

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

CEE 3347a – Reinforced Concrete Design - Course Outline 2016/17

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. 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 conducting experiments 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)

Contact Hours: 3 lecture hours/week, 3 tutorial/laboratory hours/week
Attendance at the tutorial/laboratory session is **mandatory**.

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.

Instructor:

Dr. Aiham Adawi, P. Eng., SEB 3095, email: aadawi2@uwo.ca.
Administrative Support: Sandra McKay, SEB 3005.

Textbook:

Prepared class notes should be brought to each class, and may be downloaded from the course website (<http://owl.uwo.ca>).

Required: *Concrete Design Handbook (4th Edition)*, Cement Association of Canada, Ottawa, ON, 2016.

Other References:

Optional: *Reinforced Concrete Structures: Design according to CSA A23.3-04*, O. Chaallal and M. Lachemi. Presses de l'Université du Québec, 2010.
Reinforced Concrete Design: A Practical Approach, S. Brzev and J. Pao, second edition, Pearson Education Canada, 2013.

Laboratory:

Four laboratories allow the students to observe experimental tests that evaluate:

Lab 1 (Sep. 20th): the mechanical properties of concrete and steel.

Lab 2 (Oct. 11th): the flexural performance of reinforced concrete beams

Lab 3 (Nov. 15th): the shear behaviour of reinforced concrete beams

Lab 4 (Nov. 29th): behaviour of eccentrically loaded columns.

Each group of students will submit four reports that describe the conducted tests and provide analysis of the results. The reports **must be submitted** during the tutorial that follows each of the labs. The group members 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 be multiplied by the number of group members and the product allocated to the members in proportion to each member's contribution to the work.

Computing:

Students are required to use personal computers running a Windows environment.

Units:

SI units will be used in lectures and examinations

Specific Learning Objectives:

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

General Learning Objectives

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

Problem Analysis	T	Team Work	I	Ethics and Equity	
Investigation	E	Communication	T	Economics and Project Management	
Design	E	Professionalism	I	Life-Long Learning	I
Engineering Tools	T	Impact on Society			

Evaluation:

The final course mark will be determined as follows:

- Weekly Assignments 10%
 - 4 Lab Reports 20%
 - Quiz 20%
 - Participation in Lectures (Bonus) 5%
 - Final Exam 50%
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- Total 100%

- 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.
 - (b) **Students must turn in all laboratory reports, and achieve a passing grade in the laboratory component, to pass this course.** Students who do not satisfy this requirement will be assigned 48% or the aggregate mark, whichever is less.
 - (c) **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.
 - (d) If the quiz conflicts with a religious holiday that a student wishes to observe, the student must inform the instructor of the conflict no later than two weeks before the scheduled test.
(For further information on Accommodations for Religious Holidays see http://www.uwo.ca/univsec/pdf/academic_policies/appeals/accommodation_religious.pdf)

1. Quizzes and Examinations:

One 120 minutes quiz will be on Tuesday, **November 8th** from 2:00 pm to 4:00 pm. The quiz 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.

2. Weekly Assignments

One solution to Part A of each weekly assignment must be turned in by each group by the end of the tutorial period. All group members must sign the cover page of the group submission.

For assignments with part B, each group must turn in one solution by 9:30 am on Thursday of the Tutorial week in LOCKER 57, second floor, Spencer Engineering Building. **Late assignments will receive a grade of zero.** Extensions are to be negotiated with the course instructor, not the teaching assistants.

3. 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.

Plagiarism Checking:

The University of Western Ontario uses software for plagiarism checking. Students are required to submit their Laboratory Reports in electronic form to Turnitin.com for plagiarism checking.

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/pdf/academic_policies/appeals/scholastic_discipline_undergrad.pdf

Attendance:

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 (after due warning has been given). 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.

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 Services for Students with Disabilities (SSD) at 661-2111 x82147 for any specific question regarding an accommodation.

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. Late comers may be asked to wait outside the classroom until being invited in by the Instructor. 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:

http://www.uwo.ca/univsec/pdf/academic_policies/appeals/code_of_conduct.pdf

Sickness and Other Problems:

Students should immediately consult with the Instructor or Department Chair if they have any problems that could affect their performance in the course. Where appropriate, the problems should be documented (see

attached). The student should seek advice from the Instructor or Department Chair regarding how best to deal with the problem. Failure to notify the Instructor or Department Chair immediately (or as soon as possible thereafter) will have a negative effect on any appeal. For more information concerning medical accommodations, please see:

http://www.uwo.ca/univsec/pdf/academic_policies/appeals/accommodation_medical.pdf

Notices:

Students are responsible for regularly checking their email, course website (<http://owl.uwo.ca>) and notices posted outside the Civil and Environmental Engineering Department Office

Consultation:

Students are encouraged to discuss problems with their teaching assistant and/or instructor in tutorial sessions. Office hours will be arranged for the students to see the instructor and teaching assistants. Other individual consultation can be arranged by appointment with the appropriate instructor.

