

## **Advanced Finite Element Method**

EGM 6352, Sections: 12731, 12733, 12734

**Class Periods:** MWF 7<sup>th</sup> period, 1:55 PM – 2:45 PM

**Location:** CSE E118

**Academic Term:** Spring 2023

### ***Instructor:***

Ashok V. Kumar

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Office Phone Number: 352 392-0816

Office Hours: MWF 9:30 AM - 10:30 AM, MAE-A 214

### ***Course Description***

3 credits - Advanced concepts related to the finite element method with emphasis on nonlinear analysis. Applications will include static and dynamic analysis of structures involving large deformation (geometric nonlinearity) and material nonlinearity.

### ***Course Pre-Requisites / Co-Requisites***

Credits 3, Pre-requisites: EML5526

### ***Recommended Textbooks:***

- a) Introduction to Finite Element Analysis and Design  
Authors: Kim NH, Sankar BV and Kumar AV.  
Edition: 2nd Edition  
Publisher: Wiley, ISBN: 9781119078739
- b) Introduction to Nonlinear Finite Element Analysis  
Author: Nam-Ho Kim  
Publisher: Springer, ISBN: 978-1441917454

### ***Other Reference Textbooks***

- a) Nonlinear Finite Elements for Continua and Structures, 2<sup>nd</sup> edition, by Belytschko, Liu, Moran and Elkhodary, Wiley Publications.
- b) The finite method for solid and structural mechanics, 6<sup>th</sup> edition, Zienkiewicz O. C. and Taylor R. L., Elsevier.
- c) A first course in the Finite Element Method, Daryl L. Logan, Thomson Publishers.
- d) A first course in finite elements, by Fish and Belytschko, Wiley Publications.
- e) Finite Element Procedures in Engineering Analysis, by K. J. Bathe, Prentice-Hall.

### ***Course Objectives***

The objective of the course is to teach advanced concepts related to the finite element method with emphasis on nonlinear analysis. Applications will include static and dynamic analysis of structures involving large deformation (geometric nonlinearity) and material nonlinearity.

The outline of the course is as follows:

- I. Background
  - a) Introduction and notations
  - b) Review of linear finite elements
  - c) Review of relevant numerical methods

- d) Plate and Shell elements
- II. Dynamic analysis of structures
  - a) Modal analysis and Modal Superposition method
  - b) Newmark method for linear dynamics
  - c) Explicit nonlinear dynamic analysis
  - d) Implicit nonlinear dynamic analysis
- III. Continuum mechanics concepts
  - a) Large deformation kinematics
  - b) Principle of Virtual Work in reference configuration
  - c) Nonlinear measures of stress and strain
- IV. Nonlinear equation solving
  - a) Newton Raphson
  - b) Modified Newton-Raphson
  - c) Quasi-Newton methods
- V. Total Lagrange Formulation
- VI. Updated Lagrange Formulation
- VII. Large deformation of truss like structures
- VIII. Continuum nonlinear elements
  - a) Plane stress & Plane strain elements
  - b) Axisymmetric elements
  - c) 3D elements
- IX. Constitutive equations for nonlinear materials

***Attendance Policy, Class Expectations, and Make-Up Policy***

**Attendance:**

You must attend lectures/lecture videos in a timely manner to keep up with the class. If you fall behind due to legitimate reasons such as medical or university work/sports then you will be allowed to take any missed quiz or exam on a later date.

**Make-up Policy:**

Late assignments will receive 75% credit if submitted within the time allowed for late submission by the e-learning system and will not be graded thereafter (if submitted by email or other means). Make up exams will be given only for students with medical reasons for missing the exam. Documentation in the form of a doctor's note must be provided for make-up exams and homework.

***Evaluation of Grades***

<b>Assignment</b>	<b>Percentage of Final Grade</b>
Exams	60%
Homework & Projects	40%
	100%

***Grading Policy***

The following is given as an example only.

Percent	Grade	Grade Points
93 - 100	A	4.00
90 - 93	A-	3.67
87 - 90	B+	3.33
83 - 87	B	3.00
80 - 83	B-	2.67
77 - 80	C+	2.33
73 - 77	C	2.00
70 - 73	C-	1.67
67 - 70	D+	1.33
63 - 67	D	1.00
60 - 63	D-	0.67
0 - 60	E	0.00

### ***Students Requiring Accommodations***

Students with disabilities who experience learning barriers and would like to request academic accommodations should connect with the disability Resource Center by visiting <https://disability.ufl.edu/students/get-started/>. It is important for students to share their accommodation letter with their instructor and discuss their access needs, as early as possible in the semester.

### ***Course Evaluation***

Students are expected to provide professional and respectful feedback on the quality of instruction in this course by completing course evaluations online via GatorEvals. Guidance on how to give feedback in a professional and respectful manner is available at <https://gatorevals.aa.ufl.edu/students/>. Students will be notified when the evaluation period opens, and can complete evaluations through the email they receive from GatorEvals, in their Canvas course menu under GatorEvals, or via <https://ufl.bluera.com/ufl/>. Summaries of course evaluation results are available to students at <https://gatorevals.aa.ufl.edu/public-results/>.

