

MECHENG 4T03
FINITE ELEMENT APPLICATIONS
Spring 2024

CALENDAR/COURSE DESCRIPTION

Objective:

This course is designed to provide a fundamental understanding of the theory and application of finite element methods for mechanical systems. Upon completion of the course, the student will be knowledgeable in the capabilities and limitations of the finite element method and will gain proficiency in the use commercial finite element package ANSYS.

Course Topics:

Introduction

What are finite elements and why do we need them?

Direct Stiffness Method

Discrete Spring Systems as Finite Elements
Plane Truss Elements (coordinate transformation)
Assembly, Boundary Conditions and Solution of Equations

Continuous Systems

Principle of Minimum Potential Energy
Approximation with Piece-wise Functions (shape functions)
Method of Weighted Residuals for Approximating Continuous Systems

Two Dimensional Elasticity Elements

Basic Theory of Elasticity
Constant Strain Triangle Element
Bilinear Quadrilateral and Higher Order Elements

Beam Elements

Beam elements
Plane Frame Elements

Practical Considerations

Symmetry
Mesh Sensitivity
Troubleshooting

PRE-REQUISITES AND ANTI-REQUISITES

Prerequisite(s): Registration in the final level of a Mechanical Engineering program

INSTRUCTOR OFFICE HOURS AND CONTACT INFORMATION

Dr. Amir Partovi
partovia@mcmaster.ca

Students are welcome to make appointments by email to have virtual meetings.

TEACHING ASSISTANT OFFICE HOURS AND CONTACT INFORMATION

TA: TBD

Students are welcome to make appointments by email to have virtual meetings.

COURSE WEBSITE/ALTERNATE METHODS OF COMMUNICATION

<http://avenue.mcmaster.ca/>
www.coursewebsite.mcmaster.ca

Lectures: Mondays & Wednesdays 7:00-10:00 PM (Online via MS Teams)

Office Hours: Online, via Channel “Office Hour” on MS Teams – Date & Time: TBD

Tutorials: We will provide the students with detailed and step-by-step instructions for the tutorials on Avenue to Learn (A2L). The pre-recorded video tutorials, that are about using the software ANSYS, and instructions will be provided via A2L, and the students will have the opportunity to work with the software and learn at their own pace and time. The weekly Office Hours (MS Teams) is considered for helping the students with their questions.

COURSE INTENDED LEARNING OUTCOMES

By the end of this course, students should be able to:

1. Derive element equations and formulate global stiffness.
2. Utilize commercial finite element package ANSYS to solve solid mechanics problems.
3. Develop and validate various ANSYS models for problems such as bending of a beam and tensile loading of a thin plate with a hole.
4. Analyze numerical results obtained from the analysis.

MATERIALS AND FEES

Textbook: Logan, “A First Course in the Finite Element Method”, Brooks/Cole; 3rd or 4th edition
(Students are not required to buy a textbook, as we will provide detailed lecture notes.)

Calculator: Any

Other Materials: **ANSYS Student Version**

ANSYS software needs a Windows operating system to function. The students can have remote access to the computer labs if needed.

COURSE FORMAT AND EXPECTATIONS

The course is organized as follows:

- 6 one-hour online lectures per week (three hours on Mondays and three hours on Wednesdays via MS Teams)

- 1 online office hour per week (one hour via MS Teams – Date & Time: TBD)
- 4 Assignments
- 1 Project
- 1 Final Exam

Grading Scheme:

Assignments	40%
Project	20%
Final Exam	40%

Assignments:

Four problem sets are planned for this course. The purpose of these assignments is to provide students with an opportunity to individually work out fundamentals related to the course material. This will involve both theoretical solutions, and the use of some simple numerical methods to solve algebraic equations. Some assignments will use ANSYS.

Exercises:

Along with the assignments are exercises to provide instruction in the use of ANSYS. These exercises are not part of the grading system, but rather they provide an efficient path to using and exploring features of finite element analysis.

Project:

One project is intended to give students practical experience in the application of a fully functional finite element package. The commercial finite element package ANSYS is to be used to analyze a problem of complexity relevant to real world situations.

Final exam:

A 2.5-hour final exam will cover the theoretical aspects of the course. The final exam will be online, and we may use online proctoring software for the final exam. The software may require students to turn on their video camera, present identification, monitor and record their computer activities, and lock/restrict their browser or other applications/software during the final exam. The software may be required to be installed before the exam begins.

Deferred exam:

The deferred examination will be in person.

COURSE SCHEDULE

For information on course schedule, please visit [Avenue to Learn](#).

