MSE 3360B - Finite Element Methods for Mechatronic Systems Engineering

Course Outline 2018–2019

Description: Overview of the finite element method (FEM) and its use to solve general problems in 2-D and 3-D. Applications include structural mechanics, heat transfer, thermal stress, electromagnetism and radiation. Methods and applications of optimization in support of engineering design are also introduced.

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Room: SEB2057A
Email: pkurows@uwo.ca
Consultation hours: Wednesday 11:30AM-12:30PM

Academic Calendar Copy:
Overview of the finite element method (FEM) and its use to solve general problems in 1-D, 2-D and 3-D. Applications include structural mechanics, heat transfer and thermal stress. Methods and applications of commercial FEM programs in support of engineering design and analysis are introduced.

Anti-requisites: CEE 3384A/B, MME 3360A/B.
Pre-requisites: ES 1036A/B or Computer Science 1026A/B, Applied Mathematics 2270A/B, MME 2202A/B or MSE 2212A/B, MME 2204A/B or MSE 2214A/B, MSE 2202A/B.

Extra Information: 3 lecture hours, 2 tutorial hours, 2 laboratory hours, 0.5 course.

Contact Hours: 3 lecture hours, 2 laboratory hours, 2 tutorial hours, 0.5 course.

Unless you have either the requisites for this course or written special permission from your Dean to enroll in it, you will 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.

CEAB Academic Units: Engineering Science 80%, Engineering design 20%
Required Textbook:
Engineering Analysis with SOLIDWORKS Simulation 2018

Required Software:
SOLIDWORKS Simulation 2018
This program is installed on all laboratory computers. Students will be able to install it on their computers.

General Learning Objectives (CEAB Graduate Attributes):

<table>
<thead>
<tr>
<th>Knowledge Base</th>
<th>I</th>
<th>Use of Engineering Tools</th>
<th>D</th>
<th>Impact on Society and the Environment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Problem Analysis</td>
<td>I</td>
<td>Individual and Team Work</td>
<td>D</td>
<td>Ethics and Equity</td>
</tr>
<tr>
<td>Investigation</td>
<td></td>
<td>Communication Skills</td>
<td></td>
<td>Economics and Project Management</td>
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<tr>
<td>Design</td>
<td>I</td>
<td>Professionalism</td>
<td></td>
<td>Life-Long Learning</td>
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Notation: x represents the content level code as defined by the CEAB. blank = not applicable; I = introduced (introductory); D = developed (intermediate) and A = applied (advanced).

Topics and Specific Learning Objectives:

1. General steps in the FEM
   At the end of this section, students will be able to:
   a. Identify steps and associated errors common to any FEM project
   b. Verify and validate FEM results

2. Direct stiffness method
   At the end of this section, students will be able to:
   a. Formulate and solve FEM equations for assembly of spring, truss and beam elements.
   b. Apply applicable FEM modeling techniques

3. Applications of solid, shell beam and 2D elements
   At the end of this section, students will be able to:
   a. Use commercial FEM program to select element as required by the analyzed geometry
   b. Define analysis type and implement correct modeling techniques.

4. Types of analyses: static linear, static nonlinear, thermal stress, modal, linear buckling, thermal
   At the end of this section, students will be able to:
   a. Select the correct type of analysis as required by the analyzed problem
   b. Interface between different types of analysis to solve multi-physics problems.
5. Using a commercial FEM program to analyze design problems

At the end of this section, students will be able to:

a. Implement FEM in a design process
b. Use FEM as a design tool.

Evaluation:

<table>
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<tr>
<th>Course Component</th>
<th>Weight</th>
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<tbody>
<tr>
<td>Three homework assignments 8% each</td>
<td>24%</td>
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<tr>
<td>SOLIDWORKS Simulation certification test</td>
<td>6%</td>
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<tr>
<td>Midterm Test</td>
<td>20%</td>
</tr>
<tr>
<td>Final Examination</td>
<td>50%</td>
</tr>
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</table>

To obtain a passing grade in the course, a mark of 50% or more must be achieved on the final examination. A final examination mark < 65% will result in a final course grade of 48% or less.

Homework Assignments: Three individual assignments due on: 4th week, 6th week, 11th week; submitted to drop box in course OWL

Certification test: On-line SOLIDWORKS Simulation certification test scheduled during lab hours.

Laboratory: Laboratories take place every week, students will work on assignment problems.

Midterm Examination: Scheduled during 8th week of semester. 2 hours long, closed book examination. Nonprogrammable calculators (any type) permitted.

Final Examination: The final examination will be take place during the regular examination period. 3 hours long, closed book examination. Nonprogrammable calculators (any type) permitted.

Late Submission Policy: Assignment submissions will be accepted for two days after assignment deadline; late submission penalty is 10% per day.

