

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

CEE 9512a – Finite Element Method (Theory and Applications)
Course Outline – Fall 2018

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 SAP2000.
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 plane 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

Administrative Support: SEB 3005

Contact Hours:

3 hours lecture per week – Fridays 9:30 am – 12:30 pm, 3C+ – 1410
(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:	25%
Project I	15%
Final Project II	30%
Final Exam	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.

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.

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

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. 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.

Course Outlines

COURSE OUTLINES (SYLLABI) FOR UNDERGRADUATE COURSES

No later than the first day of class in the term a course is given, Faculties, Departments, Schools or Programs (hereafter called "Academic Units") must post on the appropriate Web site a course outline for each course offered. With the exception of courses taught by Distance Studies (WebCT), this outline also must be available electronically and/or in hard copy form at the first meeting of the course.

In order to allow students to make informed decisions on their course selection and the scheduling of their studies, each course outline must include the following information or direct students to an appropriate course Web site where these details are available:

1. **Course Information**

This includes the course name and number, and the location and days and hours that the course is scheduled (including lecture, laboratory and tutorial hours).

A) **Prerequisite checking - the student's responsibility**

If applicable, a list of the prerequisites for the course and the following notation regarding the Senate regulation with respect to the student's responsibility for ensuring that course prerequisites have been completed successfully or special permission from the Dean obtained:

"Unless you have either the requisites for this course or written special permission from your Dean to enroll in it, you may be removed from this course and it will be deleted from your record. This decision may not be appealed. You will receive no adjustment to your fees in the event that you are dropped from a course for failing to have the necessary prerequisites."

2. **Instructor Information**

Full name, title and appropriate contact information of the instructor and, if the course is taught by more than one instructor, the name of the person responsible for the course [course coordinator].

3. **Course Syllabus**

A description of the objectives and content of the course, which shall include a statement of what is expected of the student by way of preparation, tests, exercises, essays, laboratory reports, etc. (hereafter called "assignments"), and any specific requirements for attendance and participation.

4. **Course Materials**

A description of the materials that are required (or recommended) for the course, including text books, supplemental information, notes, manuals, laboratory or safety materials, and any specific electronic devices.

5. **Methods of Evaluation**

A statement of the methods by which student performance will be evaluated and the weight of each, including an exact timetable and schedule of assignments, is required. When exact dates cannot be supplied, a tentative schedule must be issued, with an exact schedule to follow as soon as possible. This regulation does not preclude the administration of surprise assignments and quizzes, as long as the total number, approximate frequency, and value of such assignments are specified in the course outline.

Any course-specific conditions that are required to pass the course must be outlined. Conditions might include (i) minimum attendance at lectures, tutorials or laboratories, (ii) minimum overall grade on laboratory, tutorial or essay components of the methods of evaluation, or (iii) minimum required grades on a final exam, to name a few.

A clear indication of how non-medical absences from midterms, tutorials, laboratory experiments, or late essays or assignments, will be dealt with must be provided. The course outline must direct the student to the Policy on Accommodation for Medical Illness (<https://studentservices.uwo.ca/secure/index.cfm>). In addition, as indicated in the policy, instructors must state how they will be dealing with accommodation for medical illness of work worth less than 10% of the total course grade, and whether or not medical documentation for such accommodation will be required. If documentation is required for either medical or non-medical academic accommodation, then such documentation must be submitted by the student directly to the appropriate Faculty Dean's office and not to the instructor. It will be the Dean's office that will determine if accommodation is warranted.

Course instructors who wish to change the evaluation procedure shown in the course outline must receive prior approval to do so from the dean of the faculty concerned.

6. **Additional Statements**

Statement on Use of Electronic Devices

A clear statement of what electronic devices will or will not be allowed during tests and examinations.

Statement on Use of Personal Response Systems ("Clickers")

If Personal Response Systems ("Clickers") are used in the course, a reference to the Guidelines for their use (*Guidelines are shown below*). Instructors are to communicate clearly to students information on how clickers are used including: how the student's privacy will be protected, how clickers may be used by the instructor for data gathering and for evaluating the student, and why they cannot be used by anyone but the student (since the students involved in misuse of a clicker may be charged with a scholastic offence).