We will do our best to follow this schedule:

ME4T03 (2024 Spring/Summer)

Lectures: Mondays & Wednesdays 7:00 – 10:00 PM (Online via MS Teams)

Office Hours: Online, via Channel “Office Hour” on MS Teams – Date & Time: TBD

Tutorials: Detailed step-by-step guides and pre-recorded videos available on A2L

Instructor: Dr. Amir Partovi (partovia@mcmaster.ca)

TA: TBD

Time	Lecture Notes	Videos	Assessments Due dates
Week of May 6 (May 6, 8)	Lecture 1 (May 6): Introduction and Uniaxial Rod Elements Lecture 2 (May 8): Plane Truss Elements		
Week of May 13 (May 13, 15)	Lecture 3 (May 13): Principle of Min. PE Lecture 4 (May 15): Shape Functions Tutorial 1	Tutorials/ Tutorial 1	Assignment 1 Due May 16
Week of May 20 (May 22)	Lecture 5 (May 22): Triangle Elements Tutorial 2	Tutorials/ Tutorial 2	Assignment 2 Due May 23
Week of May 27 (May 27, 29)	Lecture 6 (May 27): More Continuum Elements Lecture 7 (May 29): Modeling Techniques Project	Project	Assignment 3 Due June 3
Week of June 3 (May 3, 5)	Lecture 8 (June 3 & 5): Beam and Frame Elements Tutorial 3	Tutorials/ Tutorial 3	
Week of June 10 (June 10, 12)	Lecture 10 (June 10 & 12): Review		Assignment 4 Due June 13
Week of June 17	No Class		Project Due June 19
June 21	Final Exam^{1,2}	7:00 PM – 9:30 PM	

1- Final exam will be online. Extra time will be given for preparing and submitting the answers. Online proctoring software may be used.

2- Deferred examination will be in person.

EQUITY, DIVERSITY, AND INCLUSION

Every registered student belongs in this course. Diversity of backgrounds and experiences is expected and welcome. You can expect your Instructor to be respectful of this diversity in all aspects of the course, and the same is expected of you.

The Department of Mechanical Engineering is committed to creating an environment in which students of all genders, cultures, ethnicities, races, sexual orientations, abilities, and socioeconomic backgrounds have equal access to education and are welcomed and treated fairly. If you have any concerns regarding inclusion in our Department, in particular if you or one of your peers is experiencing harassment or discrimination, you are encouraged to contact the Chair, Associate Undergraduate Chair, Academic Advisor or to contact the [Equity and Inclusion Office](#).

PHYSICAL AND MENTAL HEALTH

For a list of McMaster University's resources, please refer to the [Student Wellness Centre](#).

ACADEMIC INTEGRITY

You are expected to exhibit honesty and use ethical behaviour in all aspects of the learning process. Academic credentials you earn are rooted in principles of honesty and academic integrity. **It is your responsibility to understand what constitutes academic dishonesty.**

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. For information on the various types of academic dishonesty please refer to the [Academic Integrity Policy](#), located at <https://secretariat.mcmaster.ca/university-policies-procedures-guidelines/>

The following illustrates only three forms of academic dishonesty:

1. plagiarism, e.g. the submission of work that is not one's 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.

COURSES WITH AN ON-LINE ELEMENT

McMaster is committed to an inclusive and respectful community. These principles and expectations extend to online activities including electronic chat groups, video calls and other learning platforms.

Some courses may use on-line elements (e.g. e-mail, Avenue to Learn (A2L), LearnLink, web pages, capa, Moodle, ThinkingCap, etc.). Students should be aware that, when they access the electronic components of a course using these elements, private information such as first and last names, usernames 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 a course that uses on-line elements will be deemed consent to this disclosure. If you have any questions or concerns about such disclosure, please discuss this with the course instructor.

CONDUCT EXPECTATIONS

As a McMaster student, you have the right to experience, and the responsibility to demonstrate, respectful and dignified interactions within all of our living, learning and working communities. These expectations are described in the [Code of Student Rights & Responsibilities](#) (the “Code”). All students share the responsibility of maintaining a positive environment for the academic and personal growth of all McMaster community members, **whether in person or online**.

It is essential that students be mindful of their interactions online, as the Code remains in effect in virtual learning environments. The Code applies to any interactions that adversely affect, disrupt, or interfere with reasonable participation in University activities. Student disruptions or behaviours that interfere with university functions on online platforms (e.g. use of Avenue 2 Learn, WebEx or Zoom for delivery), will be taken very seriously and will be investigated. Outcomes may include restriction or removal of the involved students’ access to these platforms.

ACADEMIC ACCOMMODATION OF STUDENTS WITH DISABILITIES

Students with disabilities who require academic accommodation must contact [Student Accessibility Services](#) (SAS) at 905-525-9140 ext. 28652 or sas@mcmaster.ca to make arrangements with a Program Coordinator. For further information, consult McMaster University’s [Academic Accommodation of Students with Disabilities](#) policy.

