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

CEE 9550 – Seismic Analysis and Design of Buildings
Course Outline – Winter 2024

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.

PREREQUISITE:

Bachelor degree in Structural Engineering and CEE 9512a or equivalent

TOPICS:

Topic #	Description	Learning Activities	Tentative timeline
1	Earthquake Ground Motions Characteristics		
	Lecture 1: Thursday Jan 11 • Causes and effects of earthquakes • Seismic waves • Characteristics of earthquakes • Characteristics of ground record accelerations • Attenuation relationship • Return periods • Design intensity	• In-person Lecture during the scheduled class hours. Attending lectures is mandatory* • Reading material (Course notes – Chapter 1)	Week 1
2	Response of a Single Degree of Freedom System		
	Lecture 2: Thursday Jan 18 • Free vibration response • Response to harmonic loads Lecture 3: Friday Jan 19 • Response to earthquake loading using numerical integration (time history analysis) Concept of elastic response spectrum	• In-person Lecture during the scheduled class hours. Attending lectures is mandatory* • Reading material (Course notes – Chapter 2) • Help session (office hour)	Week 2

	• 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		
3	Seismic Analysis of Multi Degrees of Freedom Structures		
	Lecture 4: Thursday Jan 25 • Dynamic analysis of MDOF systems using the modal analysis procedure • Dynamic analysis of MDOF systems using the time history procedure Lecture 5: Friday Jan 26 • Linear seismic analysis using modal analysis • Linear seismic analysis using time history approach	• In-person Lecture during the scheduled class hours. Attending lectures is mandatory* • Reading material (Course notes – Chapter 3) • Help session (office hour)	Week 3

4	Code Procedures for Earthquake Resistant		
	Lecture 6: Thursday Feb 1 • Inelastic behaviour and ductility • Seismic provisions of the National Building Code of Canada NBCC • Concept of capacity design Lecture 7: Friday Feb 2 • Code Provisions for dynamic analysis	• In-person Lecture during the scheduled class hours. Attending lectures is mandatory* • Reading material (Course notes - Chapter 4) • Help session (office hour)	Week 4
5	Seismic Analysis Using Computer Modeling		
	Lecture 7: Thursday Feb 8 • 3D modelling for high-rise building subjected to earthquake loading according to NBCC code using ETABS software	• In-person Lecture during the scheduled class hours. Attending lectures is mandatory* • Reading material (Course notes - Chapter 5) • Help session (office hour)	Week 5

6	Seismic Design of Steel Buildings		
	Lecture 8: Thursday Feb 15 • Seismic behaviour and design provisions of ductile moment resisting steel frames • Seismic behaviour and design provisions of ductile steel braced frames Lecture 9: Friday Feb 16 • Solved example: Seismic Design of a steel building	• In-person Lecture during the scheduled class hours. Attending lectures is mandatory* • Reading material (Course notes – Chapter 6) • Help session (office hour)	Week 7 *

7	Seismic Design of Reinforced Concrete Structures		
	Lecture 10: Tuesday Feb 29 • Seismic behaviour and design provisions of ductile moment resisting reinforced concrete frames Lecture 11: Wednesday March 1 • Seismic behaviour and design provisions of ductile reinforced concrete shear walls	• In-person Lecture during the scheduled class hours. Attending lectures is mandatory* • Reading material (Course notes - Chapter 7) • Help session (office hour)	Week 9

*There is no class during reading week

SPECIFIC LEARNING OUTCOMES

Degree Level Expectation	Weight	Assessment Tools	Outcomes
Depth and breadth of knowledge	30%	• Assignments • Project • Final Examination	• 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%	• Assignments • Project	• Ability to conduct critical evaluation of current advancements in the field of specialization • Ability to conduct coherent and thorough analyses of complex problems using established techniques/principles and judgment
Application of knowledge	30%	• Assignments • Projects • Final Examination	• 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%	• Project	• 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%	• Project	• Ability to communicate (oral and/or written) ideas, issues, results and conclusions clearly and effectively
Awareness of limits of knowledge	10%	• Project	• 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 (five)	Topics 1, 2, 3, 4, 6	Check course calendar	25%
Participation	Topics 1-7	Weekly activity	5%
Project	Topics 4,5,7	April 18th ,2024	35%
Final Exam	Topics 1 – 7	April 12th , 2024	35%
Project (Oral Exam)		April 25th, 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 postquestions/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*** groupmembers 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

CONTACT INFORMATION:

Course instructor: Dr. Ashraf El Damatty, P.Eng.,
email:
damatty@uwo.ca

Contact policy:

- Contact instructor via email (above) or through messages in OWL
- Weekly Office hours will be announced

A general FAQ section on the 'forums' section of OWL will be used for students to post course-related questions so that all have the same information.

CONTACT HOURS
3 or 6 hours lecture per week based on the schedule above

COURSE MATERIALS
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.

Other References:

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.*

COMPUTING
Several assignments will involve computer modelling of structures using the commercial programs SAP2000and ETABS. The full version of the programs is available at the PC lab in the Engineering building. Remote access to the computer lab and the software license servers will be provided. Instructions on how to remotelyaccess the software license will be posted on course OWL site.

UNITS
SI units will be used in lectures and examinations

USE OF ENGLISH
In accordance with Senate and Faculty Policy, students may be penalised up to 10% of the marks on all assignments, tests, and examinations for the improper use of English. Additionally, poorly written work with the exception of the final examination may be returned without grading. If resubmission of the work is permitted, it may be graded with marks deducted for poor English and/or late submission.

COURSE CONTENT
The lecture notes and online lecture videos are copyrighted 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 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.

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.