Finite Element Analysis

ME 478
University of Washington, Seattle — Spring Quarter 2013

Location: Loew 216 (Lecture); MEB 231 & 232 (Computer Lab)
Time: M-W 10:30-11:20am; F 10:30-11:20am

Instructor: Prof. Nathan J. Sniadecki, MEB 318
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Office Hours:

Prof:	M	11:30-12:30pm	MEB 318
TAs:	Tu	4:30-5:30pm	MEB 236
TAs:	Th	5:00-6:00pm	MEB 236

Website: `http://courses.washington.edu/nsniadec/ME478/S13`

GoPost: `https://catalyst.uw.edu/gopost/board/nsniadec/32343/`

Description: This course is an introduction to finite element analysis. The basic mathematical theory of finite element analysis will be introduced throughout the quarter. The course will also introduce you to a commercial finite element packages through several design projects in the area of linear solid mechanics, thermal analysis, and vibration analysis. At the end of the quarter you should be familiar with the theory and capable of designing and analyzing structures using finite element analysis. Lecture and Computer Recitations.

Prerequisites:
M E 123 – CAD
M E 374 – Systems Dynamic Analysis and Design
MATH 308 – Matrix Algebra with Applications
(or) AMATH 352 – Applied Linear Algebra

Required Text:

[1] Logan, *A First Course in the Finite Element Method*, Cengage Learning (ISBN: 0534552986)

Recommended Texts:

[2] Hibbeler, R.C., *Mechanics of Materials,* Pearson/Prentice Hall, Upper Saddle Ridge, NJ

Grading:

1) Homework 20%
2) Labs 15%
3) Projects 30%
4) Midterm Exam 15%
5) Final Exam 20%

Course Policies:

Homework Policy: All assignments must be handed in before class starts. If you used MATLAB or other software to complete your homework, print out the code and results and circle your answer. Late homework will be accepted if and only if arrangements are made by Sunday evening.

Lab Policy: There will be lab sessions for this course where you will run guided tutorials with the TAs. After completing the tutorial, you are required to show the TA your final work to receive full credit before you leave the computer lab. You will not receive credit if you do not show your completed work to the TA. If you are not able to complete the lab in the time for the class, please make arrangements with the TAs to turn in the completed lab via email.

Project Report Policy: This course has projects that require you to run commercial FEA software and write a memo report on the results. Late reports will not be accepted. All reports are to be printed and handed in before class starts on Friday.

Collaboration Policy: You may discuss projects and homework with your fellow students, and even collaborate on the solution, but you must list on the report or homework the name of the person(s) that collaborated with you on the effort. You may not copy someone else's reports, data, or figures.

Exam Policy: All exams must be completed on the specified date. Only under proven, extraordinary circumstances will a makeup exam be permitted.

Classroom Policy: Please consider the learning mission of the course and refrain from activity that is disruptive during lectures or computer lab sessions.

Grading Policy: The instructional team pledges to return your homework within two week and your lab reports within three weeks.

I have a zero-tolerance for cheating or plagiarism. Please refer to UW's Student Conduct Code.
http://www.washington.edu/students/handbook/conduct.html

Course Outcomes and Assessment:

By the end of this course, the student will be able to:

1. Derive the element stiffness matrices for truss, beam and simple planar elements
2. Understand the advantages/disadvantages of different discretization techniques
3. Able to apply appropriate constraints and boundary conditions to finite element models
4. Use the commercial FEA code, e.g. ANSYS, to solve linear static solid and structural mechanics problems

Contribution of Course to Professional Development:

The aim of the course is to prepare students for engineering practices by familiarizing them with finite element analysis and computational packages, advancing their fundamental engineering knowledge, and developing their technical communication abilities.

Project Report Requirements:

The reports you submit for the projects in this class are to be in the form of a full report. The following items are required in the report: abstract, introduction, procedure, results, discussion, and conclusions. The memo reports will be graded out of 100 points and based upon the grading items in Table 1.

Table 1. Report Grading Points

Item	Points
Overall grammar, spelling, and punctuation	10
Abstract:	
Briefly describe what was done, why it was done, and what was the finding. The most important point should be made in the first sentence.	5
Introduction:	
Very brief background and purpose for the model.	5
Procedure:	
Indicate the elements used, material properties, boundary conditions/loads assigned, and how the model was meshed (number of nodes, node seeding if any, etc.). Include a computer drawn figure of your model with dimensions. DO NOT have figures with black backgrounds.	20
Results (and Appendices):	
Analysis of the modeling data is complete, clear, and correct.	15
Results in figures, graphs, and tables are accurate and important features are described in the text.	20
Format of graphs and tables is professional looking. Appropriate units are indicated. Captions to describe the contents of the graph or table. Reference to graphs, tables, and appendices are made in the memo.	10
Discussion:	
Describe your engineering insight on the results of the model and explain any errors or differences between model and theory	10
Conclusions:	
Summarize the modeling results and give recommendations based upon your findings.	5