Course Policies: The following course-specific policies will be enforced throughout the course:

Laboratory sessions: Attendance to all laboratory sessions is strongly recommended. Laboratory exercises include assignment problems. Completion of exercises in each laboratory session assures timely completion of all assignments.
Midterm examination: No make-up midterm options will be offered, regardless of the circumstances for which the midterm test was missed. If a student misses a midterm examination, the student must follow the Instructions for Students Unable to Write Tests and provide documentation to Undergraduate Services within 24 hours of the missed test. If a student is going to miss the midterm examination for religious reasons, they must inform the instructor in writing within 48 hours of the announcement of the exam date or they will be required to write the exam. Missing a midterm examination with academic consideration will automatically shift the weight of the missed midterm test to the final exam. If no reasonable justification for missing a midterm examination is provided, then the student will receive a grade of zero for the examination.

Final examination: To obtain a passing grade in the course, a mark of 60% or more must be achieved on the final examination. A final examination mark < 60% will result in a final course grade of 48% or less. Students who have failed this course (i.e., final average < 50%) must repeat all components of the course.

Use of English: In accordance with Senate and Faculty Policy, students may be penalized up to 10% of the marks on all assignments, tests, and examinations for 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.

Attendance: All classes, laboratories, and tutorials are mandatory unless otherwise stated. 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 program, and with the permission of the Dean, the student will be debarred from taking the regular final examination in the course.

Absence Due to Illness or Other Circumstances: Students should immediately consult with the instructor or program Director if they have any problems that could affect their performance in the course. Where appropriate, the problems should be documented (see the attached “Instructions for Students Unable to Write Tests or Examinations or Submit Assignments as Scheduled”). The student should seek advice from the instructor or program Director regarding how best to deal with the problem. Failure to notify the instructor or program Director immediately (or as soon as possible thereafter) will have a negative effect on any appeal.

For more information concerning medical accommodations, see the relevant section of the Academic Handbook:
http://www.uwo.ca/univsec/pdf/academic_policies/appeals/accommodation_medical.pdf

For more information concerning accommodations for religious holidays, see the relevant section of the Academic Handbook:
http://www.uwo.ca/univsec/pdf/academic_policies/appeals/accommodation_religious.pdf

Missed Midterm Examinations: If a student misses a midterm examination, the exam will not be rescheduled. The student must follow the Instructions for Students Unable to Write Tests and provide documentation to their program within 24 hours of the missed test. The program will decide whether to allow the reweighting of the test, where reweighting means the marks
normally allotted for the midterm will be added to the final exam. If no reasonable justification for missing the test can be found, then the student will receive a mark of zero for the test.

If a student is going to miss the midterm examination for religious reasons, they must inform the instructor in writing within 48 hours of the announcement of the exam date or they will be required to write the exam.

**Cheating and Plagiarism:** Students must write their essays and assignments in their own words. Whenever students take an idea or a passage from another author, they must acknowledge their debt both by using quotation marks where appropriate and by proper referencing such as footnotes or citations. University policy states that cheating, including plagiarism, is a scholastic offence. The commission of a scholastic offence is attended by academic penalties, which might include expulsion from the program. If you are caught cheating, there will be no second warning.

All required papers may be subject to submission for textual similarity review to commercial plagiarism-detection software under license to the University for the detection of plagiarism. All papers submitted will be included as source documents on 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).

Scholastic offences are taken seriously and students are directed to read the appropriate policy, specifically, the definition of what constitutes a Scholastic Offence, in the relevant section of the Academic Handbook: http://www.uwo.ca/univsec/pdf/academic_policies/appeals/scholastic_discipline_undergrad.pdf

**Use of Electronic Devices:** Turn off all sound for pagers and cell phones. Students may use laptops, tablet computers, or smart phones only to access the course OWL site during lectures and tutorials. Use of nonprogrammable calculators only is permitted during quizzes and examinations. No other electronic devices may be used at any time during lectures, labs, tutorials, or examinations.

**Policy on Repeating All Components of a Course:** Students who are required to repeat an Engineering course 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 by the student for grading in subsequent years.

**Internet and Electronic Mail:** Students are responsible for regularly checking their Western e-mail and the course web site (https://owl.uwo.ca/portal/) and making themselves aware of any information that is posted about the course. If the student fails to act on information that has been posted on these sites and does so without a legitimate explanation (i.e., those covered under the illness/compassionate form), then there are no grounds for an appeal.

**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 519-661-2111 ext. 82147 for any specific question regarding an accommodation.

Student Development Centre, http://www.sdc.uwo.ca/
Engineering Undergraduate Services, http://www.eng.uwo.ca/undergraduate/
USC Student Support Services, http://westernusc.ca/services/

Students who are in emotional/mental distress should refer to Mental Health @ Western, http://www.health.uwo.ca/mental_health/, for a complete list of options about how to obtain help.