate in synchronous learning activities as outlined in the course syllabus and/or described by the instructor. If you have issues that will impede your ability to participate in synchronous activities, please discuss with the course instructor at the beginning of the course.

## **CONDUCT**

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

### **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.