



# ENGG\*4470 Finite Element Analysis

01

Fall 2023

Section(s): C01

School of Engineering

Credit Weight: 0.50

Version 1.00 - September 01, 2023

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## 1 Course Details

### 1.1 Calendar Description

The theory of finite element analysis is presented including element derivation and solution procedures. Students use a finite element package to solve problems based on static and dynamic applications in mechanical systems. Examples are chosen from classical machines as well as biological systems.

**Pre-Requisites:**

ENGG\*2160, MATH\*2130, MATH\*2270

**Restrictions:**

Non-BENG students may take a maximum of 4.00 ENGG credits.

### 1.2 Timetable

Lectures:

Wednesday	7:00 - 9:50 PM	Rozanski Hall (ROZH) 102
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Labs:

Day	Time	Location	Section(s)
Thursday	9:30 AM - 11:20 AM	Thornbrough (THRN) 01 1319	
Thursday	2:30 PM - 4:20 PM	Thornbrough (THRN) 02 1319	
Wednesday	11:30 AM - 1:20 PM	Thornbrough (THRN) 03 1319	

## 1.3 Final Exam

Friday, December 8, 8:30 AM - 10:30 AM

Location: TBD

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## 2 Instructional Support

### 2.1 Instructional Support Team

<b>Instructor:</b>	Alexander Bardelcik
<b>Email:</b>	abardelc@uoguelph.ca
<b>Telephone:</b>	+1-519-824-4120 x53228
<b>Office:</b>	THRN 2501
<b>Office Hours:</b>	TBD

### 2.2 Teaching Assistants

<b>Teaching Assistant (GTA):</b>	Siyu Wu
<b>Email:</b>	swu09@uoguelph.ca
<b>Office Hours:</b>	TBD

<b>Teaching Assistant (GTA):</b>	Mohammad Mahdi Mansouri Etminan
<b>Email:</b>	mmanso07@uoguelph.ca
<b>Office Hours:</b>	TBD

<b>Teaching Assistant (GTA):</b>	Nafiseh Mohammadtabar
<b>Email:</b>	nafiseh@uoguelph.ca
<b>Office Hours:</b>	TBD

### 2.3 Lab Technician

SOE IT Help (soeithelp@uoguelph.ca) Phone: Ex. 54113

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## 3 Learning Resources

### 3.1 Required Resources

#### Course Website (Website)

<http://courselink.uoguelph.ca>

Course material, news, announcements, and grades will be regularly posted to the ENGG\*4470 CourseLink site. You are responsible for checking the site regularly.

**Kim, Sankar and Kumar, Introduction to Finite Element Analysis and Design, 2nd Ed., Wiley,**

2018 (Textbook)

## 3.2 Recommended Resources

Reddy, J.N, *An Introduction to the Finite Element Method, 2nd Edition, New York ; Montreal McGraw-Hill, 1984. (Textbook)*

## 3.3 Additional Resources

### Lecture Information: (Other)

This course will be delivered in a traditional **in-person** manner. The lecture PowerPoint slides will be presented during the lectures and a PDF version of the slides will be posted on CourseLink. Voiced-over and annotated PowerPoint versions of the lectures will also be posted on CourseLink as additional support to the in-person lectures.

### Lab Information (Other)

The Teaching Assistants will hold **in-person** lab sessions at the posted times. These labs will be used to go over the assignment solutions and provide instruction on the use of Matlab and Ansys. The lab time will also be used to ask question related to the assignments, project and exams.

### Miscellaneous Information: (Other)

Lectures are the main source of material which includes important discussions and worked examples that might not be found elsewhere. Other information related to this course will also be posted on CourseLink.

### Assignments: (Other)

The assignments (ungraded) will be posted on CourseLink. The solutions will be posted just prior to the exams. You are expected to attend the labs to work through the solutions with the TA's.

### PDF Handouts (Notes)

A set of PDF worksheet handouts (for long derivations/examples) will be posted on CourseLink. You are responsible to print these work sheets (full Letter size, 8.5'X11") and bring them to lectures as we will be filling them out together throughout the semester. You can also use a tablet to complete the notes. This is optional.

## 4 Learning Outcomes

This course aims at: (1) equipping the students with an understanding of theory and practice of the finite element method, (2) developing the ability to analyze and design using a commercial FEA software package.

### 4.1 Course Learning Outcomes

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

1. Utilize approximate numerical methods in solving structural problems such as the Ritz and the Galerkin methods.

2. Derivation of expressions describing the stiffness matrices and equivalent nodal load vectors for simple linear truss, beam and plane finite elements.
3. Apply principles of the isoparametric element formulation.
4. Use a commercial finite element software package (ANSYS) to solve engineering problems in solid mechanics.
5. Assess the accuracy and reliability of finite element solutions and troubleshoot problems arising from errors in a given finite element analysis.
6. Develop finite element formulations of engineering problems from a variety of application areas.
7. Demonstrate their ability to communicate their analysis and design ideas through technical reporting and presentation.

