

Course Outline

1. COURSE INFORMATION

Session Offered	Summer 2019	
Course Name	Finite Element Analysis	
Course Code	ENG TECH 4FA3	
Date(s) and Time(s) of lectures	Saturdays, 9am-Noon	
Program Name	Civil Engineering and Infrastructure Technology Manufacturing Engineering Technology	
Calendar Description	Matrix operation. Direct stiffness method to form global stiffness matrix and solve problems. Derivation and application of rod, truss, beam, frame and 2D element. Dynamic and thermal stress analysis using FE method. Create and analyze structure models with ANSYS.	
Instructor(s)	Christopher Young	E-Mail: cyoung@avenue.cllmcmaster.ca

2. COURSE SPECIFICS

Course Description			
Instruction Type	Code	Type	Hours per term
	C	Classroom instruction	21
	L	Laboratory, workshop or fieldwork	18
	T	Tutorial	
	DE	Distance education	
	Total Hours		39
Resources	ISBN	Textbook Title & Edition	Author & Publisher
	ISBN-10: 0-13-189080-8	Finite Element Analysis, Theory and Application with ANSYS Third Edition	Saeed Moaveni & Pearson
	Other Supplies	Source	
Prerequisite(s)	ENG TECH 3ML3, ENG TECH 3MA3		
Corequisite(s)			
Antirequisite(s)	ENG TECH 2FE3, 3FE3, 3FN3		
Course Specific Policies	<p>This course will be using a range of software. Students should be aware that, when they access the electronic components of this course, private information such as first and last names, user names for the McMaster e-mail accounts, and program affiliation may become apparent to all other students in the same course. The available information is dependent on the technology used. Continuation in this course will be deemed consent to this disclosure. If you have any questions or concerns about such disclosure please discuss this with the course instructor. The instructor may also use other software including: e-mail, Avenue, LearnLink, web pages, capa, Moodle, Thinking Cap, etc.</p> <p>Missed quiz and late lab submissions will not be marked.</p>		
Departmental Policies	Students must maintain a GPA of 3.5/12 to continue in the program.		

	<p>In order to achieve the required learning objectives, on average, B.Tech. students can expect to do at least 3 hours of “out-of-class” work for every scheduled hour in class. “Out-of-class” work includes reading, research, assignments and preparation for tests and examinations.</p> <p>Where group work is indicated in the course outline, such collaborative work is mandatory.</p> <p>The use of cell phones, iPods, laptops and other personal electronic devices are prohibited from the classroom during the class time, unless the instructor makes an explicit exception.</p> <p>Announcements made in class or placed on Avenue are considered to have been communicated to all students including those individuals that are not in class.</p> <p>Instructor has the right to submit work to software to identify plagiarism.</p>	
3. SUB TOPIC(S)		
<p>Week 1 May 11, 2019</p>	<ul style="list-style-type: none"> - Matrix Algebra <ul style="list-style-type: none"> ○ Definition of a Matrix ○ Matrix Operation ○ Inverse of a Matrix by Row Reduction ○ Solving simultaneous equations using Gauss Elimination method and Cramer’s Rule - Uniaxial Rod Elements <ul style="list-style-type: none"> ○ Assembling global stiffness matrix of a spring assemblage using direct stiffness method ○ Specify boundary conditions for structure models ○ Work equivalent loads - Plane Truss Elements <ul style="list-style-type: none"> ○ Transformation of vectors two dimensions ○ Assembling global stiffness matrix in global reference frame 	<p>Chp 2 Chp 1.4-1.5 Chp 3 + Notes</p>
<p>Week 2 May 18, 2019</p>	<ul style="list-style-type: none"> - Principle of Minimum Potential Energy Approach to Derive Rod Element Equations <ul style="list-style-type: none"> ○ Development of rod element shape functions ○ Express stress/strain relationship in matrix notation ○ Derive Rod Element stiffness matrix from strain energy ○ Comparison of Finite Element Solution to Exact Solution for Rod Element 	<p>Chp 5.1, 5.2, 5.4 + Notes</p>
<p>Week 3 May 25, 2019</p>	<ul style="list-style-type: none"> - Principle of Minimum Potential Energy Approach to Derive Beam Element Equations <ul style="list-style-type: none"> ○ Development of beam element shape functions ○ Express stress/strain relationship in matrix notation ○ Derive Beam Element stiffness matrix from strain energy ○ Comparison of Finite Element Solution to Exact Solution for Rod Element - Frame Elements 	<p>Chp 7.3, 9.3, 10.2 + Notes</p>

