EML 4507 – Finite Element Analysis and Design – Fall 2020

Instructor: Dr. Xin Tang; Department of Mechanical and Aerospace Engineering
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Lecture Times: MWF (8th period; 3:00 pm – 3:50 pm) on-line
Office Hours: MWF (4:00 pm – 5:00 pm), other times by Email appointment

Core Textbook: Introduction to Finite Element Analysis and Design, Nam H. Kim, Bhavani V. Sankar, and Ashok V. Kumar, John Wiley & Sons, Ltd., 2018

Please note that this course will be participating in the UF All Access program. Login at the following website and Opt-In to gain access to your required course materials – https://www.bsd.ufl.edu/G1CO/IPay1f/start.aspx?TASK=INCLUDED – This option will provide you with digital content that is the best value in the marketplace. Materials will be available approximately 1 week prior to the first day of class.

Optional Textbooks: Finite Element Procedures, Klaus-Jurgen Bathe, MIT, 2014
A number of additional excellent books and journal papers will be introduced in class.

Software: Some homework will be carried out using commercial finite element software Abaqus. Students are expected to download and install the software on their personal computer. The software can be downloaded from https://academy.3ds.com/en/software/abaqus-student-edition

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Prerequisites: Elementary Differential Equations, Linear Algebra, or equivalent

Course Objectives: The objective of this course is to teach how to design, analyze and optimize structural components of machine systems using finite element method (FEM). The course exposes students to analytical and numerical methods for computing stresses and strains in structures, use of finite element software for static structural analysis and the application of design and failure criteria to ensure that mechanical components can carry the design load without failure. Another important area of the course is to make the students recognize the importance of self-education and life learning.

Course Content:

1. Introduction
2. Uniaxial bar and Truss Finite Element
3. Finite Element Analysis of Beams and Plane Frames
4. Stress-Strain Analysis- Design Criteria
5. Finite elements for plane and 3D solids
6. Finite Elements for Heat Transfer Problems
7. Finite Element Analysis Procedures and Modeling

Reading Assignments: Reading assignments will be made periodically. If I feel that the bulk of the class is not keeping up with the reading assignments, I reserve the right to give unannounced additional quizzes.

Student Expectations: It is expected that this course will require at least 15 hours of effort per week when you consider time spent for lectures, reading assignments, homework, and re-writing of your class notes. I also expect that you will attend every lecture. If you cannot attend a lecture, please notify me prior to class unless in the case of an unanticipated emergency. I strongly recommend that you implement the "Five Times Strategy (recommended by Prof. Mark Shaplak)" for learning in this class. This requires that you cover the course material at least 5 times before exams. The first time that you cover the material is when you perform your reading assignment before class. The second time that you cover the material is during lecture. The third time that you cover the material is when you re-write your "lecture set" of notes that includes material from lecture and the reading assignments, including all derivations and your additions. The fourth time that you cover the material is when you do your homework assignments. Finally, the fifth time that you cover the material is when you study for your exams. This technique will help you master the material and also will provide you with a comprehensive set of notes to potentially teach.

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As part of a pilot program at UF, this course has been chosen to require each student to complete online course evaluation in order to pass the course. Specifically, each student must log into the system https://evaluations.ufl.edu and either fill out an evaluation or opt out (this requires logging in). While students can log in and opt out, the department much prefers the valuable feedback from each of you.

Homework/Projects: 10–12 homework sets and 4 projects will be assigned periodically via Canvas. Projects are analysis and design problems involving the use of finite element software Abaqus (its tutorials are online (https://mediasite.video.ufl.edu/Mediasite/Catalog/catalogs/eml4507). I will post solutions on Canvas for you to review.

Student Behavior: You are expected to show up on time for class. Please turn off all cell phones and electronic devices prior to the start of class. Please do not bring food to class.

Late/Makeup Policy: No late homework assignments will be accepted, but 2 home-works with the lowest scores will be dropped. Makeup exams are not allowed. If you cannot attend an exam or cannot meet a due date, you must contact the instructor **prior** to the exam or due date.

Graduate School Policy: Letter grades of C-, D+, D, D- or E are not considered passing at the graduate level. Although the grade points associated with these letter grades are included in grade point average calculations, courses with these grades will not be credited towards graduation. Also, grades of B-, C+ or C count toward a graduate degree if an equal number of credits in courses numbered 5000 or higher have been earned with grades of B+, A- and A, respectively. Further explanation of the University of Florida graduate grading policies can be found at http://gradcatalog.ufl.edu/content.php?catoid=12&navoid=2750#grades.

Accommodations: Students with disabilities who are requesting classroom accommodation must first register with the Dean of Students Office. They will provide documentation to the student who must then provide this documentation to the Instructor when requesting accommodations. I am not permitted to make these decisions. See http://www.dso.ufl.edu/drc/ for more information.

Academic Honesty: All students **MUST** review the University's "Student Honor Code" (https://sccr.dso.ufl.edu/students/student-conduct-code/). All students admitted to the University of Florida have signed a statement of academic honesty committing themselves to be honest in all academic work and understanding that failure to comply with this commitment will result in disciplinary action. This statement is reminder to uphold your obligation as a student at the University of Florida and to be honest in all work submitted and exams taken in this class and all others. All honor code violations will be reported to appropriate university authorities. Any misconduct in exams will lead to an E grade for the course. Misconduct in quizzes and HWs will result in reduction of grade by a point.

