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

CEE 3343b – FINITE ELEMENT METHODS & APPL. - Course Outline 2019/20

This course introduces the basis of the finite element method and its application in solving engineering problems. It also covers different approximate methods for structural analysis, especially frame and shear walls structures under the effect of lateral loads. The objectives are for the student to be able to:

- Apply knowledge of mathematics to understand the basic concepts of the finite element method;
- Model, analyse, and solve engineering problems using the finite element method;
- Use finite element digital computer programs;
- Improve communication skills by documenting modelling assumptions and results of the analysis in coherent and legible analyses calculations;
- Recognize the need for life-long learning to keep abreast of new numerical analysis methods, and to enhance one’s abilities as an analyst.
- Understand and quantify the behaviour of buildings with lateral resisting system consisting of both shear wall and frame elements.
- Develop computer models to analyse buildings with various types of lateral resisting systems.
- Idealize bridges using three-dimensional computer modelling.

Calendar Copy:

This course starts by introducing the finite element method including equilibrium through the principle of minimum potential energy, assembly of stiffness matrices and the imposition of boundary conditions. This is followed by topics covering approximate analysis methods for; frames, shear walls, and coupled frame-shear wall buildings under lateral loads. Also, computer simulation and modelling of buildings and bridges are covered in this course. (0.5 Course)

Contact Hours:

3 lecture hours per week; 3 tutorial/laboratory hours per week; (recommended additional personal study 4 hours). Attendance at the tutorial session is mandatory. Some of the tutorials will be held in the PC computer lab. Attendance at the tutorial/laboratory session is mandatory

Prequisites: CEE2221b, CEE 3340A/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. Ayman El Ansary, P. Eng., SEB 3090, email: aelansa@uwo.ca. Administrative Support: Room 3005

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

Other References:
The above references will be put on reserve for a maximum of 2 hours borrowing in the Taylor Library.

Computing:
Most of the assignments will involve computer modeling of structures using the commercial program SAP2000. The full-version of the program is available at the PC lab in the Engineering building. Also, the students are encouraged to install the SAP2000 on their own computers through “Western Engineering Web Store” – Link: https://www.eng.uwo.ca/itg/services/webstore/.

Units:
SI units will be used in lectures and examinations

Specific Learning Objectives:

Part I

1. Introduction to the Finite Element Method. At the end of this section, the student should be able to:
   a) Know the history of development and the engineering applications of the Finite Element Method;
   b) Identify the Basic Equations and various Boundary conditions applied in beam and uni-axial problems.

2. Finite Element Formulation and Application of Bar Elements. At the end of this section, the student should be able to:
   a) Recognize the displacement field and shape functions used in the formulation of a bar finite element.
   b) Derive the stiffness matrix as well as load vector due to various load conditions acting on a bar element.
   c) Perform a finite element analysis for a complete bar problem in order to evaluate displacements and stresses along the length of the bar.
   d) Judge on the accuracy of a specific bar element mesh used to solve a certain bar problem.

3. Finite element formulation and application of beam elements:
   a) Learn about the displacement field and shape functions used in the formulation of a beam element.
   b) Derive the stiffness matrix as well as load vector due to various load conditions acting on a beam element.
   c) Develop numerical models for beam and plane frame problems using Sap 2000.
Part II

1. **Lateral Systems for Tall Building Structures.** At the end of this section, the student should be able to:
   a) Recognize different types of structural system used to provide the lateral resistance of tall building structures.
   b) Identify the suitable system for various ranges of building heights.

2. **Approximate analysis for frame under lateral loads.** At the end of this section, the student should be able to:
   a) Evaluate the properties of an equivalent shear and bending beam models that can be used to estimate the deflection of the frame.
   b) Develop computer model for the lateral analysis of frame structures.

3. **Response of shear wall structures.** At the end of this section, the student should be able to:
   a) Idealise the structural response including torsion effect of unsymmetrical structures
   b) Apply equation of equilibrium to calculate the bending moment and shear forces for walls

4. **Behaviour of coupled shear wall elements.** At the end of this section, the student should able to:
   a) Understand the behaviour of shear walls connected by rigid lintel beams.
   b) Analyse coupled shear walls using the continuum approximate approach
   c) Develop computer model for the lateral analysis of coupled shear wall systems

5. **Behaviour of coupled frame-shear wall systems.** At the end of this section, the student should be able to:
   a) Understand the interaction behaviour between frame and shear wall subjected to lateral load
   b) Describe the benefit of combining frame and shear wall for tall buildings.
   c) Analyze coupled frame-shear wall structures using the continuum approximate approach.
   d) Develop computer model for the lateral analysis of coupled frame-shear wall systems

6. **Computer modelling of bridges.** At the end of this section, the student should be able to:
   a) Idealize different types of bridges for evaluation of internal forces using three-dimensional computer models.

