THE UNIVERSITY OF UTAH

ME EN 5510/6510
Applied Finite Element Analysis

There are three links that we will use throughout the semester (hyperlinks here): zoom, canvas, gradescope

Class Meetings are on T and Th from 10:45-12:05

- Lectures in WEB L102, Labs in WEB L210

Textbook: A First Course in the Finite Element Method, any edition, by Daryl L. Logan
Instructor: Jacob Hochhalter, email via canvas

- office hours are T and Th, 1-2 pm, MEK 1352

TA: Joe Spencer, email via canvas

- office hours are M and W, 10-11 AM, MEK 2455C

Official Course Description

A practical approach to finite element analysis (FEA). The course will provide an introduction to the theoretical basis of the direct-stiffness and potential energy formulation methods of simple elements (1D, 2D). Students will learn how to implement the numerical solving technique Gauss Legendre Quadrature. Students will also get exposure to commercial finite element software (e.g. **ABAQUS**) and learn to critically create and evaluate finite element models. Examples will be provided for solid, fluid, and heat transfer applications. A brief introduction to some advanced methods (uncertainty quantification, design optimization, etc.) will be provided.

Prerequisites

MEEN 3310 (Mechanics of Materials); MEEN 2450 (Numerical Methods); MATH 2250 (Linear Algebra & ODEs); MATH 3140 (Vector Calculus);

Course Objectives

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

- Implement the various numerical methods of FEA for basic 1D and 2D elements
- Understand the ability of FEA to be easily implemented in multiple disciplines
- Develop an understanding of the structure of 1D and 2D elements
- Understand the mathematics behind the FEA process
- Understand the limitations of FEA and the importance of verification/validation
- Successfully create a finite element model using a commercial software of choice
- Critically evaluate finite element models developed by yourself and others

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Grading

Grading:	Homework	20%
	Lab and Project Assignments	20%
	Exams	30%
	Quizzes	10%
	Final Project	20%

Table 1: Grade Scale

0-59	60-62	63-66	67-69	70-72	73-76	77-79	80-82	83-86	87-89	90-92	93-96	97-100
E	D-	D	D+	C-	C	C+	B-	B	B+	A-	A	A+

Quizzes: Quizzes will be completed on canvas periodically on class lecture days to evaluate attendance and assigned reading.

Exams: Three exams will be given for this course and will be on topics discussed during lecture or lab sessions. All exams are **closed book**, **closed notes** (equations will be provided). There will be no make-up exams unless arranged in advance.

Final Exam: There will be no final exam for this course. Instead, a final project will be graded with the same weight as a final exam. The topic of the project is up to each student and will build upon the material from the labs. Details regarding the project will be provided.

Lecture Materials

The course syllabus, lecture slides, assignments, any supplementary materials, and class announcements will be posted in canvas. While the lecture slides contain important concepts that we will cover in class, I will go into more depth during lecture, which includes working through example problems on the board. Therefore, it is imperative that you attend lectures and labs.

Assignment Submission

All assignment submissions will be due by 11:59 pm on the due-date specified. All assignments must be submitted on gradescope. All students enrolled in the course prior to the first day of school, will automatically be added to gradescope. If you have not yet used gradescope, a step-by-step tutorial is provided here.

Homework Assignments (HW), Lab Assignments (LA), Project Assignments (PA)

- Homework assignments are meant to test and affirm your understanding of the theoretical background provided during lecture. Many of these assignments will be completed using MATLAB, Python, ABAQUS, or any other program of your choice.
- LAs are short lab assignments associated with lab tutorials.
- PAs will consist of a component required for your final FEA project. A significant portion of lab time will be allotted for you to work on the project and lab assignments, but these assignments will likely require additional out-of-class time.
- The TAs will grade the assignment directly in gradescope, and feedback will be provided immediately upon completion.

Late HW Policy

Late homework will be accepted with a penalty of 20% reduction per day i.e.

$$\text{HW}_{\text{Score}} = \text{HW}_{(\text{Your Score})} \cdot (1 - 0.2 \cdot \#_{\text{Days}}) \quad \forall (0 \leq \#_{\text{Days}} < 5)$$

Academic Integrity

From the Universitys Code of Student Rights and Responsibilities:
Academic misconduct includes, but is not limited to, cheating, misrepresenting one's work, inappropriately collaborating, plagiarism, and fabrication or falsification of information (see here for more details). It also includes facilitating academic misconduct by intentionally helping or attempting to help another to commit an act of academic misconduct.