COURSE POLICY ON MISSED WORK, EXTENSIONS, AND LATE PENALTIES

It is the students’ responsibility to regularly check the course webpage (ex. Avenue to Learn) for updates and announcements.

SUBMISSION OF REQUEST FOR RELIEF FOR MISSED ACADEMIC WORK

In the event of an absence for medical or other reasons, students should review and follow the Academic Regulation in the Undergraduate Calendar “Requests for Relief for Missed Academic Term Work”.

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:

- Use the [McMaster Student Absence Form](#) (MSAF) on-line self-reporting tool. No further documentation is required.
- Students may submit requests for relief using the MSAF once per term.
- An automated email will be sent to the course instructor, who will determine the appropriate relief. Students must immediately follow up with their instructors. Failure to do so may negate the opportunity for relief.

- The MSAF cannot be used to meet a religious obligation or to celebrate an important religious holiday.
- The MSAF cannot be used for academic work that has already been completed attempted.
- An MSAF applies only to work that is due within the period for which the MSAF applies, i.e. the 3-day period that is specified in the MSAF; however, all work due in that period can be covered by one MSAF.
- The MSAF cannot be used to apply for relief for any final examination or its equivalent.
See Petitions for Special Consideration above.

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 been used previously in that term:

- Students must report to their Faculty Office to discuss their situation and will be required to provide appropriate **supporting documentation**.
- If warranted, the Faculty Office will approve the absence, and the instructor will determine appropriate relief.

ACADEMIC ACCOMMODATION FOR RELIGIOUS, INDIGENOUS OR SPIRITUAL OBSERVANCES (RISO)

Students requiring academic accommodation based on religious, indigenous or spiritual observances should follow the procedures set out in the [RISO](#) policy. Students should submit their request to their Faculty Office **normally within 10 working days** of the beginning of term in which they anticipate a need for accommodation or to the Registrar's Office prior to their examinations. Students should also contact their instructors as soon as possible to make alternative arrangements for classes, assignments, and tests.

COPYRIGHT AND RECORDING

Students are advised that lectures, demonstrations, performances, and any other course material provided by an instructor include copyright protected works. The Copyright Act and copyright law protect every original literary, dramatic, musical and artistic work, **including lectures** by University instructors.

The recording of lectures, tutorials, or other methods of instruction may occur during a course. Recording may be done by either the instructor for the purpose of authorized distribution, or by a student for the purpose of personal study. Students should be aware that their voice and/or image may be recorded by others during the class. Please speak with the instructor if this is a concern for you.

EXTREME CIRCUMSTANCES

The University reserves the right to change the dates and deadlines for any or all courses in extreme circumstances (e.g., severe weather, labour disruptions, etc.). Changes will be communicated through regular McMaster communication channels, such as McMaster Daily News, A2L and/or McMaster email.

COURSE OUTLINE – APPROVED ADVISORY STATEMENTS

ACADEMIC INTEGRITY

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The following illustrates three forms of academic dishonesty:

- plagiarism, e.g. the submission of work that is not one's own or for which other credit has been obtained.
- improper collaboration in group work.
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AUTHENTICITY / PLAGIARISM DETECTION

Some courses may use a web-based service (Turnitin.com) to reveal authenticity and ownership of student submitted work. For courses using such software, students will be expected to submit their work electronically either directly to Turnitin.com or via an online learning platform (e.g. Avenue to Learn, etc.) using plagiarism detection (a service supported by Turnitin.com) so it can be checked for academic dishonesty.

Students who do not wish their work to be submitted through the plagiarism detection software must inform the Instructor before the assignment is due. No penalty will be assigned to a student who does not submit work to the plagiarism detection software. **All submitted work is subject to normal verification that standards of academic integrity have been upheld** (e.g., on-line search, other software, etc.). For more details about McMaster's use of Turnitin.com please go to www.mcmaster.ca/academicintegrity.

COURSES WITH AN ON-LINE ELEMENT

Some courses may use on-line elements (e.g. e-mail, Avenue to Learn, LearnLink, web pages, capa, Moodle, ThinkingCap, etc.). Students should be aware that, when they access the electronic components of a course using these elements, 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 a course that uses on-line elements will be deemed consent to this disclosure. If you have any questions or concerns about such disclosure please discuss this with the course instructor.

ONLINE PROCTORING

Some courses may use online proctoring software for tests and exams. This software may require students to turn on their video camera, present identification, monitor and record their computer activities, and/or lock/restrict their browser or other applications/software during tests or exams. This software may be required to be installed before the test/exam begins.