	Solving structure models that combine beam and rod elements	
Week 4 June 1, 2019	Mid-term Test	
Week 5-9 June 8, 2019 June 15, 2019 June 22, 2019 June 29, 2019 July 6, 2019	Lab 1 to Lab 5, and Practical Test(MARC 269)	
Week 10 July 13, 2019	<ul style="list-style-type: none"> - Two Dimensional Finite Element <ul style="list-style-type: none"> o Basic concepts of plane stress and plane strain o Two-Dimensional state of stress and strain 	
Week 11 July 20, 2019	<ul style="list-style-type: none"> - Structural Dynamics with FE - Rod Element <ul style="list-style-type: none"> o Derivation of Consistent Mass Matrix for Rod Element o Modal Analysis of a Rod - Truss Element <ul style="list-style-type: none"> o Derivation of Consistent Mass Matrix for Plane Truss Element - Beam Elements <ul style="list-style-type: none"> o Derivation of Consistent Mass Matrix for Beam Elements o Modal Analysis of a beam - 2D Elements <ul style="list-style-type: none"> o Derivation of Consistent Mass Matrix for 2D Elements o Modal Analysis of a 2D structure 	
Week 12 July 27, 2019	<ul style="list-style-type: none"> - Thermal Stress <ul style="list-style-type: none"> o Formulation of thermal stress problem o Evaluate thermal force matrix o Thermal stress analysis of rod element, truss element, 2D plane element 	Chap 11 + Notes
Week 13 August 3, 2019	Final Exam	Notes

All examinations MUST be written during the scheduled examination period.

List of experiments

Note that this structure represents a plan and is subject to adjustment term by term. The instructor and the University reserve the right to modify elements of the course during the term. The University may change the dates and deadlines for any or all courses in extreme circumstances. If either type of modification becomes necessary, reasonable notice and communication with the students will be given with explanation and the opportunity to comment on changes.

4. ASSESSMENT OF LEARNING *including dates*	Weight
Quizzes	10%
Mid-Term Test	20%
Labs	10%
Lab Test	20%
Final examination	40%
TOTAL	100%

Percentage grades will be converted to letter grades and grade points per the University calendar.

5. LEARNING OUTCOMES

1. Able to use direct stiffness method to solve finite element problems.
2. Understand and apply the concept of minimum potential energy to generate various types of element equations.
3. Solve structural, thermal problems and modal analysis.
4. Able to use commercial code ANSYS to design problems into finite element models. Interpret and compare the results yield when using various types of elements. Explain the trends obtained from the model.
5. Implement various techniques such as symmetric, axisymmetric and localized mesh refinement to optimize computational time using ANSYS.

6. POLICIES

Anti-Discrimination

The Faculty of Engineering is concerned with ensuring an environment that is free of all discrimination. If there is a problem, individuals are reminded that they should contact the Department Chair, the Sexual Harassment Officer or the Human Rights Consultant, as soon as possible.

http://www.mcmaster.ca/policy/General/HR/Discrimination_Harassment_Sexual_Harassment-Prevention&Response.pdf

Academic Integrity

You are required to exhibit honestly and use ethical behaviour in all aspects of the learning process. Academic credentials you earn are rooted in principles of honesty and academic integrity.

Academic dishonesty is to knowingly act or fail to act in a way that results or could result in unearned academic credit or advantage. This behaviour can result in serious consequences e.g. the grade of zero on an assignment, loss of credit with a notation on the transcript (notation reads: "Grade of F assigned for academic dishonesty"), and/or suspension or expulsion from the university.

It is your responsibility to understand what constitutes academic dishonesty. For information on the various kinds of academic dishonesty please refer to the Academic Integrity Policy, located at: <http://www.mcmaster.ca/policy/Students-AcademicStudies/AcademicIntegrity.pdf>.

The following illustrates only three forms of academic dishonesty:

1. Plagiarism. E.g. the submission of work that is not own or for which other credit has been obtained
2. Improper collaboration in group work
3. Copying or using unauthorized aids in tests and examinations.

Requests for Relief for Missed Academic Term Work (Assignments, Mid-Terms, etc.)

