# ENGG*4470: FINITE ELEMENT ANALYSIS
# Fall 2015

UNIVERSITY of GUELPH

**School of Engineering**

(Revision 2: September 22, 2015)

---

## 1. INSTRUCTIONAL SUPPORT

### 1.1 Instructor

Instructor: Mostafa Elsharqawy
Office: THRN 2407
Email: melsharq@uoguelph.ca
Office Hours: Thursday 2:00PM – 3:00PM

### 1.2 Teaching Assistants

| GTA | Email | Office Hours |
|---|---|---|
| Amatulraheem Al-Abassi | aalaba01@uoguelph.ca | Tuesday 2:30PM – 3:30PM |

**NOTE: ALL TA OFFICE HOURS WILL BE HELD IN THRN 1425.**

### 1.3 Lab Technicians

| Technician | Email | Phone |
|---|---|---|
| SOE IT Help | soeithelp@uoguelph.ca | Ex. 54113 |

---

## 2. LEARNING RESOURCES

### 2.1 Course website

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

### 2.2 Required Resources

1. Kim and Sankar Introduction to Finite Element Analysis and Design Wiley, 2008

### 2.3 Recommended Resources

2. Reddy, J.N, An Introduction to the Finite Element Method, 2nd Edition, New York ; Montreal Mcgraw-Hill, 1984.
3. Petyt, M. Introduction to finite element vibration analysis, 2nd ed., New York : Cambridge University Press 2010

## 2.4 Additional Resources

**Lecture Information:** Some of the lecture notes will be posted on the course website (CourseLink) throughout the semester. You will be granted access to the website when you register for the course.

**Assignments:** Download the assignments according to the schedule given in the CourseLink website. All the solutions will be posted as indicated.

**Miscellaneous Information:** Lectures are the main source of material which includes important discussions and worked examples that might not be found elsewhere. Other information related to Machine Design are also posted on the CourseLink.

## 2.5 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: melsharq@uoguelph.ca. Please note that all email communication must be made through your University of Guelph email account.

---

# 3. ASSESSMENT

## 3.1 Dates and Distribution

**Assignments:** (7 unmarked assignments) 0%

**In-class Test 1:** 20% Friday October 16, 2:30PM – 3:50PM, Room JTP 212

**In-Lab Test 2:** 20% Tuesday November 3,
Sec. 102: 08:30AM – 10:20AM, Room THRN 1004
Sec. 103: 11:30AM – 01:20PM, Room THRN 1004

**Project:** 30%

Project Part I Report (15%), Tuesday, Nov 10, 2015
Project Part II Report (15%): Friday, Dec 4, 2015
Note: Reports to be submitted both hardcopy and softcopy on CourseLink

**Final Exam:** 30% Thursday December 17, 2:30PM – 4:30PM, Room TBA on WebAdvisor

## 3.2 Course Grading Policies

**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

**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

**Passing Grade:** The exam portion (2 Tests + Final Exam) accounts 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.

Failure to meet any of the two criteria will result in a failure grade (your total mark or 49%, whichever is less).

**Missed Tests:** If you miss a test due to grounds for granting academic consideration or religious accommodation, the weight of any missed test will be added to the final exam weight. There will be no makeup tests.

**Lab Work:** You must attend and submit all project milestone reports. If you miss a project report due to grounds for granting academic consideration or religious accommodation, arrangements must be made with the teaching assistant to complete a makeup project.

**Late Lab Reports:** Late submissions of reports will not be accepted.

---

# 4. AIMS, OBJECTIVES & GRADUATE ATTRIBUTES

## 4.1 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.
*Prerequisite(s):* ENGG*2340, MATH*2130, MATH*2270
*Corequisite(s):* None

## 4.2 Course Aims

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 FEA software.

## 4.3 Learning Objectives

At the successful completion of this course, the student will have demonstrated the ability to:

1. Utilize approximate numerical methods in solving structural problems such as the Ritz and the Galerkin methods.
2. Derive of expressions describing the stiffness matrices and equivalent nodal load vectors for simple linear truss, beam and plane finite elements.

3. Perform co-ordinate transformation and its use in the finite element method.
4. Apply principles of the isoparametric formulation
5. Write special-purpose finite element programs within a procedural programming computer environment, such as MATLAB.
6. Use professional-level finite element software to solve engineering problems in solid mechanics, fluid mechanics, heat transfer and electromagnetism.
7. Assess the accuracy and reliability of finite element solutions and troubleshoot problems arising from errors in a given finite element analysis.
8. Develop finite element formulations of engineering problems from a variety of application areas including stress, heat transfer, and vibration analysis.
9. Utilize finite element to conduct an analysis of a mechanical system
10. Demonstrate their ability to communicate their analysis and design ideas through technical reporting and presentation.

## 4.4 Graduate Attributes

Successfully completing this course will contribute to the following CEAB Graduate Attributes:

| Graduate Attribute | Learning objectives | Assessment |
|---|---|---|
| 1. Knowledge Base for Engineering | 1 – 4 | Quizzes, Exams |
| 2. Problem Analysis | 9 | Exams, Project |
| 3. Investigation | - | - |
| 4. Design | 9 | Project |
| 5. Use of Engineering Tools | 6 | Labs, Project |
| 6. Communication | 10 | Project |
| 7. Individual and Teamwork | 9 | Project |
| 8. Professionalism | - | - |
| 9. Impact of Engineering on Society and the Environment | - | - |
| 10. Ethics and Equity | - | - |
| 11. Environment, Society, Business, & Project Management | - | - |
| 12. Life-Long Learning | - | - |

## 4.5 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. 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 assessments.