Instructor may expand on material presented in the course as appropriate.

**General Learning Objectives**

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

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

**Evaluation:**
The final course mark will be determined as follows:

- Final examination 50%
- Assignments 20%
- Quizzes 20%
- Participation 10%

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 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.

(c) Should any of the quizzes 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/handbook/appeals/accommodation_religious.pdf](http://www.uwo.ca/univsec/handbook/appeals/accommodation_religious.pdf))

1. **Quizzes and Examinations:**

Two, 60 minutes, quizzes will be scheduled during tutorial periods, on **Tuesdays February 11th and March 24th, 2020**. A three-hour final examination will take place during the April 2020 final examination period. The quizzes and the final examination are OPEN BOOK.

2. **Weekly Assignments**

Assignments: Solution to Part A of each assignment must be turned in by each student by the end of tutorial period. Each student must turn the solution to Part B of the assignment at **2:00 pm on Friday** of the same week of the tutorial in **locker # 65** – Spencer Engineering Building. Late assignments will be accepted till 8:30 am on Monday of the next tutorial and have to be submitted directly to the instructor. Late assignments will be marked out of 70% of the total mark. Extensions are to be negotiated with the course instructor, not the teaching assistants.

3. **In-class Participation (iClicker Cloud):**

We will be using iClicker Cloud, a cloud-based student response software, in class this semester. This will help me understand what you know, give everyone a chance to participate in class, and provide more interaction on concepts and example questions. We will also use this software to keep track of attendance. At the start of every class you will register your attendance; only after you do this will you be able to answer any poll questions posted.

You are required to bring a device connected to the university Wi-Fi to participate in iClicker Cloud during class, including a smartphone, tablet, laptop or iClicker remote. You will need to create an iClicker Reef Student account to participate in class.

Creating Your iClicker Reef Student Account: Go to iclicker.com/students or download the iClicker Reef Student app for your Apple or Android device to sign up for a Reef account. You should use your university email address and your University ID (e.g., “aelansa” for student aelansa@uwo.ca) in the Student ID field. You can edit your email address, password, or student ID from your account profile. Do not create and use more than one Reef account as you will only receive credit from a single account.

You do not need to purchase anything – iClicker Cloud is fully supported by Western and is free to all its students. Make sure you choose Western University Ontario when signing up.

Add This Course to Your Reef Account Search with the following information to find this course and add it to your Reef account:

**Institution:** Western University Ontario  
**Course:** CEE 3343 FEM and Analysis of Buildings under lateral loads
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:

University policy states that plagiarism, defined as the “act or an instance of copying or stealing another’s words or ideas and attributing them as one’s own.” (excerpted from Black’s Law Dictionary, West Group, 1999, 7th ed., p. 1170) is a scholastic offence. In submitting any written work as part of the coursework requirements for this course students must ensure that this work is written in their own words. A student who is found guilty of plagiarism in respect of any written work submitted as part of the coursework requirements for this course will be given a grade of zero for the submitted work. Repeated acts of plagiarism, either in this course or any other course subsequent to a first offence, will result in the student being given a failing grade for the course in which the subsequent offence occurs, and may also incur further penalties such as requiring the student to withdraw from the program in which they are enrolled in.

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

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 x 82147 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/board/code.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/handbook/appeals/accommodation_medical.pdf

Notice:
Students are responsible for regularly checking their email, course website (https://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 Science = 100%

The document “INSTRUCTIONS FOR STUDENTS UNABLE TO WRITE TESTS OR EXAMINATIONS OR SUBMIT ASSIGNMENTS AS SCHEDULED” is part of this course outline.
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 relief will not be granted automatically on request. You must demonstrate to your department (or the Undergraduate Services Office) that there are compelling medical or compassionate grounds that can be documented before academic relief will be considered. Different regulations apply to term tests, final examinations and late assignments. Please read the instructions carefully.

NEW: Requests for Academic Consideration using the Self-Reported Absence Form

If you experience an unexpected illness or injury or an extenuating circumstance (48 hours or less) that is sufficiently severe to temporarily render you unable to meet academic requirements (e.g., attending lectures or labs, writing tests or midterm exams, completing and submitting assignments, participating in presentations) you should self-declare using the online Self-Reported Absence portal. This option should be used in situations where you expect to resume academic responsibilities within 48 hours or less.

