

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

**CEE 9512a – Finite Element Method (Theory and Applications)**  
**Course Outline – Fall 2017**

**Objectives:**

This course is designed to achieve the following objectives:

- Apprise the students about the basic theory of finite element method in linear analysis.
- Understand modelling aspects and techniques for 1-D, 2-D and 3-D problems.
- Learn about modelling of simple and complex structural systems, develop their mathematical and computational models and analyze the results.
- Learn how to model structures using professional programs like Sap2000 and ETABS.

**Topics:**

1. Introduction to the finite element method (FEM):  
What is FEM - Applications of FEM - Basic types of elements – Degrees of freedom - principle of minimum potential energy and approximate analysis.
2. Finite element formulation and application of bar elements:
  - a) Learn about the displacement field and shape functions used in the formulation of a bar element.
  - b) Derive the stiffness matrix as well as load vector due to various load conditions acting on a bar element.
  - c) Develop numerical models for bar problems and plane trusses using Sap2000.
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.
4. Introduction to theory of elasticity:  
This section will enable the student to understand the basic equilibrium and kinematic equations, the constitutive relations as well as the potential energy expression for 2-D plane stress and plane strain elasticity problems.
5. Introduction to various types of 2-D elements:  
Recognize various types of elements used to solve 2-D plane problems. Develop numerical models to solve plane stress and plan strain problems using Sap2000.
6. Introduction to 3-D modelling using Sap2000:  
Use the commercial program Sap2000 to develop a three-dimensional computer model to idealize a cable-stayed bridge for the evaluation of internal forces.
7. Introduction to 3-D modelling using ETABS:  
Use the program ETABS to develop three-dimensional computer models to idealize high-rise buildings under different types of loading.

**Prerequisite:**

Bachelor degree in Structural Engineering.

**Corequisite:**

None

**Antirequisite:**

None

**Instructor:**

Dr. Ayman El Ansary, P.Eng., SEB 3090, email: [aelansa@uwo.ca](mailto:aelansa@uwo.ca)

*Administrative Support:* SEB 3005

**Contact Hours:**

3 hours lecture per week – Fridays 9:30 am – 12:30 pm, Room KB 106  
(personal study – 9 hours per week).

**Course Materials:**

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:**

- 1) *A First Course in the Finite Element Method*, D.L. Logan, 2nd Ed., PWS Kent Publ. Co., Boston, 1992.
- 2) *Introduction to Finite elements in Engineering*, T.R. Chandrupatla and a.D. Beleguner, 2nd Ed., Prentice Hall., NJ, 1992.

**Computing:**

Several assignments will involve computer modelling of structures using the commercial programs SAP2000 V19 and ETABS V16. The full-version of the programs is available at the PC lab in the Engineering building.

**Units:**

SI units will be used in lectures and examinations

**Evaluation:**

The final course mark will be determined as follows:

Assignments:	50%
Project I (Sap2000 3D Modelling of Bridges):	20%
Final Project II (ETABS 3D Modelling of Buildings):	30%
	-----
Total	100%

**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.

**Scholastic Offences:**

Scholastic offences are taken seriously and students are directed to read the appropriate policy, specifically, the definition of what constitutes a Scholastic Offence, at the following Web site:

[http://www.uwo.ca/univsec/handbook/appeals/scholastic\\_discipline\\_grad.pdf](http://www.uwo.ca/univsec/handbook/appeals/scholastic_discipline_grad.pdf).

**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. Whenever students take an idea or a passage of text from another author, they must acknowledge their debt both by using quotation marks where appropriate and by proper referencing such as footnotes or citations.

All required papers may be subject to submission for textual similarity review to the commercial plagiarism-detection software under license to the University for the detection of plagiarism. All papers submitted for such checking will be included as source documents in the reference database for the purpose of detecting plagiarism of papers subsequently submitted to the system. Use of the service is subject to the licensing agreement, currently between Western University and Turnitin.com (<http://www.turnitin.com>).

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.

**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 questions regarding 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](http://www.uwo.ca/univsec/handbook/appeals/accommodation_medical.pdf).

**Notice:**

Students are responsible for regularly checking their email, and the course OWL site for new notices related to the course.

As part of a successful graduate student experience at Western, we encourage students to make their health and wellness a priority. Western provides several on campus health-related services to help you achieve optimum health and engage in healthy living while pursuing your graduate degree. For example, to support physical activity, all students, as part of their registration, receive membership in Western's Campus Recreation Centre. Numerous cultural events are offered throughout the year. Please check out the Faculty of Music web page <http://www.music.uwo.ca/>, and our own McIntosh Gallery <http://www.mcintoshgallery.ca/>. Information regarding health- and wellness-related services available to students may be found at <http://www.health.uwo.ca/>

Students seeking help regarding mental health concerns are advised to speak to someone they feel comfortable confiding in, such as their faculty supervisor, their program director (graduate chair), or other relevant administrators in their unit. Campus mental health resources may be found at [http://www.health.uwo.ca/mental\\_health/resources.html](http://www.health.uwo.ca/mental_health/resources.html)

To help you learn more about mental health, Western has developed an interactive mental health learning module, found here: [http://www.health.uwo.ca/mental\\_health/module.html](http://www.health.uwo.ca/mental_health/module.html). This module is 30 minutes in length and provides participants with a basic understanding of mental health issues and of available campus and community resources. Topics include stress, anxiety, depression, suicide and eating disorders. After successful completion of the module, participants receive a certificate confirming their participation.