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.

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Weekly Schedule

<u>Week¹</u>	<u>Topics</u>	<u>Tutorial</u>
Sep. 12	Introduction The Design Process	Introduction
Sep. 19	Materials Flexure Basic Concept	Lab # 1
Sep. 26	Analysis of RC Beams	Asgmt. # 1 <i>(Lab # 1 report is due on Sept. 7)</i>
Oct. 3	Design of Rectangular Beams	Asgmt. # 2
Oct. 10	T beams	Lab # 2
Oct. 17	Beams with compression RFT	Asgmt. # 3 <i>(Lab # 2 report is due on Oct. 18)</i>
Oct. 24	Cracking Development Length Design for Anchorage	Asgmt. # 4
Oct. 31	Bar Cutoffs Shear basic theory	Asgmt. # 5
Nov. 7	Design of beams for shear Continuity	<i>Quiz (Nov. 8)</i>
Nov. 14	Continuous beams One-Way slabs	Lab # 3
Nov. 21	Deflections Columns	Asgmt. # 6 <i>(Lab # 3 report is due Nov. 22)</i>
Nov. 28	Interaction Diagrams Design of Short Columns	Lab # 4
Dec. 5		Asgmt. # 7 <i>(Lab # 4 report is due on Dec. 6)</i>

¹ Dates are an approximate guide for students and the lectures may not exactly follow this schedule.

**INSTRUCTIONS FOR STUDENTS UNABLE TO WRITE TESTS
OR EXAMINATIONS OR SUBMIT ASSIGNMENTS AS SCHEDULED**

If, on medical or compassionate grounds, you are unable to write term tests or final examinations or complete course work by the due date, you should follow the instructions listed below. You should understand that academic accommodation will not be granted automatically on request. You must demonstrate to your department (or the Undergraduate Services office if you are in first year) that there are compelling medical or compassionate grounds that can be documented before academic accommodation will be considered. Different regulations apply to term tests, final examinations and late assignments. Read the instructions carefully. (see the 2016 Western [Academic Calendar](#)).

A. GENERAL REGULATIONS & PROCEDURES

1. Check the course outline to see if the instructor has a policy for missed tests, examinations, late assignments or attendance.
2. Bring your request for academic accommodation to the attention of the Chair of the department (or the Undergraduate Services office if you are in first year) prior to the scheduled time of the test or final examination or due date of the assignment. If you are unable to contact the relevant person, leave a message with the appropriate department (or Undergraduate Services office, if you are in first year). The addresses, telephone and fax numbers are given at the end of these instructions. Documentation must be provided as soon as possible.
3. If you decide to write a test or an examination you should be prepared to accept the mark you earn. Rewriting tests or examinations or having the value of a test or exam reweighted on a retroactive basis is not permitted.

B. TERM TESTS

1. If you are unable to write a term test, inform your instructor and the Chair of your Department (or the Undergraduate Services Office if you are in first year) prior to the scheduled date of the test. If the instructor is not available, leave a message for him/her at the department office and inform the Chair of the Department (or the Undergraduate Services Office if you are in first year).
2. Be prepared to provide supporting documentation to the Chair and the Undergraduate Services Office (see next page for information on documentation).
3. Discuss with the instructor if and when the test can be rescheduled. **N.B.** The approval of the Chair (or the Undergraduate Services Office if you are in first year) is required when rescheduling term tests.

C. FINAL EXAMINATIONS

1. If you are unable to write a final examination, contact the Undergraduate Services Office **PRIOR TO THE SCHEDULED EXAMINATION TIME** to request permission to write a Special Final Examination. If no one is available in the Undergraduate Services Office, leave a message clearly stating your name & student number (please spell your full name).
2. Be prepared to provide the Undergraduate Services Office with supporting documentation (see next page for information on documentation) the next day, or as soon as possible (in cases where students are hospitalized). The following circumstances are not considered grounds for missing a final examination or requesting special examinations: common cold, sleeping in, misreading timetable and travel arrangements.
3. In order to receive permission to write a special examination, you must obtain the approval of the Chair of the Department **and** the Associate Dean and in order to apply you must sign a "Recommendation for a Special Examination Form" available in the Undergraduate Services Office. The Undergraduate Services Office will then notify the course instructor(s) and reschedule the examination on your behalf.

