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

CEE 3347a - Reinforced Concrete Design - Course Outline 2023/2024

This one-term course integrates material from previous structural analysis and design courses and extends the knowledge and abilities of the students in structural behaviour and design. The general objectives are for students to develop an understanding of behaviour, and to develop abilities in the design of reinforced concrete (RC). To achieve these objectives, students apply their knowledge of mathematics, science, and engineering while identifying, formulating, and solving structural design problems. The students design structural components to meet current code criteria. The techniques and skills used by the students prepare them for engineering practice. In the laboratory component of the course, students develop abilities in understanding aspects of experimental testing as well as interpreting data.

Calendar Copy:

Introduction to reinforced concrete design including serviceability and ultimate limit states; analysis and design of reinforced concrete beams and one-way slabs for flexure and shear; bar cutoffs in flexural members; deflections; short columns. (0.5 course)

Prerequisites:

CEE 2202a/b, CEE 2221a/b

Corequisites:

None

Antirequisite:

None

Note: It is the **student's responsibility** to ensure that all Prerequisite and Corequisite conditions are met or that special permission to waive these requirements has been granted by the Faculty. It is also the **student's responsibility** to ensure that they have not taken a course listed as an Antirequisite. The student may be dropped from the course or not given credit for the course towards their degree if they violate the Prerequisite, Corequisite or Antirequisite conditions.

Contact Hours:

3 lecture hours/week, 3 tutorial hours/week, 4 laboratories

Attendance:

Attendance in lectures, tutorials, and laboratories will be monitored. Any student who, in the opinion of the instructor, is absent too frequently from class, laboratory, or tutorial periods will be reported to the Dean. On the recommendation of the Department concerned, and with the permission of the Dean, the student will be debarred from taking the regular final examination in the course. Absence from laboratories will lead to mark deduction.

Students must follow University policies and public health directives, or they will be referred to the Dean, and their actions might be considered a violation of the Student Code of Conduct.

Instructor:

Dr. M. A. Youssef, P. Eng., SEB 3043, email: youssef@uwo.ca

References:

Required: Prepared class notes can be downloaded from the course website (<u>http://owl.uwo.ca</u>).

• Students are responsible for regularly checking their email, and course OWL site (<u>https://owl.uwo.ca</u>). If students need assistance with the course OWL site, they can seek support on the OWL Help page. Alternatively, they can contact the Western Technology Services Helpdesk. They can be contacted by phone at 519-661-3800 or ext. 83800.

Recommended: Concrete Design Handbook, Cement Association of Canada, Ottawa, ON.

Recommended: Reinforced Concrete Design: A Practical Approach, S. Brzev and J. Pao, Pearson Education.

<u>Units:</u>

SI units will be used in lectures and examinations

Specific Learning Objectives:

- 1. The Design Process:
 - a) Recognize structural elements in typical RC structures [KB4].
 - b) Recognize the advantages and disadvantages of concrete as a building material [KB4].
 - c) Identify the different codes and design standards related to the course [KB4, LL2].
 - d) Understand the different design limit states [KB4].
 - e) Know the requirements to satisfy the strength and serviceability limit states [KB4].
 - f) Compute and sketch the distribution of maximum moments and shear forces for simple structures considering all potential cases of loading [PA2].
- Properties of Concrete and Reinforcing Bars: Know the actual and simplified material constitutive relationships for both concrete and steel [I3, ITW1, CS3].
- 3. RC Beams: Flexural Behaviour and Design:
 - a) Develop an understanding of the flexural behaviour of RC beams [I3, ITW1, CS3]
 - b) Calculate the moment capacity of a given beam section [PA2].
 - c) Identify the expected failure mechanism for a given beam section [PA2].
 - d) Calculate balanced section properties [KB4].
 - e) Design rectangular beam sections [D4].
 - f) Design T and L beam sections [D4].
 - g) Design beams with compression reinforcing bars [D4].
 - h) Sketch the designed beam sections that satisfy the skin reinforcements and crack control conditions [D4].
- 4. Development, Anchorage, and Splicing of Reinforcing Bars:
 - a) Calculate the required tension and compression development lengths [PA2].
 - b) Calculate the length of bars being curtailed in flexural members [PA2]
- 5. RC Beams: Shear Behaviour and Design:
 - a) Develop an understanding of the shear behaviour of RC beams [I3, ITW1, CS3]
 - b) Calculate the shear capacity for a given section [PA2].
 - c) Design a concrete beam to satisfy A23.3 shear requirements [D4].
- 6. Continuous Beams and one-way slabs:
 - a) Sketch the moment and shear force diagrams for continuous beams and one-way slabs using A23.3 approximate values [KB4].
 - b) Sketch the free-body diagrams for slabs and beams of a given structural system [PA2].
 - c) Perform detailed design of one-way slabs and beams [D4].
 - d) Sketch reinforcing bar details for slabs and beams [D4].
- 7. Short Columns:
 - a) Develop an understanding of the flexural behaviour of short columns [I3, ITW1, CS3]
 - b) Sketch an approximate interaction diagram for a given section [PA2].
 - c) Design of RC columns using interaction diagrams in the design aids [D4].
- 8. Deflections:
 - a) Calculate deflections of RC beams and slabs [PA2].