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REQUESTS FOR RELIEF FOR MISSED ACADEMIC TERM WORK

In the event of an absence for medical or other reasons, students should review and follow the [Policy on Requests for Relief for Missed Academic Term Work](#).³

ACADEMIC ACCOMMODATION FOR RELIGIOUS, INDIGENOUS OR SPIRITUAL OBSERVANCES (RISO)

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³ Updated to the [Policy on Requests for Relief for Missed Academic Term Work](#) effective May 1, 2021

STUDENT SUPPORTS

WELLNESS

Student Wellness Centre

On-Campus Support for Medical and Mental Health Concerns. Doctors and Counsellors available.
Located in PGCL, 2nd Floor.
Mon-Fri 9AM-5PM 905-525-9140 ext. 27700
<https://wellness.mcmaster.ca/contact-us/>

Main St. West Urgent Care Centre

For immediate health concerns that do not require the emergency room.
690 Main St W - Mon-Sun 9AM-9PM

Emergency Rooms

For **immediate, serious** health concerns.

St. Joseph's Healthcare Hamilton
50 Charlton Ave E

McMaster Children's Hospital
Students 17 and under

Telehealth Ontario

Telehealth Ontario is a free, confidential service you can call to get health advice or information. A Registered Nurse will take your call 24 hours a day, seven days a week.
Toll-free: 1-866-797-0000 Toll-free TTY: 1-866-797-0007

Phone Lines

Good2Talk
Confidential helpline providing professional counselling, info and referrals for mental health, addiction, and well-being
1-866-925-5454

LGBT Youthline
Confidential, non-judgemental & informed LGBTQ2SI peer support.
Sun-Fri, 4-9:30 PM, Text 647-694-4275

SACHA (SEXUAL ASSAULT CENTRE - HAMILTON AREA)

Confidential, anonymous 24-hour nonjudgmental telephone support for adults who have experienced sexual violence at any point in their lives; will provide accompaniment to hospital or police station for survivors wishing to seek medical attention or report; counselling services & public education
905-525-4162

Empower Me (Graduate Students)

24/7 accessible counselling services to empower you to thrive, crisis support, mental health and well-being services.
1-844-741-6389

Bounceback

CBT skills-building for mild to moderate depression and anxiety for people 15 or older. If accessed through self-referral, the client's primary care provider will be notified.
1-866-345-0224

INDIGENOUS STUDENTS

Indigenous Student Services

Academic & social counselling, employment aid
LRW 1010
ext. 23788
indigenous.admin@mcmaster.ca
indigenous.mcmaster.ca

INTERNATIONAL STUDENTS

International Student Services

Advising services for international students and exchange students
GH 104
ext. 24254
iss@mcmaster.ca
iss.mcmaster.ca

STUDENT SUPPORTS

ACADEMIC

Student Success Centre

Academic skills assistance, job search, volunteering
GH 110
ext. 24254
studentsuccess@mcmaster.ca

Student Accessibility Services

Disability services, assistive technology support
MUSC B107
ext. 28652
sas@mcmaster.ca

TutorOcean

Student to Student Tutoring Services
<https://mcmaster.tutorocean.com/>

FINANCIAL

Office of Student Financial aid and Scholarships

Emergency funding, government funds, OSAP assistance, scholarships, work programs
GH 120
ext. 24319
<https://registrar.mcmaster.ca/aid-awards/>

FOOD

Food Collective Centre (FKA Mac Bread Bin)

The Food Collective Centre is a service run by students dedicated to cultivating stronger food systems in the McMaster and surrounding community. (MSU Service)
macbreadbin@msu.mcmaster.ca
<https://www.msumcmaster.ca/services-directory/14-food-collective-centre>

Neighbour 2 Neighbour

Food bank, community kitchen, community counselling, help with paying for utilities, and more. Hamilton Mountain.
905-574-1334 <http://www.n2ncentre.com/>

CRISIS SUPPORT

Barrett Centre for Crisis Support

Provides a safe environment in the community and responds to the needs of individuals, 16 years of age or older, who experience a mental health crisis and do not require a hospital stay. Confidential and free services 24/7/365
24 Hour Crisis Line: 905-529-7878, Toll Free: 1-844-777-3571

COAST (Crisis Outreach and Support Team)

Hamilton's crisis line is answered 24 hours a day, 7 days a week. The COAST mobile team, consisting of a mental health worker, and a police officer, will respond to crisis calls between the hours of 8 a.m. and 1 a.m. daily.
905-972-8338

Oakville Distress Centre

Distress Centre Halton provides telephone and online support to people to better cope with crisis, loneliness, and emotional stress. Also serves the Hamilton area.
905-849-4541

Assaulted Women's Helpline

Free, anonymous and confidential telephone and TTY crisis telephone line to all women in the province of Ontario who have experienced any form of abuse. Provides crisis counselling, safety planning, emotional support, information and referrals accessible 24/7/365.
Toll-free: 1-866-863-0511 TTY: 1-866-863-7868

Crisis Resources in the GTA

The CAMH Distress Crisis Resources web page lists a number of phone lines, response teams and hospitals in the GTA.
<https://www.camh.ca/en/health-info/crisis-resources>