Statement on Academic Offences

The statement: "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/pdf/academic_policies/appeals/scholastic_discipline_undergrad.pdf."

Additionally,

- A) If written work will be assigned in the course and plagiarism-checking software might be used, the following statement to this effect must be included in the course outline:

"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 The University of Western Ontario and Turnitin.com (<http://www.turnitin.com>)."

- B) If computer-marked multiple-choice tests and/or exams will be given, and software might be used to check for unusual coincidences in answer patterns that may indicate cheating, the following statement must be added to course outlines:

"Computer-marked multiple-choice tests and/or exams may be subject to submission for similarity review by software that will check for unusual coincidences in answer patterns that may indicate cheating."

Support Services

The Web sites for Registrarial Services (<http://www.registrar.uwo.ca>), and the same for affiliated university colleges when appropriate, and any appropriate Student Support Services (including the services provided by the USC listed here: <http://westernusc.ca/services/>) and the Student Development Services, should be provided for easy access.

All course outlines should contain the following statement: "Students who are in emotional/mental distress should refer to Mental Health@Western <http://www.uwo.ca/uwocom/mentalhealth/> for a complete list of options about how to obtain help."

Retention of Electronic Version of Course Outlines (Syllabi)

At the same time that course outlines/syllabi are posted on the appropriate Web site, each Department must forward an electronic version of items 1-5 of each course outline (syllabus) to the Office of the Dean of the Faculty or College. By the fourth week after the start of term, the Dean's Office will forward all of the collected outlines to Registrarial Services, where they will be maintained in electronic form in the faculty/staff extranet for a minimum of ten years after the completion of the course. (Final retention periods and disposition will be determined by the relevant records retention and disposition schedule approved by the President's Advisory Committee on University Records and Archives).

COURSE OUTLINES FOR GRADUATE COURSES

As soon as possible and in any case no later than two weeks prior to the course's start, Faculties, Departments, Schools or Programs (hereafter called "Academic Units") must post on the appropriate Web site a course outline for each course offered. At the start of each course this outline also must be available electronically and/or in hard copy form.

In order to allow students to make informed decisions on their course selection and the scheduling of their studies, each course outline must include the following information or direct students to an appropriate course Web site where these details are available:

1. Course Information

This includes the course name and number, and the location and days and hours that the course is scheduled (including all required components of the class: lectures, seminars, colloquia, labs, etc).

2. Instructor Information

Full name, title and appropriate contact information of the instructor and, if the course is taught by more than one instructor, the name of the person responsible for the course [course coordinator].

3. Course Description

A description of the objectives and content of the course, which shall include a statement of what is expected of the student by way of preparation, tests, exercises, essays, laboratory reports, etc. (hereafter called "assignments"), and any specific requirements for attendance and participation.

4. Course Materials

A description of the materials that are required (or recommended) for the course, including textbooks, supplemental information, notes, manuals, laboratory or safety materials, and any specific electronic devices.

5. Methods of Evaluation

A statement of the methods by which student performance will be evaluated and the weight of each, including an exact timetable and schedule of assignments. When exact dates cannot be supplied, a tentative schedule must be issued with an exact schedule to follow as soon as possible. This regulation does not preclude the administration of surprise assignments and quizzes, as long as the total number, approximate frequency, and value of such assignments are specified in the course outline.

Any course-specific conditions that are required to pass the course must be outlined. For example, conditions might include (i) minimum attendance at lectures or laboratories, (ii) minimum overall grade on laboratory or essay components of the methods of evaluation, or (iii) minimum required grades on a final exam.

Course instructors who wish to change the evaluation procedure shown in the course outline must receive prior approval to do so from the graduate chair of the program concerned.

