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

CEE 3343b – FINITE ELEMENT METHODS & APPL. - Course Outline 2025/26

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 necessity of lifelong learning to remain current with advances in numerical analysis and to continuously develop and enhance analytical proficiency.
- 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.
- Develop simplified three-dimensional models to idealize bridge structures.

Calendar Copy:

This course introduces the finite element method, including equilibrium based on the principle of minimum potential energy, assembly of stiffness matrices, and the application of boundary conditions. The course then examines approximate analysis methods for frames, shear walls, and coupled frame–shear wall buildings subjected to lateral loads. Computer-based structural analysis is also covered, including two-dimensional (2-D) frame analysis and three-dimensional (3-D) modelling of bridge structures. (0.5 course)

Prerequisites:
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.

Contact Hours:

3 lecture hours per week; 3 tutorial/laboratory hours per week. Attendance at the tutorial session is mandatory. Some of the tutorials will be held in the computer labs.

Note: Review of lecture material and self-study should take approximately 6 hours per week.

Instructor:

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████████████████████

Contact policy:
- • Contact the course instructor via email (above)
- • Weekly Office hours are held in-person.

Course Material:

Prepared class notes will be made available through the course website on OWL at http://owl.uwo.ca/, along with other useful reference material and data for assignments.

Lecture notes and any posted demonstration videos are copyrighted to the instructor and legally protected. Do not post these videos and lecture notes on any other website or online forums. Recording of the live/synchronous lectures of the course without permission from the course instructor is prohibited. The illegal posting and sharing of the copyrighted course content could be subjected to legal action.

Other References:

Introduction to Finite elements in Engineering, T.R. Chandruptla and a.D. Beleguner, 2nd Ed., Prentice Hall., NJ, 1992.
Stafford Smith, B. and Coull A. (1991) Tall building structures: analysis and design, New York; Toronto: Wiley Inter Science.

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

Computing:

Several assignments will involve computer modelling of structures using the commercial program SAP2000. The full version of the programs is available at the PC lab in the Engineering building. Also, the students are encouraged to access the SAP2000 on their own computers using their Western Credentials through "AppsAnywhere" – Link: https://webstore.eng.uwo.ca/.

Please contact the ITG helpdesk for any support issues. The ITG helpdesk can be reached Monday – Friday 8:30am – 4:30pm Eastern Standard Time by emailing enghelp@uwo.ca

Note: To avoid any issues running SAP2000 on your computer, it is highly recommended to have a windows-based operating system that is compatible with the commercial software SAP2000.

Units:

SI units will be used in lectures and examinations.

Specific Learning Objectives: [GA Indicator]

Part I

1. Introduction to the Finite Element Method: [KB1] 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. Potential Energy and Approximate Analysis: [KB1, **KB2**] At the end of this section, the student should be able to:
    a) Learn about the minimum total potential energy principle and how it can be applied in solving linear systems.
    b) Recognize the basic expressions for elastic strain energy and work done by external forces.

3. Finite Element Formulation and Application of Bar Elements: [KB1, PA2] 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.

4. Finite element formulation and application of beam elements: [**KB1,** PA2] At the end of this section, the student should be able to:
    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: [KB4] 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: [PA2] 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: [PA2] 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: [**PA2**] 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. <u>Behaviour of coupled frame-shear wall systems</u>: [PA2] 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) Analyse 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. <u>Computer modelling of bridges</u>: [ET3] 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*)

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

Evaluation:

The final course mark will be determined as follows:

Assignments	15%
Participation	5%
Quiz 1	20%
Quiz 2	20%
Final Exam	40%

Total	100%

<u>Note</u>:   **(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)

1. Weekly Assignments:

A three-hour tutorial session will be held each week during the scheduled tutorial period. The platform "gradescope.ca" will be used for assignment submission throughout the course. Each assignment will consist of two parts. **Part A** must be submitted individually by each student by the end of the tutorial session. **Part B** must be submitted individually by **4:00 p.m. on Friday** of the same week as the tutorial.

Late assignments will be accepted until **9:30 am on Monday** of the next tutorial and have to be submitted directly to the course 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.

2. Quizzes and Examinations:
Two, 90 minutes, quizzes will be scheduled during tutorial periods, as follows:
Quiz 1 will be held on ▮▮▮▮▮▮▮▮▮▮▮▮▮▮▮▮▮▮▮▮▮▮▮▮▮▮▮.

A three-hour final examination will take place during the April 2026 final examination period. All quizzes and the final examination are limited OPEN BOOK, only lecture notes and student's marked assignment are allowed. Only non-programmable calculators are allowed in the exam. Laptops, iPads, and/or tablets are not permitted in the exam.

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 Applications**

This activity is worth **5% of the overall course grade**.

Activities in which collaboration is permitted:
- *In-class Participation using iClicker Cloud*
- *Tutorial Assignments* **– Part (A).**
- Homework Assignments - **Part (B)**

Activities in which students must work alone (collaboration is not permitted):
- Quizzes
- Final Exam

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

http://www.westerncalendar.uwo.ca/PolicyPages.cfm?Command=showCategory&PolicyCategoryID=1&SelectedCalendar=Live&ArchiveID=#Page_16

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:

http://www.westerncalendar.uwo.ca/PolicyPages.cfm?Command=showCategory&PolicyCategoryID=1&SelectedCalendar=Live&ArchiveID=#Page_10

Sickness and Other Problems:
If you are unable to meet a course requirement due to illness or other serious circumstances, please follow the procedures below.

Assessments worth less than 10% of the overall course grade:

In Class Participation (iClicker):
Any missed participation activity/class attendance will receive no credit (zero grade.) Students with an approved academic consideration from the Dean's Office Academic Counselling unit (undergraduate services office), their missed in-class participation activities will be weighted according to the average grade calculated based on the student's overall participation in the course.

Assignments:
For a student with an approved academic consideration from the Dean's Office Academic Counselling unit (undergraduate services office), if Part A of any of the in-tutorial assignments is missed, the missed assignment grade will be weighted according to the average grade of all submitted assignments. if Part B of any of the in-tutorial assignments is missed, the student will be provided with an extension to work on this assignment as a take-home. The duration of this extension will be decided according to the conditions specified in the approved academic consideration.

Assessments worth 10% or more of the overall course grade:

For work totaling 10% or more of the final course grade (**quizzes and final exam**), you must provide valid medical or supporting documentation to the Academic Counselling Office of your Faculty of Registration as soon as possible.

Quizzes:
For a student with an approved academic consideration from the Dean's Office Academic Counselling unit (undergraduate services office), there is no make-up for a missed quiz. However, the accommodation for a missed quiz will be having the quiz grade reweighted to the April Final Examination.

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

Notice:
Students are responsible for regularly checking their email, course website (https://owl.uwo.ca).

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, has not engaged sufficiently in 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.

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 consultations can be arranged by appointment with the appropriate instructor.

Important Contacts:

Engineering Undergraduate Services	SEB 2097	engugrad@uwo.ca
Civil & Environmental Engineering	SEB 3005	civil@uwo.ca
Office of the Registrar/Student Central	WSSB 1120	

Important Links:

Western Academic Calendar
Undergraduate Academic Policies

Course breakdown:
Engineering Science = 100%

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