

Western University
Faculty of Engineering
Department of Civil and Environmental Engineering

CEE 9550 – Seismic Analysis and Design of Buildings

COURSE OUTLINE 2024-2025

DESCRIPTION

Seismic analysis and design of buildings course is designed to achieve the following objectives:

- Understand the fundamentals of structure dynamics.
- Perform seismic analysis of buildings manually and using computer modelling.
- Apply the seismic provisions of the building code of Canada.
- Understand the concept of capacity design.
- Design seismic-resistant steel buildings.
- Design seismic-resistant reinforced concrete buildings.

ENROLLMENT RESTRICTIONS

Enrollment in this course is restricted to graduate students in (PhD, MEng, MSc).

INSTRUCTOR CONTACT INFORMATION

Course instructor: Abdelrahman Ahmed

Email address: aahme377@uwo.ca

Office: SEB 3030

Office hours: TBD

COURSE FORMAT

Face-to-face

TOPICS

Topic #	Description	Learning Activities	Tentative timeline
1	Earthquake ground motions characteristics		
	Lecture 1: <ul style="list-style-type: none">• Causes and effects of earthquakes• Seismic waves• Characteristics of earthquakes• Characteristics of ground record accelerations• Attenuation relationship• Return periods	<ul style="list-style-type: none">• In-person lecture during the scheduled class hours. Attending lectures is mandatory*• Reading material (Course notes – Chapter 1)	Week 1

	<ul style="list-style-type: none"> • Design intensity 		
2	Response of a single degree of freedom system		
	<p>Lecture 2:</p> <ul style="list-style-type: none"> • Free vibration response • Response to harmonic loads <p>Lecture 3:</p> <ul style="list-style-type: none"> • Response to earthquake loading using numerical integration (time history analysis) Concept of elastic response spectrum. • Seismic response of a single degree of freedom using the response spectrum procedure. • Seismic response of a single degree of freedom using the time history procedure. 	<ul style="list-style-type: none"> • In-person lecture during the scheduled class hours. Attending lectures is mandatory* • Reading material (Course notes – Chapter 2) • Help session (office hour) 	Week 2-3
3	Seismic analysis of multi degrees of freedom structures.		
	<p>Lecture 4:</p> <ul style="list-style-type: none"> • Dynamic analysis of MDOF systems using the modal analysis procedure • Dynamic analysis of MDOF systems using the time history procedure <p>Lecture 5:</p> <ul style="list-style-type: none"> • Linear seismic analysis using modal analysis. • Linear seismic analysis using time history approach. 	<ul style="list-style-type: none"> • In-person lecture during the scheduled class hours. Attending lectures is mandatory* • Reading material (Course notes – Chapter 3) • Help session (office hour) 	Week 4-5
4	Code procedures for earthquake resistant		
	<p>Lecture 6:</p> <ul style="list-style-type: none"> • Inelastic behaviour and ductility • Seismic provisions of the National Building Code of Canada NBCC • Concept of capacity design <p>Lecture 7:</p> <ul style="list-style-type: none"> • Code provisions for dynamic analysis. 	<ul style="list-style-type: none"> • In-person Lecture during the scheduled class hours. Attending lectures is mandatory* • Reading material (Course notes – Chapter 4) • Help session (office hour) 	Week 6

5	Seismic analysis using computer modeling		
	Lecture 7: <ul style="list-style-type: none"> 3D modelling for high-rise building subjected to earthquake loading according to NBCC code using ETABS software 	<ul style="list-style-type: none"> In-person Lecture during the scheduled class hours. Attending lectures is mandatory* Reading material (Course notes – Chapter 5) Help session (office hour) 	Week 8
6	Seismic design of steel buildings		
	Lecture 8: <ul style="list-style-type: none"> Seismic behaviour and design provisions of ductile moment resisting steel frames Seismic behaviour and design provisions of ductile steel braced frames Lecture 9: <ul style="list-style-type: none"> Solved example: Seismic design of a steel building 	<ul style="list-style-type: none"> In-person Lecture during the scheduled class hours. Attending lectures is mandatory* Reading material (Course notes – Chapter 6) Help session (office hour) 	Week 9
7	Seismic design of reinforced concrete structures		
	Lecture 10: <ul style="list-style-type: none"> Seismic behaviour and design provisions of ductile moment resisting reinforced concrete frames Lecture 11: <ul style="list-style-type: none"> Seismic behaviour and design provisions of ductile reinforced concrete shear walls 	<ul style="list-style-type: none"> In-person Lecture during the scheduled class hours. Attending lectures is mandatory* Reading material (Course notes – Chapter 7) Help session (office hour) 	Week 10-11

*There is no class during reading week (February 15th to 23rd).