## 4.2 Engineers Canada - Graduate Attributes (2018)

Successfully completing this course will contribute to the following:

#	Outcome	Learning Outcome
1	Knowledge Base	1, 2, 3
1.1	Recall, describe and apply fundamental mathematical principles and concepts	1, 2, 3
1.3	Recall, describe and apply fundamental engineering principles and concepts	3
1.4	Recall, describe and apply program-specific engineering principles and concepts	1, 2
5	Use of Engineering Tools	4, 5
5.2	Demonstrate proficiency in the application of selected engineering tools	4
5.3	Recognize limitations of selected engineering tools	5
6	Individual & Teamwork	7
6.3	Execute and adapt individual role to promote team success through, for example, timeliness, respect, positive attitude	7

## 5 Teaching and Learning Activities

### 5.1 Lecture

**Topics:** Mathematical Preliminaries

**References:** Appendix

**Topics:** Direct Method - Springs, Bars and Truss Elements

**References:** Chapter 1

**Topics:** Weighted Residual Methods for One-Dimensional Problems

**References:** Chapter 2

**Topics:** Finite Element Analysis of Beams and Frames

**References:** Chapter 3

**Topics:** Review of Solid Mechanics

**References:** Chapter 5

**Topics:** Finite Elements for Two-Dimensional Solid Mechanics

**References:** Chapter 6

**Topics:** Isoparametric Finite Elements

**References:** Chapter 7

**Topics:** Finite Element Procedure and Modeling

**References:** Chapter 9

## 5.2 Lab

**Mon, Sep 6 - Mon, Nov 29**

**Topics:** See the "Schedule" Content on CourseLink to view a detailed lab schedule.

## 5.3 Important Dates

Thursday, September 7: First day of classes  
 Monday, October 9: Thanksgiving Holiday (no classes)  
 Tuesday, October 10: Fall Study Break (no classes)  
 Wednesday, November 29: last day of regularly scheduled classes  
 Friday, December 8: Final exam for this course

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## 6 Assessments

### 6.1 Marking Schemes & Distributions

Name	Scheme A (%)
6 unmarked assignments	0
Project	30
Midterm Exam	30
Final Exam	40
Total	100

### 6.2 Assessment Details

#### 6 unmarked assignments (0%)

**Learning Outcome:** 4

#### Project (30%)

**Learning Outcome:** 4, 7

#### Midterm Exam (30%)

**Date:** Thu, Oct 21, Virtual

**Learning Outcome:** 1, 2

Held during regularly scheduled virtual lecture time

#### Final Exam (40%)

**Date:** Thu, Dec 16, Virtual

**Learning Outcome:** 1, 2, 3

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## 7 Course Statements

### 7.1 Communication and Email Policy

Please use lectures and tutorials as your main opportunity to ask questions about the course. Electronic communication should be limited to the course forum, however topics of a personal and confidential nature (e.g. marks) should be emailed to the instructor:

abardelc@uoguelph.ca . Please note that all email communication must be made through your University of Guelph email account.

## 7.2 Academic Consideration

If you are unable to meet an in-course requirement due to medical, psychological, or compassionate reasons, please email the course instructor. See the undergraduate calendar for information on regulations and procedures for Academic Consideration:

<http://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-ac.shtml>

## 7.3 Accommodation of Religious Obligations

If you are unable to meet an in-course requirement due to religious obligations, please email the course instructor within two weeks of the start of the semester to make alternate arrangements. See the undergraduate calendar for information on regulations and procedures for Academic Consideration of Religious Obligations:

<http://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-accomrelig.shtml>

## 7.4 Passing Grade

The exams account for 70% of the total mark of the course. The project portion accounts for 30% of the total mark of the course. In order to pass the course, you must meet the following two criteria:

- Score 35% or higher out of the 70% allocated to the exam portion of the course.
- Score 15% or higher out of the 30% allocated to the project portion of the course.

If your final combined grade (Exams and Project) is greater than 50% and you fail to meet either of the two criteria, a final course grade of 49% will be assigned.

# 8 School of Engineering Statements

## 8.1 Instructor's Role and Responsibility to Students

The instructor's role is to develop and deliver course material in ways that facilitate learning for a variety of students. Selected lecture notes will be made available to students on Courselink but these are not intended to be stand-alone course notes. Some written lecture notes will be presented only in class. During lectures, the instructor will expand and explain the content of notes and provide example problems that supplement posted notes. Scheduled classes will be the principal venue to provide information and feedback for tests and labs.

## 8.2 Students' Learning Responsibilities

Students are expected to take advantage of the learning opportunities provided during lectures and lab sessions. Students, especially those having difficulty with the course content, should also make use of other resources recommended by the instructor. Students who do (or may) fall behind due to illness, work, or extra-curricular activities are advised to keep the

instructor informed. This will allow the instructor to recommend extra resources in a timely manner and/or provide consideration if appropriate.