N.B. It is the student's responsibility to check the date, time and location of the special examination.

D. LATE ASSIGNMENTS

1. Advise the instructor if you are having problems completing the assignment on time (**prior** to the due date of the assignment).
2. Be prepared to provide documentation if requested by the instructor (see reverse side for information on documentation).
3. If you are granted an extension, establish a due date. The approval of the Chair of your Department (or the Associate Dean if you are in first year) is not required if assignments will be completed prior to the last day of classes.
4.
 - i) Extensions beyond the end of classes must have the consent of the instructor, the department Chair and the Associate Dean. Documentation is mandatory.
 - ii) A Recommendation of Incomplete Form must be filled out indicating the work to be completed and the date by which it is due. This form must be signed by the student, the instructor, the department Chair and the Associate Dean.

SHORT ABSENCES

If you miss a class due to a minor illness or other problems, check your course outlines for information regarding attendance requirements and make sure you are not missing a test or assignment. Cover any readings and arrange to borrow notes from a classmate.

EXTENDED ABSENCES

If you are absent more than one week or if you get too far behind to catch up, you should consider reducing your workload by dropping one or more courses. (Note drop deadlines listed below). You may want to seek advice from the academic counsellor in your Department or the counsellors in the Undergraduate Services Office if you are in first year.

DOCUMENTATION

If you consulted an off-campus doctor or Student Health Services regarding your illness or personal problem, you must provide the doctor with a Student Medical Certificate to complete at the time of your visit and then bring it to the Department (or the Undergraduate Services Office if you are in first year). **This note must contain the following information: severity of illness, effect on academic studies and duration of absence.**

In Case of Serious Illness of a Family Member: Provide a Student Medical Certificate to your family member's physician to complete and bring it to the Department (or the Undergraduate Services Office if you are in first year).

In Case of a Death: Obtain a copy of the death certificate or the notice provided by the funeral director's office. You must include your relationship to the deceased and bring it to the Department (or the Undergraduate Services Office if you are in first year).

For Other Extenuating Circumstances: If you are not sure what documentation to provide, ask the Departmental Office (or the Undergraduate Services Office if you are in first year) for direction.

Note: Forged notes and certificates will be dealt with severely. To submit a forged document is a scholastic offence (see below).

ACADEMIC CONCERNS

You need to know if your instructors have a policy on late penalties, missed tests, etc. This information may be included on the course outlines. If not, ask your instructor(s).

You should also be aware of attendance requirements in some courses. You can be debarred from writing the final examination if your attendance is not satisfactory.

If you are in academic difficulty, check out the minimum requirements for progression in the calendar. If in doubt, see your academic counsellor.

Calendar References: Check these regulations in your 2016 Western Academic Calendar available at www.westerncalendar.uwo.ca.

[Absences Due to Illness](#) - page 117

[Academic Accommodations for Students with Disabilities](#) - page 118

[Academic Accommodations for Religious Holidays](#) - page 119

[Incomplete Standing](#) - page 104

[Scheduling of Term Assignments](#) – page 97

[Scholastic Offences](#) - page 113

[Special Examinations](#) - page 132

Note: These instructions apply to all students registered in the Faculty of Engineering regardless of whether the courses are offered by the Faculty of Engineering or other faculties in the University.

<u>Drop Deadlines:</u>	First term half course (i.e. "A" or "F"):	November 5, 2016
	Full courses and full-year half courses (i.e. "E", "Y" or no suffix):	November 30, 2016
	Second term half or second term full course (i.e. "B" or "G"):	March 7, 2017

Undergraduate Services Office:	SEB 2097	telephone: (519) 661-2130	fax: (519) 661-3757
Dept. of Chemical and Biochemical Engineering:	TEB 477	telephone: (519) 661-2131	fax: (519) 661-3498
Dept. of Civil and Environmental Engineering:	SEB 3005	telephone: (519) 661-2139	fax: (519) 661-3779
Dept. of Electrical and Computer Engineering, Software Engineering Mechatronics Engineering	TEB 279	telephone: (519) 661-3758	fax: (519) 850-2436
Dept. of Mechanical and Materials Engineering:	SEB 3002	telephone: (519) 661-4122	fax: (519) 661-3020