Western University
Faculty of Engineering
Department of Civil and Environmental Engineering

CEE 9549 – Advanced Design and Behavior of Reinforced Concrete

COURSE OUTLINE 2021-2022

DESCRIPTION

This course sheds light on fundamentals of the analysis and design of reinforced concrete sections and members to resist flexural, shear, and axial loads. It also covers topics on serviceability, durability criteria and slender columns. More complex design techniques such as strut-and-tie methods are also explored. Course content is delivered as per CSA Standard CAN/CSA A23.3.

PREREQUISITES

CEE 2220a, CEE 2221b, CEE 2202a, CEE 3340a, CEE 3341b, CEE 347a, CEE 358b, or their equivalent, by permission of the Instructor.

TOPICS

Topic #	Description	Learning Activities	Tentative timeline
1	Behavior and Strength of Sections in Flexure		
	Lesson 1: • Compute moment-curvature relationships for reinforced concrete sections subjected to bending or combined bending and axial loads using the basic conditions of equilibrium, compatibility, and force-deformation relationships. • Recognize the impact of the response of concrete in uniaxial compression on the stress-strain diagram, and on the response for biaxial and triaxial stress states.	• One lecture • Practice problems • Discussion	Week 1
	Lesson 2: • Compute the flexural capacity of T-beams, isolated unsymmetrical beams, and beams with compression reinforcement. • Summarize the additional assumptions necessary to develop a	• One lecture • Practice problems • Discussion	Week 1

	simplified flexural theory for reinforced concrete. • Apply simple truss-based models to determine appropriate transverse reinforcing for T-beam flanges.		
2	Shear Strength of Reinforced Concrete		
	Lesson 1: • Explain from first principles and experimental evidence the behavior of beams without web reinforcement, and the transfer of forces after inclined cracking in beams with and without web reinforcement. • Design beams to resist shear using section design methods or whole member design methods.	• One lecture • Practice problems • Discussion	Week 2
	Lesson 2: Distinguish between shear design using Compression Field Theory, Modified Compression Field Theory or Simplified Modified Compression Field Theory.	• One lecture • Practice problems • Discussion	Week 2
3	Lesson 1: Tutorial on using selected commercial software in the design of beams for flexure and shear	• One lecture • Practice problems • Discussion	Week 3
4	Discontinuity Regions, Strut-and-Tie Models		
	Lesson 1: Identify B and D regions in concrete structures and analyze D regions using strut-and-tie methods.	• One lecture • Practice problems • Discussion	Week 3
	Lesson 2: • Layout plastic trusses, size compression struts and nodal regions, and check the anchorage of tension ties. • Correlate the mechanics of bottle-shaped compression regions and strut-and-tie models for opening and closing corners to the observed behavior of these regions.	• One lecture • Practice problems • Discussion	Week 4
5	Columns		
	Lesson 1:	• One lecture • Practice problems	Week 5

	• Classify columns as "short" or "long" and characterize the column behavior based on this classification. • Distinguish between the axial response of short tied and spiral columns and determine the geometry of the spiral reinforcement necessary to obtain the desired response. • Construct interaction diagrams for columns from first principles. •	• Discussion	
	Lesson 2: • Determine the capacity of a column subjected to biaxial bending. • Compute the resistance of a slender column using approximate analyses involving moment magnifiers, or the design criteria presented in A23.3. • Distinguish between material failures and stability failures, recognizing the impact of tangent and secant stiffnesses, non-uniform end moments, and sustained loads on stability failures.	• One lecture • Practice problems • Discussion	Week 5

SPECIFC LEARNING OUTCOMES

Degree Level Expectation	Weight	Assessment Tools	Outcomes
Depth and breadth of knowledge	40%	• Assignments • Examinations	• 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	NA	• 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	40%	• Assignments • Examinations	• 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	NA	• 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%	• Assignments • Examinations	• Ability to communicate (oral and/or written) ideas, issues, results and conclusions clearly and effectively
Awareness of limits of knowledge	10%	• Assignments • Examinations	• 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	Topics 1, 2, 3, 4,5	Two days after each topic is completed	40%
Participation (in class or assignments)	Topics 1, 2, 3, 4,5	Random	10%
Final Exam (written)	Topics 1, 2, 4, 5	August 22nd, 2022	35%
Final Exam (oral)	Topics 1, 2, 4, 5	August 25th, 2022	15%

Activities in which collaboration is permitted:

- Students can collaborate in solving assignments, but each student must submit their assignment separately.

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

- Final Exam

CONTACT INFORMATION

Course instructor: Dr. Aiham Adawi, PhD, P.Eng.
Email address: aadawi2@uwo.ca

Contact policy:

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

REQUIRED TEXTBOOK

None.

OPTIONAL COURSE READINGS

MacGregor, J. G. and Bartlett, F. M. (2000): *Reinforced Concrete: Mechanics and Design (1st Canadian Edition)*. Prentice-Hall Canada Inc.

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. Campus mental health resources may be found at 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.

ACCESSIBLITY

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, for any specific question regarding an accommodation.