You are allowed, expected, and encouraged to collaborate on homework by sharing ideas, verbally. Copying written work or code will not be tolerated. Shared work will receive a shared grade, meaning that the assignment score will be divided by the number of students submitting identical work. Cheating on an exam will result in failure of the class. Also, submitted work copied from others will be considered academic misconduct and will be reported to the appropriate University entities.

Clarifying examples (not comprehensive, but intended to make the line clear):

In ME EN 5510/6510, academic misconduct is not:

- Discussing course materials with classmates
- Verbally communicating about assignments
- Helping classmates learn software used in class or labs
- Using the internet for instruction beyond details provided in class
- Working with a tutor or your TA

In ME EN 5510/6510, academic misconduct is:

- Transcribing or copying/pasting other classmates work
- Allowing others to copy your work
- Uploading assignments without consent of the professor (e.g. to Course Hero or Chegg)
- Soliciting for solutions online
- Splitting assignment workload and submitting a combined result

Students must provide acknowledgment of the ME EN Academic Misconduct policy and course specific definitions of academic misconduct via the Canvas Academic Integrity Module for this course before the end of the second week of class or they will be asked to drop the class and will otherwise receive an EU grade.

Students with Disabilities

The University of Utah seeks to provide equal access to its programs, services and activities for people with disabilities. If you will need accommodations in the class, reasonable prior notice needs to be given to the Center for Disability Services, 162 Olpin Union Building, 581-5020 (V/TDD). CDS will work with you and the instructor to make arrangements for accommodations. All written information in this course can be made available in alternative format with prior notification to the Center for Disability Services.

College of Engineering (COE) Guidelines

Please visit the link below to familiarize yourself with the COE guidelines pertaining to the summer 2020 semester. The PDF version of the guidelines can also be downloaded from the Course Info folder on canvas or here.

Tentative Course Schedule

Week	Date	C, L	Lecture Topic	Reading	Assignment due
1	8/20/2024	C	Course overview & Intro to FEM	1.4-6	
	8/22/2024	C	Direct method - 1D axial springs	2.1-5, 3.4-6	Practice
2	8/27/2024	C	Planar trusses	2.6, 3.10-13	
	8/29/2024	C	Potential Energy method - beam elements	4.1-3, 4.7-8	HW 1
3	9/3/2024	L	Lab: Planar trusses		LA 1
	9/5/2024	C	1D Elements Review	Chapters 1-3	HW 2
4	9/10/2024	L	Lab: Beam elements	13.1-4, 14.1-4	LA 2
	9/12/2024	C	Gauss quadrature in FEM	8.1-2, 9.1-3	HW 3
5	9/17/2024	C	Exam 1		
	9/19/2024	C	2D models and isoparametric elements	10.1-5	
6	9/24/2024	C	2D Coding FEA	6.2-4	HW 4
	9/26/2024	L	Lab: 2D heat transfer	13.5, 14.3	LA 3
7	10/1/2024	C	Quadratic 2D, 3D elements	11.1-3	HW 5
	10/3/2024	L	Lab: 3D elements and BCs		LA 4
9	10/8/2024		**Fall Break**		
	10/10/2024		**Fall Break**		
10	10/15/2024	C	2D review	7.1, 7.4-8	
	10/17/2024	C	Exam 2		
11	10/22/2024	C	Boeing: FEA for aerospace	Guest	
	10/24/2024	C	Material modeling and solver concepts	Handout	
12	10/29/2024	L	Geometry, materials, BCs, solvers		PA 1
	10/31/2024	C	Meshing, convergence, and error		
13	11/5/2024	L	Meshing, convergence, and error		PA 2
	11/7/2024	C	Post-processing, verification and validation	TMS Handout	
14	11/12/2024	L	Post-processing, verification and validation		PA 3
	11/14/2024	C	Model reduction and UQ at NASA	Guest	
15	11/19/2024	L	Exam 3		PA 4
	11/21/2024	C	Design with topology optimization	Guest	
16	11/26/2024	L	Project exchange or Topology Optimization Demo	Guest	
	11/28/2024		**Thanksgiving**		
17	12/3/2024	L	Custom Lab Module (Senior Design Day)		PA 5
	12/5/2024	C	Course review and project discussions		PA 6
Final	12/11/2023	-	No Final		Final Project
		C = Class			
		L = Lab			