The McMaster Student Absence Form is an on-line self-reporting tool for Undergraduate Students to report absences for:

- 1) Relief for missed academic work worth less than 25% of the final grade resulting from medical or personal situations lasting up to three calendar days:
 - Students may submit a maximum of one academic work missed request per term. It is the responsibility of the student to follow up with instructors immediately (within the 3 day period that is specified in the MSAF) regarding the nature of the accommodation. All work due in that time period however can be covered by one MSAF.
 - MSAF cannot be used to meet religious obligation or celebration of an important religious holiday, for that has already been completed or attempted or to apply for relief for any final examination or its equivalent.
- 2) For medical or personal situations lasting more than three calendar days, and/or for missed academic work worth 25% or more of the final grade, and/or for any request for relief in a term where the MSAF has not been used previously in that term:

- Students must visit their Associate Dean's Office (Faculty Office) and provide supporting documentation.

E-Learning Policy

Consistent with the Bachelor of Technology's policy to utilize e-learning as a complement to traditional classroom instruction, students are expected to obtain appropriate passwords and accounts to access Avenue To Learn for this course. Materials will be posted by class for student download. It is expected that students will avail themselves of these materials prior to class. Students should be aware that, when they access the electronic components of this course, private information such as first and last names, user names for the McMaster e-mail account, and program affiliation may become apparent to all other students in the course. The available information is dependent on the technology used. Continuation in this course will be deemed consent to this disclosure. If you have any questions or concerns about this disclosure please discuss this with the course instructor. Avenue can be accessed via <http://avenue.mcmaster.ca>.

Communications

It is the student's responsibility to:

- Maintain current contact information with the University, including address, phone numbers, and emergency contact information.
- Use the University provided e-mail address or maintain a valid forwarding e-mail address.
- Regularly check the official University communications channels. Official University communications are considered received if sent by postal mail, by fax, or by e-mail to the student's designated primary e-mail account via their @mcmaster.ca alias.
- Accept that forwarded e-mails may be lost and that e-mail is considered received if sent via the student's @mcmaster.ca alias.
- Check the McMaster/Avenue email and course websites on a regular basis during the term.

Turnitin (Optional)

This course will be using a web-based service (Turnitin.com) to reveal plagiarism. Students submit their assignment/work electronically to Turnitin.com where it is checked against the internet, published works and Turnitin's database for similar or identical work. If Turnitin finds similar or identical work that has not been properly cited, a report is sent to the instructor showing the student's work and the original source. The instructor reviews what Turnitin has found and then determines if he/she thinks there is a problem with the work. Students who do not wish to submit their work to Turnitin.com must still submit a copy to the instructor. No penalty will be assigned to a student who does not submit work to Turnitin.com. All submitted work is subject to normal verification that standards of academic integrity have been upheld (e.g., on-line search, etc.). To see the Turnitin.com Policy, please go to <http://www.mcmaster.ca/academicintegrity/turnitin/students/>

Protection of Privacy Act (FIPPA)

The Freedom of Information and Protection of Privacy Act (FIPPA) applies to universities. Instructors should take care to protect student names, student numbers, grades and all other personal information at all times. For example, the submission and return of assignments and posting of grades must be done in a manner that ensures confidentiality.

<http://www.mcmaster.ca/univsec/fippa/fippa.cfm>

Academic Accommodation of Students with Disabilities Policy

Students who require academic accommodation must contact Student Accessibility Services (SAS) to make arrangements with a Program Coordinator. Academic accommodations must be arranged for each term of study. Student Accessibility Services can be contacted by phone 905-525-9140 ext. 28652 or e-mail sas@mcmaster.ca. For further information consult McMaster's policy for Academic Accommodation of Students with Disabilities

<http://www.mcmaster.ca/policy/Students-AcademicStudies/AcademicAccommodation-StudentsWithDisabilities.pdf>

Students must forward a copy of the SAS accommodation to the instructor of each course and to the Program Administrator of the B.Tech. Program immediately upon receipt. If a student with a disability

chooses NOT to take advantage of a SAS accommodation and chooses to sit for a regular exam, a petition for relief may not be filed after the examination is complete. <http://sas.mcmaster.ca>

Student Code of Conduct

The Student Code of Conduct (SCC) exists to promote the safety and security of all the students in the McMaster community and to encourage respect for others, their property and the laws of the land. McMaster University is a community which values mutual respect for the rights, responsibilities, dignity and well-being of others. The purpose of the Student Code of Conduct is to outline accepted standards of behavior that are harmonious with the goals and the well-being of the University community, and to define the procedures to be followed when students fail to meet the accepted standards of behavior. All students have the responsibility to familiarize themselves with the University regulations and the conduct expected of them while studying at McMaster University.

<http://www.mcmaster.ca/policy/Students-AcademicStudies/Studentcode.pdf>