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 including two-dimensional (2-D) frame analysis and three-dimensional (3-D) modelling of bridges are covered in this course. (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;

Lectures will be delivered asynchronously through pre-recorded videos posted to course OWL site. Lecture videos will be organized in 20-30 mins parts which students should review on a weekly basis. The scheduled lecture time will be used as a help session “Flipped classroom approach” where students are strongly encouraged to attend to ask questions, engage in discussing concepts related to the posted lecture material. Attending lectures is not mandatory but students seeking assistance are encouraged to join live lectures. Live sessions will not be recorded.
3 tutorial/computer laboratory hours per week;
A 3-hour tutorial session (Part (A) of assignments) scheduled every week as per the course timetable will be delivered synchronously. Students can download the assignments through the course site on OWL under the “Assignments” tool that can be found in the left menu bar. A zoom meeting session will be held during each tutorial time for students seeking assistance while working on part A of the assignment. The link to the zoom meeting will be posted on a weekly basis to the course OWL. During the tutorial time, the course Teaching Assistants (TAs) will provide live sessions to teach/demonstrate solved examples and training modules for the software required in this course. Attending the zoom meeting during the 3-hour tutorial session is mandatory.

A take-home assignment (Part (B) of assignments) will be delivered asynchronously every week through the course site on OWL under the “Assignments” tool. Course Teaching Assistants (TAs) will hold weekly zoom meetings for students seeking help with Part (B) of the assignment. The link to the zoom meeting and date/time of these help sessions will be posted weekly on course OWL.

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

Instructor:
Dr. Ayman El Ansary, P. Eng., SEB 3090, email: aelansa@uwo.ca. Administrative Support: Room 3005

Contact policy:
• Contact instructor via email (above)
• Weekly Office hours are held via Zoom
• A general FAQ section on the ‘forums’ section of OWL will be used for students to post course-related questions so that all have the same information.

Textbook:
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.

Other References:
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 V19. The full version of the programs is available at the PC lab in the Engineering building. Remote access to the computer lab and the software license servers will be provided. Instructions on how to remotely access the software license will be posted on the course OWL site. Also, students can install SAP2000 locally on their computer devices using their Western Credentials through “Western Engineering Web Store” – Link: https://webstore.eng.uwo.ca/. This approach requires remote access to Western network since running the software locally have dependencies on accessing the license servers remotely.
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 which 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: 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 be 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:** [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. **Computer modelling of bridges:** [PA2] 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**

<table>
<thead>
<tr>
<th>Knowledge Base</th>
<th>E</th>
<th>Engineering Tools</th>
<th>I</th>
<th>Impact on Society</th>
<th>-</th>
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</thead>
<tbody>
<tr>
<td>Problem Analysis</td>
<td>E</td>
<td>Teamwork</td>
<td>T</td>
<td>Ethics and Equity</td>
<td>-</td>
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<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>
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**Evaluation:**

The final course mark will be determined as follows:

<table>
<thead>
<tr>
<th>Component</th>
<th>Percentage</th>
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<tbody>
<tr>
<td>Final examination</td>
<td>50%</td>
</tr>
<tr>
<td>Assignments</td>
<td>20%</td>
</tr>
<tr>
<td>Quizzes</td>
<td>20%</td>
</tr>
<tr>
<td>Participation</td>
<td>10%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>100%</strong></td>
</tr>
</tbody>
</table>

**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. Weekly Assignments:

Solution to Part A of the assignment should be uploaded by the end of each tutorial as a single PDF file to course site on OWL through the “GradeScope” tool that can be found in the left menu bar. Instructions on how to prepare the PDF file and how to upload the assignment to GradeScope will be provided on the course site on OWL at the beginning of the term.

Each student must submit the solution to Part B of the assignment at 4:00 pm on Friday of the same week of the tutorial. Part (B) of the assignment should be uploaded as a single PDF file to course site on OWL under “GradeScope” tool.

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.

2. Quizzes and Examinations:

Two, 60 minutes, quizzes will be scheduled during tutorial periods, on Tuesdays February 23rd and March 16th, 2021. These dates are tentative and are subject to change. Please check Course calendar on OWL for weekly activities and important deadlines.

A three-hour final examination will take place during the April 2021 final examination period. The quizzes and the final examination are “remote proctored/open book”. Please check the next page for the “online proctoring” policy.

Quizzes/Final examination follow-up policy:

Some fraction of students may be selected for a follow-up virtual meeting while having their webcam on. The students chosen for this meeting may be assigned randomly. The students chosen may also be those whose answers raise any suspicion that they are not the authentic and unique responses of that individual. During the virtual meeting it is expected that: i) students should be prepared to answer quiz/final exam related questions. ii) students should be ready to attempt solving any course related problems according to instructor’s discretion.

Should an instructor decide to initiate follow-up discussion, all selected students will be informed within one week after the quiz/final exam. If a student is selected for a follow-up discussion, that discussion will constitute a mandatory component of the quiz/final exam and the instructor may change the quiz/exam mark based on the outcome of the discussion.

Note: Emails requesting a follow-up virtual meeting will be sent to the selected students only once. It is the students’ responsibility to check Western email daily for at least one week after the quiz/final exam date. A student who ignores the course instructor’s call for a meeting or doesn’t show up for a follow-up discussion will be considered as a cheating case.

3. Participation (“Forums” tool on OWL):

Weekly forums will be posted on the course site on OWL. Each week students will be expected to interact with the course content and with each other by posting questions/responding to existing questions on OWL. Minimum expectation regarding this participation activity is at least one posting per week.