### **8.3 Lab Safety**

Safety is critically important to the School and is the responsibility of all members of the School: faculty, staff and students. As a student in a lab course you are responsible for taking all reasonable safety precautions and following the lab safety rules specific to the lab you are working in. In addition, you are responsible for reporting all safety issues to the laboratory supervisor, GTA or faculty responsible.

## **9 University Statements**

### **9.1 Email Communication**

As per university regulations, all students are required to check their e-mail account regularly: e-mail is the official route of communication between the University and its students.

### **9.2 When You Cannot Meet a Course Requirement**

When you find yourself unable to meet an in-course requirement because of illness or compassionate reasons please advise the course instructor (or designated person, such as a teaching assistant) in writing, with your name, id#, and e-mail contact. The grounds for Academic Consideration are detailed in the Undergraduate and Graduate Calendars.

Undergraduate Calendar - Academic Consideration and Appeals

<https://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-ac.shtml>

Graduate Calendar - Grounds for Academic Consideration

<https://www.uoguelph.ca/registrar/calendars/graduate/current/genreg/index.shtml>

Associate Diploma Calendar - Academic Consideration, Appeals and Petitions

<https://www.uoguelph.ca/registrar/calendars/diploma/current/index.shtml>

### **9.3 Drop Date**

Students will have until the last day of classes to drop courses without academic penalty. The deadline to drop two-semester courses will be the last day of classes in the second semester. This applies to all students (undergraduate, graduate and diploma) except for Doctor of Veterinary Medicine and Associate Diploma in Veterinary Technology (conventional and alternative delivery) students. The regulations and procedures for course registration are available in their respective Academic Calendars.

Undergraduate Calendar - Dropping Courses

<https://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-drop.shtml>

Graduate Calendar - Registration Changes

<https://www.uoguelph.ca/registrar/calendars/graduate/current/genreg/genreg-reg-regchg.shtml>



Associate Diploma Calendar - Dropping Courses

<https://www.uoguelph.ca/registrar/calendars/diploma/current/c08/c08-drop.shtml>

## 9.4 Copies of Out-of-class Assignments

Keep paper and/or other reliable back-up copies of all out-of-class assignments: you may be asked to resubmit work at any time.

## 9.5 Accessibility

The University promotes the full participation of students who experience disabilities in their academic programs. To that end, the provision of academic accommodation is a shared responsibility between the University and the student.

When accommodations are needed, the student is required to first register with Student Accessibility Services (SAS). Documentation to substantiate the existence of a disability is required; however, interim accommodations may be possible while that process is underway.

Accommodations are available for both permanent and temporary disabilities. It should be noted that common illnesses such as a cold or the flu do not constitute a disability.

Use of the SAS Exam Centre requires students to make a booking at least 14 days in advance, and no later than November 1 (fall), March 1 (winter) or July 1 (summer). Similarly, new or changed accommodations for online quizzes, tests and exams must be approved at least a week ahead of time.

For Guelph students, information can be found on the SAS website  
<https://www.uoguelph.ca/sas>

For Ridgetown students, information can be found on the Ridgetown SAS website  
<https://www.ridgetownc.com/services/accessibilityservices.cfm>

## 9.6 Academic Integrity

The University of Guelph is committed to upholding the highest standards of academic integrity, and it is the responsibility of all members of the University community—faculty, staff, and students—to be aware of what constitutes academic misconduct and to do as much as possible to prevent academic offences from occurring. University of Guelph students have the responsibility of abiding by the University's policy on academic misconduct regardless of their location of study; faculty, staff, and students have the responsibility of supporting an environment that encourages academic integrity. Students need to remain aware that instructors have access to and the right to use electronic and other means of detection.

Please note: Whether or not a student intended to commit academic misconduct is not relevant for a finding of guilt. Hurried or careless submission of assignments does not excuse students from responsibility for verifying the academic integrity of their work before submitting it. Students who are in any doubt as to whether an action on their part could be construed as an academic offence should consult with a faculty member or faculty advisor.

Undergraduate Calendar - Academic Misconduct

<https://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-amisconduct.shtml>

Graduate Calendar - Academic Misconduct

<https://www.uoguelph.ca/registrar/calendars/graduate/current/genreg/index.shtml>

## 9.7 Recording of Materials

Presentations that are made in relation to course work - including lectures - cannot be recorded or copied without the permission of the presenter, whether the instructor, a student, or guest lecturer. Material recorded with permission is restricted to use for that course unless further permission is granted.

## 9.8 Resources

The Academic Calendars are the source of information about the University of Guelph's procedures, policies, and regulations that apply to undergraduate, graduate, and diploma programs.

Academic Calendars

<https://www.uoguelph.ca/academics/calendars>

## 9.9 Illness

Medical notes will not normally be required for singular instances of academic consideration, although students may be required to provide supporting documentation for multiple missed assessments or when involving a large part of a course (e.g.. final exam or major assignment).

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