

# Finite Element Analysis and Design

EML 4507 (Section 3258)  
Spring 2020, 8<sup>th</sup> Period, MWF, MAEA 303

## Basic information

**Catalog information:** Credits: 3; Stress-strain analysis and design of machine elements; finite element analysis.

**Class time and location:** MWF 8th period (3:00 - 3:50 PM) MAEA 303

**Instructor:** Nam Ho Kim, MAE-A 210, Email: [nkim@ufl.edu](mailto:nkim@ufl.edu)

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**Office hours:** Nam Ho Kim: MWF 9th period (4:05 – 4:50 PM) 210 MAEA  
Hannah Moring: TBD, NEB 109  
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Ting Dong: TBD, NEB 109

**Textbook:** “Introduction to Finite Element Analysis and Design” by Nam-Ho Kim, Bhavani V. Sankar, and Ashok V. Kumar, 2<sup>nd</sup> Edition, Wiley (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.)

**Course description:** Fundamentals of finite element analysis including, discrete system analysis, steady state heat transfer analysis, static analysis of structures. Modeling, analysis and design using FEA software. The objective of the course is to teach the fundamentals of finite element method with emphasize on the underlying theory, assumption, and modeling issues as well as providing hands-on experience using finite element software to model, analyze and design systems of mechanical and aerospace engineers.

### Course content:

1. Uniaxial bar and Truss Finite Element
2. Finite Element Analysis of Beams and Frames
3. Finite elements for plane solids
4. Isoparametric Finite elements
5. Finite Elements for Heat Transfer Problems
6. Finite Element Analysis Procedures and Modeling

### Course schedule:

Lecture	Date	Chapter	Topics	
1	6-Jan		Syllabus and course introduction	
2	8-Jan	1	Direct method: 1-D spring	
3	10-Jan	1	Uniaxial bar element	
4	13-Jan	1	Plane truss	
5	15-Jan	1	Method of superposition, space truss	Quiz 1
6	17-Jan	1	Thermal stress and load	
7	22-Jan	1	Finite element modeling for truss	

8	24-Jan	2	Interpolation	
9	27-Jan	2	Interpolation for beam	
10	29-Jan	3	Beam theory & Rayleigh Ritz method	Quiz 2
11	31-Jan	3	Beam finite element	
12	3-Feb	3	Assembly and bending/shear force diagram	
13	5-Feb		Exam 1 review	
14	7-Feb		Exam 1	
15	10-Feb	3	Distributed load	
16	12-Feb	3	Plane frame	
17	14-Feb	3	Project 1 discussion, beam finite element analysis	Quiz 3
18	19-Feb	3	Buckling of columns	
19	21-Feb	3	Buckling finite element analysis	
20	24-Feb	5	Stress-strain relationship	
21	26-Feb	6	2D plane stress & strain, 2D triangle interpolation	
22	28-Feb	6	CST element	Quiz 4
23	9-Mar	6	Interpolation of 2D rectangle	
24	11-Mar	6	Q4 element	
25	13-Mar	6	Performance of CST and Q4 elements	
26	16-Mar	6	Finite element analysis for plane problems	
27	18-Mar		Exam 2 review	
28	20-Mar		Exam 2	
29	23-Mar	7	Project 2 discussion, 1D Isoparametric elements	
30	25-Mar	7	2D Isoparametric mapping, Jacobian, validity	
31	27-Mar	7	Interpolation of displacement, strain	Quiz 5
32	30-Mar	7	Numerical integration	
33	1-Apr	7	Higher-order isoparametric elements	
34	3-Apr	4	1D Heat conduction and FE formulation	
35	6-Apr	4	Heat convection	
36	8-Apr	4	2D heat transfer analysis	Quiz 6
37	10-Apr	9	Finite element analysis procedure	
38	13-Apr	9	Convergence study, finite element modeling techniques	
39	15-Apr	9	Finite element modeling techniques	
40	17-Apr		Exam 3 review	
41	20-Apr		Exam 3	
42	22-Apr	10	Structural design and optimization	

**Program Objectives and Outcomes:** Program objectives supported by this course include educating students to

1. Comprehend quantitative and analytical methods
2. Understand and perform engineering analysis of machine systems
3. Apply mathematics, science, and engineering to design
4. Communicate ideas graphically and in writing
5. Recognize the need for, and engage in lifelong learning

## Course Assignment

**Homework:** There will be about 9 homeworks. Students are required to submit homeworks on Canvas (scanned PDF file). Homework problems may require using commercial finite element software. Late homework will not be accepted under any circumstances.