The instructor may expand, or revise material presented in the course as appropriate.

General Learning Objectives

Problem Analysis	Т	Teamwork	Ι	Ethics and Equity	
Investigation	Е	Communication	Ι	Economics and Project Management	
Design	Е	Professionalism		Life-Long Learning	Ι
Engineering Tools		Impact on Society			

E=Evaluate, T=Teach, I=Introduce (Developing Level)

Evaluation:

The final course mark will be determined as follows:

	Total	 100% + 5% Bonus
•	Written Final Exam	45%
•	Midterm	25%
•	Four Lab Reports	20%
•	Assignments & Participation (includes 5% bonus)	15%

- Note: (a) Students **must pass the final examination to pass this course**. Students who fail the final examination will be assigned the aggregate mark, as determined above, or 48%, whichever is less. **Students who have failed this course previously must repeat all components** of the course. No special permissions will be granted enabling a student to retain laboratory, assignment, or test marks from previous years. Previously completed assignments and laboratories cannot be resubmitted.
 - (b) Following Senate and Faculty Policy, students may be penalized up to 10% of the marks 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.

1. Assignments & Participation:

10% of the mark will be assigned based on the weekly "gradescope.ca" assignments. The additional 5% will be assigned based on your attendance, participation in the lectures and tutorials, and solution of bonus assignments.

2. Laboratories and tutorials:

During the term, you will have 4 in-person laboratories and weekly in-person tutorials. The laboratories will allow you to observe experiments that evaluate the mechanical properties of concrete and steel (Lab 1), flexural performance of RC beams (Lab 2), shear behaviour of RC beams (Lab 3), and capacity of eccentrically loaded RC columns (Lab 4).

Students will be divided into groups and each group of students will submit one report for each of the labs. The reports should describe the conducted tests and provide a detailed analysis of the results. The reports **must be submitted** on gradescope.ca within 7 days following the laboratory.

Although it is expected that the lab mark will be the same for all group members, students can individually recommend in writing, with stated reasons, a suitable allocation of the report mark. The course instructor reserves the responsibility for making the final allocation. The mark for group work will then be allocated to the members in proportion to each member's contribution to the work.

3. Midterm and Final Exam:

One 120-minute midterm will be scheduled. The midterm and the final exam are OPEN BOOK. Hand-held programmable calculators may be used, but programs and information stored in advance of the examination may not be used.

Cheating:

University policy states that cheating is a scholastic offence. The commission of a scholastic offence is attended by academic penalties that might include expulsion from the program. If you are caught cheating, there will be no second warning.

For more information on scholastic offences, please see:

http://www.uwo.ca/univsec/handbook/appeals/scholastic_discipline_undergrad.pdf

Conduct:

Students are expected to arrive at lectures on time and to conduct themselves during class professionally and respectfully so that are not disruptive to others. Please turn off your cell phone before coming to a class, tutorial, quiz or exam. On the premises of the University or at a University-sponsored program, students must abide by the Student Code of Conduct: https://www.uwo.ca/univsec/pdf/board/code.pdf

Scholastic offences are taken seriously, and students are directed to read the appropriate policy, specifically, the definition of what constitutes a Scholastic Offence, at the following Web site:

http://www.uwo.ca/univsec/pdf/academic_policies/appeals/scholastic_discipline_undergrad.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 to detect 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).

Consultation:

Students are encouraged to discuss problems with their teaching assistant and/or the instructor. Office hours will be arranged for the students to meet with the instructor and teaching assistants. Other individual consultations can be arranged by appointment.

Course breakdown:

Engineering design = 100%