Each student will be allowed a maximum of two self-reported absences between September and April and one self-reported absence between May and August. Self-reporting may not be used for final exams or assessments (e.g. midterm exams, tests, reports, presentations, or essays) worth more than 30% of any given course.

For full instructions about the Self-Reporting System refer to the Academic Calendar link here.

A. GENERAL REGULATIONS & PROCEDURES (other than self-reported absences)

1. All first year students will report to the Undergraduate Services Office, SEB 2097, for all instances.

2. If you are an upper year student and you are missing a test/assignment/lab or examination that is worth LESS THAN 10% of your mark, you should report to your department office to request relief. If your course work is worth MORE THAN 10% of your final grade, you will report to the Undergraduate Services Office, SEB 2097.

3. Check the course outline to see if the instructor has a policy for missed tests, examinations, late assignments or attendance.

4. Documentation must be provided as soon as possible. If no one is available in your department office or the Undergraduate Services Office, leave a message clearly stating your name & student number and reason for your call. The department telephone numbers are given at the end of these instructions.

5. 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 examination reweighted on a retroactive basis is not permitted.

B. TERM/MIDTERM TESTS (other than self-reported absences)

1. If you are in first year and you are unable to write a midterm/term test, contact the Undergraduate Services Office, SEB 2097 PRIOR to the scheduled date of the test.

2. If you are an upper year student and you are unable to write a midterm/term test, inform your instructor PRIOR to the scheduled date of the test. If the instructor is not available, leave a message for him/her at the department office. If the test is worth LESS THAN 10% of your mark, you should report to your department office to request relief. If the test is worth MORE THAN 10% of your final grade you will report to the Undergraduate Services Office, SEB 2097 to request relief.

3. Be prepared to provide supporting documentation to the Department Chair and/or the Undergraduate Services Office (see next page for information on documentation).

4. Discuss with the instructor if and when the test can be rescheduled. N.B. The approval of the Chair or the Undergraduate Services Office is required when rescheduling midterm/term tests.
C. **FINAL EXAMINATIONS (cannot be self-reported)**

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.

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, headache, 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.

**PLEASE NOTE:** 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 Assistant Dean, First Year Studies, 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, Undergraduate Studies. 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, Undergraduate Studies.

E. **SHORT ABSENCES**

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

F. **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 are strongly encouraged to seek advice from your Academic Counsellor in the Undergraduate Services Office.

G. **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). **This note must contain the following information: severity of illness, effect on academic studies and duration of absence. Regular doctor’s notes will not be accepted; only the Student Medical Certificate will be accepted.**

**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).
H. **ACADEMIC CONCERNS**

1. 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).

2. **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.**

3. 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 2019 Western Academic Calendar available at [www.westerncalendar.uwo.ca](http://www.westerncalendar.uwo.ca).

- Self-Reporting Absences
- Absences Due to Illness
- Academic Accommodations for Students with Disabilities
- Academic Accommodations for Religious or Holy Days
- Course Withdrawals
- Examinations
- Scheduling of Term Assignments
- Scholastic Offences
- Student Medical Certificate
- Engineering Academic Regulations

**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.

---

**Add Deadlines:**
- First term half course (i.e. “A” or “F”) September 13, 2019
- Full courses and full-year half course (i.e. “E”, “Y” or no suffix) September 13, 2019
- Second term half course (i.e. “B” or “G”) January 14, 2020

**Drop Deadlines:**
- First term half course (i.e. “A” or “F”) November 12, 2019
- Full courses and full-year half courses (i.e. “E”, “Y” or no suffix) November 30, 2019
- Second term half or second term full course (i.e. “B” or “G”) March 7, 2020

**Contact Information:**

- Undergraduate Services Office: SEB 2097 Phone: 519-661-2130 E-mail: engugrad@uwo.ca
- Chemical & Green Process Engineering: TEB 477 Phone: 519-661-2131 E-mail: cbeugrad@uwo.ca
- Civil Engineering: SEB 3005 Phone: 519-661-2139 E-mail: civil@uwo.ca
- Computer, Electrical, Mechatronic Systems & Software Engineering TEB 279 Phone: 519-661-3758 E-mail: eceugrad@uwo.ca
- Integrated Engineering ACEB 2410 Phone: 519-661-6725 E-mail: engceli@uwo.ca
- Mechanical Engineering: SEB 3002 Phone: 519-661-4122 E-mail: mmeundergraduate@uwo.ca

Revised 08/01/19