6. Statement on Academic Offences

The statement: "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/pdf/academic_policies/appeals/scholastic_discipline_grad.pdf

Additionally,

A) If written work will be assigned in the course and plagiarism-checking software might be used, the following statement to this effect must be included in the course outline:

"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 The University of Western Ontario and Turnitin.com (<http://www.turnitin.com>)."

B) If computer-marked multiple-choice tests and/or exams will be given, and software might be used to check for unusual coincidences in answer patterns that may indicate cheating, the following statement must be added to course outlines:

"Computer-marked multiple-choice tests and/or exams may be subject to submission for similarity review by software that will check for unusual coincidences in answer patterns that may indicate cheating."

Retention of Electronic Version of Course Outlines (Syllabi)

At the same time that course outlines/syllabi are posted on the appropriate Web site, each program must forward an electronic version of items 1-5 of each course outline to the School of Graduate and Postdoctoral Studies (SGPS). By the fourth week after the start of term, SGPS will forward all of the collected outlines to Registrarial Services, where they will be maintained in electronic form in the faculty/staff extranet for a minimum of ten years after the completion of the course. (Final retention periods and disposition will be determined by the relevant records retention and disposition schedule approved by the President's Advisory Committee.)

GUIDELINES FOR INSTRUCTORS ON THE USE OF PERSONAL RESPONSE SYSTEMS ("CLICKERS")

Personal Response Systems ("clickers") may be used in some classes. If used, instructors should contact the Classroom Management Group (CMG) unit in the Department of Institutional Planning and Budgeting well in advance of delivery of the course. Information is at the following Web site: <http://www.ipb.uwo.ca/cm/>

If clickers are to be used by an instructor, it is the responsibility of the instructor to:

1. give students thorough instructions on how to use the devices,
2. indicate to students by what means they can confirm that the clicker is functional
3. explain how the devices will be used in service of the educational objectives of the course,
4. explain how tasks done by the students using the device are evaluated for their mark in the course,
5. clarify that students' privacy will be protected with respect to data gathered from the responses,
6. confirm for students that data gathered using the devices will not be used for research purposes without the express written permission of the student,
7. include the Guidelines for Students on the Use of Personal Response Systems in their course outlines.

GUIDELINES FOR STUDENTS ON THE USE OF PERSONAL RESPONSE SYSTEMS (“CLICKERS”)

Personal Response Systems (“clickers”) may be used in some classes. If clickers are to be used in a class, it is the responsibility of the student to ensure that the device is activated and functional. Students must see their instructor if they have any concerns about whether the clicker is malfunctioning.

Students must use only their own clicker. If clicker records are used to compute a portion of the course grade:

- the use of somebody else’s clicker in class constitutes a scholastic offence,
- the possession of a clicker belonging to another student will be interpreted as an attempt to commit a scholastic offence.

The following policies have been moved to “Exams, Scheduling of Examinations and Responsibility for Printing” - http://www.uwo.ca/univsec/pdf/academic_policies/exam/scheduling.pdf

FINAL EXAMINATION WEIGHTING
SCHEDULING ASSIGNMENTS
SCHEDULING TESTS/EXAMINATIONS
(S.13-#)

Related Policies and Notes:

Note: With reference to the Methods of Evaluation Section (page 1, item 5) the following is a suggestion as to what could be used to refer students to the policy on Accommodation for Medical Illness:

For UWO Policy on Accommodation for Medical Illness and a downloadable SMC see:
http://www.uwo.ca/univsec/pdf/academic_policies/appeals/accommodation_medical.pdf
[downloadable Student Medical Certificate (SMC): <https://studentservices.uwo.ca/>
under the Medical Documentation heading]

Students seeking academic accommodation on medical grounds for any missed tests, exams, participation components and/or assignments worth 10% or more of their final grade must apply to the Academic Counselling office of their home Faculty and provide documentation. Academic accommodation cannot be granted by the instructor or department.

The instructor must then provide a statement, indicating what procedure he/she intends to follow with regards to elements worth less than 10% (bearing in mind that medical documentation can only be received by the student's home Faculty/Academic Counselling).

http://www.uwo.ca/univsec/pdf/academic_policies/exam/scheduling.pdf