Exams: There will be 6 Quizzes (20-min each), 2 mid-term exams (1-hour each) and 1 final exam (1-hour). One quiz with the lowest score will be dropped. All will be given in class. Students are allowed to bring one hand-written 8½ ×11 inch formula sheet written on both sides for quizzes and exams.

Grading:

HWs (10–12)	20%
ABAQUS Projects (4)	20 %
Mid-term Exams (2)	30 %
Quizzes (6)	10%
Final Exam (1)	20%
Total	100 %

Grading scale:

Percent	Grade	Grade Points
90.0 - 100.0	A - A+	4.00

87.0 - 89.9	A-	3.67
84.0 - 86.9	B+	3.33
81.0 – 83.9	B	3.00
78.0 - 80.9	B-	2.67
75.0 - 79.9	C+	2.33
72.0 – 74.9	C	2.00
69.0 - 71.9	C-	1.67
66.0 - 68.9	D+	1.33
63.0 - 65.9	D	1.00
60.0 - 62.9	D-	0.67
0 - 59.9	E	0.00

Course Notes:

The course will be taught from the PowerPoint slides. These slides are meant to illustrate the concepts and accompany the assigned readings from the text and reference books. **They are not to be considered being comprehensive and substitutes for additional readings.** You will be responsible for both the material covered in class and the assigned readings.

Policies/Procedures for Homework/Projects:

1. Homework and projects are essential elements of this course as they will help you to learn the material via application.
2. Solutions to the homework and projects will be available on the class website after class on the date the assignment is due. It will be submitted via Canvas.
3. Performance on the homework and projects will count the student's final grade directly and exam material may be taken directly from HWs. Consequently, individual work must be expected on all problems to ensure a proper grasp of the material. Students are encouraged to discuss the general principles involved in the homework sets with one another, but the solution of each problem must be attempted individually.
4. Here is a suggested format for HWs that will help you organized your thoughts.

Format:

1. Use 8.5" x 11" paper and write on one side. State each problem on a new page.
2. Each homework problem must be completed in a standard format, which includes the following labeled steps:
   - *GIVEN:* After carefully reading the problem, state briefly and concisely what is known. Do not repeat the problem statement.
   - *FIND*: State briefly and concisely what must be found.
   - *SCEMATIC:* Draw a schematic of the physical problem to be considered. Note the control volumes used in the analysis by dashed lines on the sketch. Include coordinate axes when appropriate, and label relevant dimensions and velocities.
   - *BASIC EQUATIONS:* Provide the appropriate assumptions and mathematical formulation for the basic laws that you consider necessary to solve the problem.
   - *SOLUTION:* Provide full details of the analysis in a logical manner. Develop the analysis as far as possible before substituting numerical values. Give the answer algebraically before computing the final numerical result (if required). Clearly indicate your final answer.
3. Attach a listing of any computer program(s) used in the solution. Matlab/ABAQUS are preferred.

Course schedule:

Lecture	Date	Day	Topic
1	8/31/20	Mon	Introduction
2	9/2/20	Wed	Direct Method
3	9/4/20	Fri	Direct Method

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Labor Day	9/7/20	Mon	
4	9/9/20	Wed	Uniaxial Bar and Truss Elements
5	9/11/20	Fri	Uniaxial Bar and Truss Elements
6	9/14/20	Mon	Uniaxial Bar and Truss Elements
7	9/16/20	Wed	Uniaxial Bar and Truss Elements
8	9/18/20	Fri	Watch online tutorial 1: FEA using ABAQUS CAE
9	9/21/20	Mon	Watch online tutorial 2: FEA using ABAQUS input file
10	9/23/20	Wed	Beam Finite Element
11	9/25/20	Fri	Beam Finite Element
12	9/28/20	Mon	Beam Finite Element
13	9/30/20	Wed	Beam Finite Element
Homecoming	10/2/20	Fri	
14	10/5/20	Mon	Beam Finite Element
15	10/7/20	Wed	Beam Finite Element
16	10/9/20	Fri	Exam 1
17	10/12/20	Mon	Watch online tutorial 3: FEA using beam elements
18	10/14/20	Wed	Review of Solid Mechanics
19	10/16/20	Fri	Review of Solid Mechanics
20	10/19/20	Mon	Review of Solid Mechanics
21	10/21/20	Wed	Review of Solid Mechanics
22	10/23/20	Fri	Plane Solid Elements (CST)
23	10/26/20	Mon	Plane Solid Elements (CST)
24	10/28/20	Wed	Plane Solid Elements (CST)
25	10/30/20	Fri	Plane Solid Elements (Rectangular element)
26	11/2/20	Mon	Plane Solid Elements (Rectangular element)
27	11/4/20	Wed	Plane Solid Elements (Isoparameteric element)
28	11/6/20	Fri	Watch online tutorial 4: FEA using solid elements
29	11/9/20	Mon	Plane Solid Elements (Isoparameteric element)
Veterans	11/11/20	Wed	
30	11/13/20	Fri	Plane Solid Elements (Isoparameteric element)
31	11/16/20	Mon	Examples of problem solving
32	11/18/20	Wed	Exam 2
33	11/20/20	Fri	Watch online tutorial 5: FEA with CAD model
34	11/23/20	Mon	Examples of problem solving
Thanksgiving	11/25/20	Wed	
Thanksgiving	11/27/20	Fri	
35	11/30/20	Mon	1D Heat Conduction
36	12/2/20	Wed	1D Heat Conduction
37	12/4/20	Fri	1D Heat Conduction
38	12/7/20	Mon	Review
39	12/9/20	Wed	Final Exam