**Projects:** There will be 2 Abaqus projects. Students are required to submit formal project reports on Canvas along with simulation model/results files.

**Exams:** There will be 3 in-class exams. Tentative Exam Schedule: Exam1: February 7<sup>th</sup>, Exam2: March 20<sup>th</sup>, Exam3: April 20<sup>th</sup>. Students are allowed to bring one hand-written 8½ ×11 inch formula sheet written on both sides for exams. All exams equally contribute to the grade and there will be no final exam.

**Quizzes:** There will be 6 pop quizzes given in class. The purpose of quizzes is to make students closely follow course materials.

**Grading:** Homeworks (15%), exams (50%), projects (30%), Pop quizzes (10%)

## Other course information

**Finite element analysis software:** Many homeworks and projects 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 <http://academy.3ds.com/simulia/freese>

**Grading Scale:** The final grade will be calculated by the following table.

Table 1. Grading Table. %GE = Percent Grade Earned.

Percentage Range	Grade Point
$93.33 \leq \%GE < 105.00 \implies$ A	4.00
$90.00 \leq \%GE < 93.33 \implies$ A-	3.67
$86.67 \leq \%GE < 90.00 \implies$ B+	3.33
$83.33 \leq \%GE < 86.67 \implies$ B	3.00
$80.00 \leq \%GE < 83.33 \implies$ B-	2.67
$76.67 \leq \%GE < 80.00 \implies$ C+	2.33
$73.33 \leq \%GE < 76.67 \implies$ C	2.00
$70.00 \leq \%GE < 73.33 \implies$ C-	1.67
$66.67 \leq \%GE < 70.00 \implies$ D+	1.33
$63.33 \leq \%GE < 66.67 \implies$ D	1.00
$60.00 \leq \%GE < 63.33 \implies$ D-	0.67
$00.00 \leq \%GE < 60.00 \implies$ E	0.00

**Grade Corrections:** Corrections of grades should be submitted to instructor within 5 business days of the grade posting in writing with a concise statement of why you believe there has been an error. Note that the instructor has the final determination in the grade assigned. If a grade change is determined, it may result in a lower or higher grade.

**Academic honesty:** 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 a 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.

**Accommodation for Students with Disabilities:** Students with disabilities requesting accommodations should first register with the Disability Resource Center (352-392-8565, <https://www.dso.ufl.edu/drc>) by providing appropriate documentation. Once registered, students will receive an accommodation letter which must be presented to the instructor when requesting accommodation. Students with disabilities should follow this procedure as early as possible in the semester.

**Course Evaluation:** Students are expected to provide feedback on the quality of instruction in this course by completing online evaluations at <https://evaluations.ufl.edu/evals>. Evaluations are typically open during the last two or three weeks of the semester, but students will be given specific times when they are open. Summary results of these assessments are available to students at <https://evaluations.ufl.edu/results/>.

## Health and Wellness

- U Matter, We Care: If you or a friend is in distress, please contact [umatter@ufl.edu](mailto:umatter@ufl.edu) or 352 392-1575 so that a team member can reach out to the student.
- Counseling and Wellness Center: <http://www.counseling.ufl.edu/cwc>, and 392-1575; and the University Police Department: 392-1111 or 9-1-1 for emergencies.
- Sexual Assault Recovery Services (SARS), Student Health Care Center, 392-1161.
- University Police Department at 392-1111 (or 9-1-1 for emergencies), or <http://www.police.ufl.edu/>.

**Software Use:** All faculty, staff and student of the University are required and expected to obey the laws and legal agreements governing software use. Failure to do so can lead to monetary damages and/or criminal penalties for the individual violator. Because such violations are also against University policies and rules, disciplinary action will be taken as appropriate. We, the members of the University of Florida community, pledge to uphold ourselves and our peers to the highest standards of honesty and integrity.

**Student Privacy:** There are federal laws protecting your privacy regarding grades earned in courses and on individual assignments. For more information, please see: <http://registrar.ufl.edu/catalog0910/policies/regulationferpa.html>