## 4.6 Students' Learning Responsibilities

Students are expected to take advantage of the learning opportunities provided during lectures and tutorials. 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.

### 4.7 Relationships with other Courses & Labs

***Previous and/or Current Courses:***
**ENGG*1210:** Mechanical system fundamentals such as force, torques, free body diagrams
**ENGG*1500:** Solving systems of linear equations, matrix algebra, and complex numbers
**MATH*1200, MATH*1210 & MATH*2270:** Limits, differentiation, integration, series, DE
**ENGG*2400:** Second order system, natural frequency
**ENGG*2160:** Fundamentals of stress analysis
**ENGG*2130:** Fundamentals of numerical analysis
***Follow-on Courses:***
**ENGG*4160:** Application of mechanical design principles
**ENGG*4220:** Interdisciplinary Mechanical Engineering Design

---

## 5. TEACHING AND LEARNING ACTIVITIES

### 5.1 Timetable

**Lectures**:

| Day | Time | Location |
|---|---|---|
| Wednesday | 02:30PM - 03:50PM | JTP 212 |
| Friday | 02:30PM - 03:50PM | JTP 212 |

**Labs:**

| Day | Time | Location | Section(s) |
|---|---|---|---|
| Tuesday | 08:30AM - 10:20AM | THRN 1004 | 0102 |
| Tuesday | 11:30AM - 01:20PM | THRN 1004 | 0103 |

### 5.2 Lecture Schedule

| Lecture # | Lecture Topic | References | Learning Objectives |
|---|---|---|---|
| 1 | Introduction and matrices review | Chapter 0 | 1 |
| 2 - 4 | Stress-strain analysis | Chapter 1 | 1, 2 |
| 5 - 8 | Uniaxial bar and truss elements – direct method | Chapter 2 | 1, 2 |
| 9 | Review and project discussion | - | - |
| 10 | Guest lecture | - | - |
| 11 | Class test | - | - |
| 12 – 14 | Weighted residual & energy methods | Chapter 3 | 2, 3, 5 |
| 15 – 17 | Finite element analysis of beams and frames | Chapter 4 | 2, 3, 5 |
| 18 – 19 | Finite elements for heat transfer problems | Chapter 5 | 3 |
| 20 – 21 | Finite elements for plane solids | Chapter 6 | 3, 4, 5 |
| 22 | Finite element procedure and modeling | Chapter 7 | 2, 3, 4, 5 |
| 23 | Structural design using finite elements | Chapter 8 | 2, 3, 4 |
| 24 | Guest lecture | - | - |

## 5.3 Lab Schedule

| Week # | Topic |
|---|---|
| 1 | No Tutorials |
| 2 | MATLAB Introduction + Solving from Assign 0 |
| 3 | Solving from Assign 1 / MATLAB |
| 4 | Solving from Assign 2 + Project Groups Formation |
| 5 | ANSYS Workbench Introduction I |
| 6 | No Tutorials |
| 7 | ANSYS Workbench Introduction II |
| 8 | Solving from Assign 3 / ANSYS |
| 9 | Test 2 (use MATLAB/ANSYS) |
| 10 | Solving from Assign 4 + Project Part I Report submission |
| 11 | Solving from Assign 5 |
| 12 | Solving from Assign 6 |
| 13 | ANSYS Help on Project + Project Part II Report submission |

## 5.4 Important Dates

Thursday, September 10 2015: First day of classes
Monday, October 12: Thanksgiving Holiday (no classes)
Tuesday, October 13: Fall Study Break
Friday, November 6 2015: drop date - 40th class
Friday, December 4 2015: last day of class
Thursday December 17, 2:30PM – 4:30PM, Final exam for this course

---

# 6. 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.

---

# 7. ACADEMIC MISCONDUCT

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 discourages misconduct. 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.

### 7.1 Resources

The Academic Misconduct Policy is detailed in the Undergraduate Calendar:
http://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-misconduct.shtml

A tutorial on Academic Misconduct produced by the Learning Commons can be found at:
http://www.academicintegrity.uoguelph.ca

Please also review the section on Academic Misconduct in your Engineering Program Guide.

The School of Engineering has adopted a Code of Ethics that can be found at:
http://www.uoguelph.ca/engineering/undergrad-counselling-ethics

---

## 8. ACCESSIBILITY

The University of Guelph is committed to creating a barrier-free environment. Providing services for students is a shared responsibility among students, faculty and administrators. This relationship is based on respect of individual rights, the dignity of the individual and the University community's shared commitment to an open and supportive learning environment. Students requiring service or accommodation, whether due to an identified, ongoing disability for a short-term disability should contact the Centre for Students with Disabilities as soon as possible.

For more information, contact CSD at 519-824-4120 ext. 56208 or email csd@uoguelph.ca or see the website: http://www.uoguelph.ca/csd/

---

## 9. RECORDING OF MATERIALS

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

---

## 10. RESOURCES

The Academic Calendars are the source of information about the University of Guelph's procedures, policies and regulations which apply to undergraduate, graduate and diploma programs:
http://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-amisconduct.shtml