This activity is worth 10% of the overall course grade.
Activities in which collaboration is permitted:

- Participation (asynchronous) using course OWL site “Forums”: Students are strongly encouraged to post questions/respond to posted questions on a weekly basis. Group discussion using “Forums” regarding course material and topics covered in lectures is permitted.
- Tutorial Assignments – Part (A).

Activities in which students must work alone (collaboration is not permitted):

- Homework Assignments - Part (B)
- Quizzes
- Final Exam

Online Proctoring Notice:

All quizzes and the final examination in this course will be a “remote proctored/open book” exam, conducted using Zoom. You will be required to keep your camera on for the entire quiz/exam session. The camera should show your workspace including: your tabletop, material allowed to use on the exam, and your sitting area. Hold up your student card for identification purposes and share your screen with the invigilator if asked to do so at any time during the exam. The exam session will not be recorded.*

More information about the use of Zoom for exam invigilation is available in the Online Proctoring Guidelines at the following link: [https://www.uwo.ca/univsec/pdf/onlineproctorguidelines.pdf](https://www.uwo.ca/univsec/pdf/onlineproctorguidelines.pdf).

Completion of this course will require you to have a reliable internet connection and a device that meets the system requirements for Zoom. Information about the system requirements are available at the following link: [https://support.zoom.us/hc/en-us](https://support.zoom.us/hc/en-us).

* Please note that Zoom servers are located outside Canada. If you would prefer to use only your first name or a nickname to login to Zoom, please discuss this with your instructor in advance of the test or examination.

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.

Course content

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

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.

**Accommodation:**
Students with disabilities work with Accessible Education (formerly SSD) which provides recommendations for accommodation based on medical documentation or psychological and cognitive testing. The accommodation policy can be found here: Academic Accommodation for Students with Disabilities.

**Academic Consideration for Student Absence**
Students will have up to two (2) opportunities during the regular academic year to use an on-line portal to self-report an absence during the term, provided the following conditions are met: the absence is no more than 48 hours in duration, and the assessment for which consideration is being sought is worth 30% or less of the student’s final grade. Students are expected to contact their instructors within 24 hours of the end of the period of the self-reported absence, unless noted on the syllabus. Students are not able to use the self-reporting option in the following circumstances:

- for exams scheduled by the Office of the Registrar (e.g., December and April exams)
- absence of a duration greater than 48 hours,
- assessments worth more than 30% of the student’s final grade,
- if a student has already used the self-reporting portal twice during the academic year

If the conditions for a Self-Reported Absence are not met, students will need to provide a Student Medical Certificate if the absence is medical, or provide appropriate documentation if there are compassionate grounds for the absence in question. Students are encouraged to contact their Faculty academic counselling office to obtain more information about the relevant documentation.

Students should also note that individual instructors are not permitted to receive documentation directly from a student, whether in support of an application for consideration on medical grounds, or for other reasons. All documentation required for absences that are not covered by the Self-Reported Absence Policy must be submitted to the Academic Counselling office of a student's Home Faculty.
For Western University policy on Consideration for Student Absence, see Policy on Academic Consideration for Student Absences - Undergraduate Students in First Entry Programs and for the Student Medical Certificate (SMC), see:  
Religious Accommodation
Students should consult the University's list of recognized religious holidays, and should give reasonable notice in writing, prior to the holiday, to the Instructor and an Academic Counsellor if their course requirements will be affected by a religious observance. Additional information is given in the Western Multicultural Calendar.

Use of Recordings:
All of the remote learning sessions for this course will be recorded. The data captured during these recordings may include your image, voice recordings, chat logs and personal identifiers (name displayed on the screen). The recordings will be used for educational purposes related to this course, including evaluations. The recordings may be disclosed to other individuals under special circumstances. Please contact the instructor if you have any concerns related to session recordings. Participants in this course are not permitted to record the sessions, except where recording is an approved accommodation, or the participant has the prior written permission of the instructor.

Conduct:
Some components of this course will involve online interactions. To ensure the best experience for both you and your classmates, please honour the following rules of etiquette:

- please “arrive” to class on time
- please use your computer and/or laptop if possible (as opposed to a cell phone or tablet)
- ensure that you are in a private location to protect the confidentiality of discussions in the event that a class discussion deals with sensitive or personal material
- to minimize background noise, kindly mute your microphone for the entire class until you are invited to speak, unless directed otherwise
- [suggested for classes larger than 30 students] In order to give us optimum bandwidth and web quality, please turn off your video camera for the entire class unless you are invited to speak
- [suggested for cases where video is used] please be prepared to turn your video camera off at the instructor’s request if the internet connection becomes unstable
- unless invited by your instructor, do not share your screen in the meeting

The course instructor will act as moderator for the class and will deal with any questions from participants. To participate please consider the following:

- if you wish to speak, use the “raise hand” function and wait for the instructor to acknowledge you before beginning your comment or question
- remember to unmute your microphone and turn on your video camera before speaking
- self-identify when speaking.
- remember to mute your mic and turn off your video camera after speaking (unless directed otherwise)

General considerations of “netiquette”:

- Keep in mind the different cultural and linguistic backgrounds of the students in the course.
- Be courteous toward the instructor, your colleagues, and authors whose work you are discussing.
• Be respectful of the diversity of viewpoints that you will encounter in the class and in your readings. The exchange of diverse ideas and opinions is part of the scholarly environment. “Flaming” is never appropriate.
• Be professional and scholarly in all online postings. Cite the ideas of others appropriately.

Note that disruptive behaviour of any type during online classes, including inappropriate use of the chat function, is unacceptable. Students found guilty of Zoom-bombing a class or of other serious online offenses may be subject to disciplinary measures under the Code of Student Conduct.

Notice:

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

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.