Tips for ANSYS Graphics:

Do not to use the print screen feature on your laptop to make an image of your ANSYS results. Instead, you can use:

PlotCtrls > Capture Image

A new image window will pop up of your model. To save the image shown in the window, go to:

File > Save As

The menu that opens will let you save your image as a BITMAP to the remote drive (Documents). Then, you will need to use Skydrive, Dropbox, Google Drive, Box, FTP, or UWCatalyst's File Manager to move your file over to your laptop. These are extra steps than using print screen, but the quality should be much better.

To switch the background from black to white:

PlotCtrls > Style > Colors > Reverse Video

This feature is very helpful for making a nice looking report without a black background in the figure.

Table 2. ME 478 Course Schedule

	Day		Room	Book Readings	Lecture/Lab Topic	Assign	Due
Week 1	1-Apr	M	Loew 216	Ch 2.1-5	Direct Formulation		
	2-Apr	T	Loew 216	Ch 2.1-5	Direct Formulation	Hw1	
	3-Apr	W	Loew 216	--	TUTORIAL: Matlab		
	5-Apr	F	MEB 231	--	LAB 1: Truss Problem	Project 1	
Week 2	8-Apr	M	Loew 216	Ch 3.1-6	Trusses		
	9-Apr	T	Loew 216	Ch 3.1-6	Trusses	Hw2	
	10-Apr	W	Loew 216	Ch 2.6, Ch 3.10	Minimum Potential Energy		Hw 1
	12-Apr	F	MEB 231	--	LAB 2: Beam/Frame Problem		
Week 3	15-Apr	M	Loew 216	Ch 3.10	Columns		
	16-Apr	T	Loew 216	Ch 4.1, 4.7	Beams	Hw3	
	17-Apr	W	Loew 216	Ch 5.1-2	Frames		Hw2
	19-Apr	F	MEB 231	--	LAB 3: Plane Stress Problem		Project 1
Week 4	22-Apr	M	Loew 216	Ch 6.1-3	Plane Stress		
	23-Apr	T	Loew 216	Ch 6.1-3	Plane Stress	Hw4	
	24-Apr	W	Loew 216	Ch 6.1-3	Plane Stress		Hw3
	26-Apr	F	MEB 231	--	LAB 4: Axisymmetric Problem	Project 2	
Week 5	29-Apr	M	Loew 216	Ch 6.1-3	Plane Stress		
	30-Apr	T	Loew 216	Ch 10.1-3	Axisymetric Problems	Hw5	
	1-May	W	Loew 216	Ch 10.1-3	Axisymetric Problems		Hw4
	3-May	F	**Loew 216**	--	**Midterm Exam**		
Week 6	6-May	M	Loew 216	Ch 10.1-3	Isoparametric Formulation		
	7-May	T	Loew 216	Ch 10.1-3	Isoparametric Formulation	Hw6	
	8-May	W	Loew 216	Ch 10.1-3	Isoparametric Formulation		Hw5
	10-May	F	MEB 231	--	LAB 5: 3D Stress Problem		Project 2
Week 7	13-May	M	Loew 216	Ch 11.1-2	3D Stress Analysis		
	14-May	T	Loew 216	Ch 11.1-2	3D Stress Analysis	Hw7	
	15-May	W	Loew 216	Ch 11.1-2	3D Stress Analysis		Hw6
	17-May	F	MEB 231	--	LAB 6: Thermal Problem	Project 3	
Week 8	20-May	M	Loew 216	Ch 13.1-5	Heat Transfer		
	21-May	T	Loew 216	Ch 13.1-5	Heat Transfer	Hw8	
	22-May	W	Loew 216	Ch 13.1-5	Heat Transfer		Hw7
	24-May	F	MEB 231	--	LAB 7: Vibration Problem		
Week 9	27-May	M	--		*No Class (Memorial Day)*		
	28-May	T	Loew 216	Ch 16.1-2, 4, 6	Vibrational Analysis	Hw9	
	29-May	W	Loew 216	Ch 16.1-2, 4, 6	Vibrational Analysis		Hw8
	31-May	F	MEB 231	--	LAB 8: ABAQUS Tutorial		Project 3
Week 10	3-Jun	M	Loew 216	Ch 16.1-2, 4, 6	Vibrational Analysis		
	4-Jun	T	Loew 216	Ch 14.6	Electrostatics		
	5-Jun	W	Loew 216		Review		Hw9
	7-Jun	F	MEB 231		LAB 9: COMSOL Tutorial		
Final							
	10-Jun	M	Loew 216		**Final Exam**		