SPECIFIC LEARNING OUTCOMES

Degree Level Expectation	Weight	Assessment Tools	Outcomes
Depth and breadth of knowledge	30%	<ul style="list-style-type: none"> Assignments Project Final Examinations 	<ul style="list-style-type: none"> Understanding of advanced concepts and theories Awareness of important current problems in the field of study Understanding of computational and/or empirical methodologies to solve related problems
Research & scholarship	10%	<ul style="list-style-type: none"> Assignments Project 	<ul style="list-style-type: none"> Ability to conduct critical evaluation of current advancements in the field of specialization

			<ul style="list-style-type: none"> Ability to conduct coherent and thorough analyses of complex problems using established techniques/principles and judgment
Application of knowledge	30%	<ul style="list-style-type: none"> Assignments Project Final Examination 	<ul style="list-style-type: none"> Ability to apply knowledge in a rational way to analyze a particular problem Ability to use coherent approach to design a particular engineering system using existing design tools
Professional capacity / autonomy	10%	<ul style="list-style-type: none"> Project 	<ul style="list-style-type: none"> Awareness of academic integrity Ability to implement established procedures and practices in the coursework Defends own ideas and conclusions Integrates reflection into his/her learning process
Communication skills	10%	<ul style="list-style-type: none"> Project 	<ul style="list-style-type: none"> Ability to communicate (oral and/or written) ideas, issues, results and conclusions clearly and effectively
Awareness of limits of knowledge	10%	<ul style="list-style-type: none"> Project 	<ul style="list-style-type: none"> Awareness of the need of assumptions in complex scientific analyses and their consequences Understanding of the difference between theoretical and empirical approaches Ability to acknowledge analytical limitation due to complexity of practical problems

ASSESSMENTS

Assessment Type	Material Covered	Tentative Due Date*	Weight
Homework Assignments (four)	Topic 1, 2, 4, 5, 6	Check course calendar	25%
Participation in class activities	Topics 1-7	Weekly activity	5%
Final Exam	Topics 1 – 7	April 11 th , 2024	35%
Project	Topics 4, 5, 7	April 18 th , 2024	35%
Project (Oral Exam)		April 22 th , 2024	30% of project weight

* The shown dates are an approximate guide for students and are subject to change.

Activities in which collaboration is permitted:

- Participation (asynchronous) using course OWL site “Forums”: Students are strongly encouraged to post questions/respond to posted questions on a weekly basis. Group discussion using “Forums” regarding course material and topics covered in lectures is permitted.
- Project: Students will be divided into groups (2-3 members per group). Collaboration between only group members is permitted. One final project report is required from each group.

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

- Homework Assignments
- Final Exam

REQUIRED TEXTBOOK

Lecture notes prepared by Dr. El Damatty will be made available through the course website on OWL at <http://owl.uwo.ca/>, along with other useful reference material and data for assignments.

OPTIONAL COURSE READINGS

- 1) Elements of earthquake engineering and structural dynamics, by Filiatrault, André., Cursus, 2013.
- 2) Dynamics of structures: theory and applications to earthquake engineering, by Anil K. Chopra. Englewood Cliffs, N.J., Prentice Hall, 1995.
- 3) Ductile design of steel structures, by Michel Bruneau, Chia-Ming Uang and Andrew Whittaker, McGraw-Hill, 1998.
- 4) Seismic Design of Reinforced Concrete and Masonry Buildings by Thomas Paulay and M. J. N. Priestley.

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

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. To connect with a case manager or set up an appointment, please contact 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

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.