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

CEE 3347a – Reinforced Concrete Design - Course Outline 2022/2023

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 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 aspect 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/laboratory hours/week.
**Attendance:**

Attendance in lectures and tutorials will be monitored using iClicker. 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.

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.

**Contingency plan for an in-person class pivoting to 100% online learning**

In the event of a COVID-19 resurgence during the course that necessitates the course delivery moving away from face-to-face interaction, all remaining course content will be delivered entirely online, either synchronously (i.e., at the times indicated in the timetable) or asynchronously (e.g., posted on OWL for students to view at their convenience). The grading scheme will not change. Any remaining assessments will also be conducted online as determined by the course instructor. In the event that online learning is required, a stable internet connection with working microphone and webcam will be required.

**Instructor:**

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

**Administrative Support:**

Sandra McKay, SEB 3005, email: smckay@uwo.ca

**References:**

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

- Students are responsible for regularly checking their email, and course OWL site (https://owl.uwo.ca). 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.

**Units:**

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 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].

2. Properties of Concrete and Reinforcing Bars:
   Know the actual and simplified material constitutive relationships for both concrete and steel [ITW1, CS3].

3. RC Beams: Flexural Behaviour and Design:
   a) Develop understanding of the flexural behaviour of RC beams [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 understanding of the shear behaviour of RC beams [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 understanding of the flexural behaviour of short columns [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**

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

<table>
<thead>
<tr>
<th>Problem Analysis</th>
<th>T</th>
<th>Teamwork</th>
<th>I</th>
<th>Ethics and Equity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Investigation</td>
<td>E</td>
<td>Communication</td>
<td>I</td>
<td>Economics and Project Management</td>
</tr>
<tr>
<td>Design</td>
<td>E</td>
<td>Professionalism</td>
<td></td>
<td>Life-Long Learning</td>
</tr>
<tr>
<td>Engineering Tools</td>
<td></td>
<td>Impact on Society</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Evaluation:**

The final course mark will be determined as follows:

- Assignments & Participation (includes 5% bonus) 15%
- Four Lab Reports 20%
- Midterm (Nov. 10th) 25%
- Written Final Exam 45%

\[ \text{Total} = 100\% + 5\% \text{ Bonus} \]

**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) In accordance with Senate and Faculty Policy, students may be penalised 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 (Sep. 14, Oct. 19, Nov. 16, and Nov. 30) and 11 in-person tutorials (Sep. 15, Sep. 22, Sep. 29, Oct. 6, Oct. 13, Oct. 20, Oct. 27, Nov. 17, Nov. 24, Dec. 1, and Dec. 8). Laboratories will be held in SEB 22 and Tutorials will be held in SH-3317. The laboratories will allow you to observe experiments that evaluate mechanical properties of concrete and steel (Lab 1-Sep. 14), flexural performance of RC beams (Lab 2-Oct. 19), shear behaviour of RC beams (Lab 3-Nov. 16), and capacity of eccentrically loaded RC columns (Lab 4-Nov. 30).
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 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 minutes midterm is scheduled on November 10th from 2:00 pm to 4:00 pm. 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 offenses, please see:
http://www.uwo.ca/univsec/handbook/appeals/scholastic_discipline_undergrad.pdf

Accommodation and Accessibility:

Religious Accommodation
When a course requirement conflicts with a religious holiday that requires an absence from the University or prohibits certain activities, students should request accommodation for their absence in writing at least two weeks prior to the holiday to the course instructor and/or the Academic Counselling office of their Faculty of Registration. Please consult University's list of recognized religious holidays (updated annually) at


Accommodation Policies
Students with disabilities are encouraged to contact Accessible Education, which provides recommendations for accommodation based on medical documentation or psychological and cognitive testing. The policy on Academic Accommodation for Students with Disabilities can be found at:

https://www.uwo.ca/univsec/pdf/academic_policies/appeals/Academic_Accommodation_disabilities.pdf

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 http://academicsupport.uwo.ca/accessible_education/index.html.
**Conduct:**
Students are expected to arrive at lectures on time, and to conduct themselves during class in a professional and respectful manner that is 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

**Sickness and Other Problems:**
If you are unable to meet a course requirement due to illness or other serious circumstances, you must provide valid medical or supporting documentation to the Academic Counselling Office of your Faculty of Registration as soon as possible. For further information, please consult the University’s medical illness policy at https://www.uwo.ca/univsec/pdf/academic_policies/appeals/accommodation_medical.pdf

The Student Medical Certificate is available at https://www.uwo.ca/univsec/pdf/academic_policies/appeals/medicalform.pdf

If your absence is approved, your course mark will be reweighted to exclude the assessment that you missed.

**Absences from Final Examinations**
If you miss the Final Exam, please contact Western Engineering Undergraduate Services as soon as possible. They will assess your eligibility to write the Special Examination.

You may also be eligible to write the Special Exam if you are in a “Multiple Exam Situation” (e.g., more than 2 exams in 23-hour period, more than 3 exams in a 47-hour period).

If a student fails to write a scheduled Special Examination, the date of the next Special Examination (if granted) normally will be the scheduled date for the final exam the next time this course is offered. The maximum course load for that term will be reduced by the credit of the course(s) for which the final examination has been deferred. See the Academic Calendar for details (under Special Examinations).

**Note:** missed work can only be excused through one of the mechanisms above. Being asked not to attend an in-person course requirement due to potential COVID-19 symptoms is not sufficient on its own.

**Academic Policies:**
The website for Registrarial Services is http://www.registrar.uwo.ca

In accordance with policy, https://www.uwo.ca/univsec/pdf/policies_procedures/section1/mapp113.pdf, the centrally administered e-mail account provided to students will be considered the individual’s official university e-mail address. It is the responsibility of the account holder to ensure that e-mail received from the University at their official university address is attended to in a timely manner.

**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 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).

**Support Services:**

Please visit the Western Engineering Undergraduate Services webpage for information on adding/dropping courses, academic considerations for absences, appeals, exam conflicts, and many other academic related matters: https://www.eng.uwo.ca/undergraduate/index.html

Students who are in emotional/mental distress should refer to Mental Health at Western (https://uwo.ca/health/) for a complete list of options about how to obtain help.

Western is committed to reducing incidents of gender-based and sexual violence and providing compassionate support to anyone who has gone through these traumatic events. If you have experienced sexual or gender-based violence (either recently or in the past), you will find information about support services for survivors, including emergency contacts at 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.

Learning-skills counsellors at the Student Development Centre (https://learning.uwo.ca) are ready to help you improve your learning skills. They offer presentations on strategies for improving time management, multiple-choice exam preparation/writing, textbook reading, and more. Individual support is offered throughout the Fall/Winter terms in the drop-in Learning Help Centre, and year-round through individual counselling.

Western University is committed to a thriving campus as we deliver our courses in the mixed model of both virtual and face-to-face formats. We encourage you to check out the Digital Student Experience website to manage your academics and well-being: https://www.uwo.ca/se/digital/.

Additional student-run support services are offered by the USC, https://westernusc.ca/services/.

**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 consultation can be arranged by appointment.

**Course breakdown:**

Engineering design = 100%

The document “INSTRUCTIONS FOR STUDENTS UNABLE TO WRITE TESTS OR EXAMINATIONS OR SUBMIT ASSIGNMENTS AS SCHEDULED” is part of this course outline.