### ***In-Class Recording***

Students are allowed to record video or audio of class lectures. However, the purposes for which these recordings may be used are strictly controlled. The only allowable purposes are (1) for personal educational use, (2) in connection with a complaint to the university, or (3) as evidence in, or in preparation for, a criminal or civil proceeding. All other purposes are prohibited. Specifically, students may not publish recorded lectures without the written consent of the instructor.

A “class lecture” is an educational presentation intended to inform or teach enrolled students about a particular subject, including any instructor-led discussions that form part of the presentation, and delivered by any instructor hired or appointed by the University, or by a guest instructor, as part of a University of Florida course. A class lecture does not include lab sessions, student presentations, clinical presentations such as patient history, academic exercises involving solely student participation, assessments (quizzes, tests, exams), field trips, private conversations between students in the class or between a student and the faculty or lecturer during a class session.

Publication without permission of the instructor is prohibited. To “publish” means to share, transmit, circulate, distribute, or provide access to a recording, regardless of format or medium, to

another person (or persons), including but not limited to another student within the same class section. Additionally, a recording, or transcript of a recording, is considered published if it is posted on or uploaded to, in whole or in part, any media platform, including but not limited to social media, book, magazine, newspaper, leaflet, or third party note/tutoring services. A student who publishes a recording without written consent may be subject to a civil cause of action instituted by a person injured by the publication and/or discipline under UF Regulation 4.040 Student Honor Code and Student Conduct Code.

### ***University Honesty Policy***

UF students are bound by The Honor Pledge which states, “We, the members of the University of Florida community, pledge to hold ourselves and our peers to the highest standards of honor and integrity by abiding by the Honor Code. On all work submitted for credit by students at the University of Florida, the following pledge is either required or implied: “On my honor, I have neither given nor received unauthorized aid in doing this assignment.” The Honor Code (<https://sccr.dso.ufl.edu/process/student-conduct-code/>) specifies a number of behaviors that are in violation of this code and the possible sanctions. Furthermore, you are obligated to report any condition that facilitates academic misconduct to appropriate personnel. If you have any questions or concerns, please consult with the instructor or TAs in this class.

### ***Commitment to a Safe and Inclusive Learning Environment***

The Herbert Wertheim College of Engineering values broad diversity within our community and is committed to individual and group empowerment, inclusion, and the elimination of discrimination. It is expected that every person in this class will treat one another with dignity and respect regardless of gender, sexuality, disability, age, socioeconomic status, ethnicity, race, and culture.

If you feel like your performance in class is being impacted by discrimination or harassment of any kind, please contact your instructor or any of the following:

- Your academic advisor or Graduate Program Coordinator
- Jennifer Nappo, Director of Human Resources, 352-392-0904, [jpennacc@ufl.edu](mailto:jpennacc@ufl.edu)
- Curtis Taylor, Associate Dean of Student Affairs, 352-392-2177, [taylor@eng.ufl.edu](mailto:taylor@eng.ufl.edu)
- Toshikazu Nishida, Associate Dean of Academic Affairs, 352-392-0943, [nishida@eng.ufl.edu](mailto:nishida@eng.ufl.edu)

### ***Software Use***

All faculty, staff, and students 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 with regards to grades earned in courses and on individual assignments. For more information, please see: <https://registrar.ufl.edu/ferpa.html>

## ***Campus Resources:***

### ***Health and Wellness***

#### **U Matter, We Care:**

Your well-being is important to the University of Florida. The U Matter, We Care initiative is committed to creating a culture of care on our campus by encouraging members of our community to look out for one another and to reach out for help if a member of our community is in need. If you or a friend is in distress, please contact [umatter@ufl.edu](mailto:umatter@ufl.edu) so that the U Matter, We Care Team can reach out to the student in distress. A nighttime and weekend crisis counselor is available by phone at 352-392-1575. The U Matter, We Care Team can help connect students to the many other helping resources available including, but not limited to, Victim Advocates, Housing staff, and the Counseling and Wellness Center. Please remember that asking for help is a sign of strength. In case of emergency, call 9-1-1.

**Counseling and Wellness Center:** <https://counseling.ufl.edu>, and 392-1575; and the University Police Department: 392-1111 or 9-1-1 for emergencies.

#### **Sexual Discrimination, Harassment, Assault, or Violence**

If you or a friend has been subjected to sexual discrimination, sexual harassment, sexual assault, or violence contact the **Office of Title IX Compliance**, located at Yon Hall Room 427, 1908 Stadium Road, (352) 273-1094, [title-ix@ufl.edu](mailto:title-ix@ufl.edu)

#### **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/>.

### ***Academic Resources***

**E-learning technical support**, 352-392-4357 (select option 2) or e-mail to Learning-support@ufl.edu. <https://lss.at.ufl.edu/help.shtml>.

**Career Connections Center**, Reitz Union, 392-1601. Career assistance and counseling; <https://career.ufl.edu>.

**Library Support**, <http://cms.uflib.ufl.edu/ask>. Various ways to receive assistance with respect to using the libraries or finding resources.

**Teaching Center**, Broward Hall, 392-2010 or 392-6420. General study skills and tutoring. <https://teachingcenter.ufl.edu/>.

**Writing Studio, 302 Tigert Hall**, 846-1138. Help brainstorming, formatting, and writing papers. <https://writing.ufl.edu/writing-studio/>.

**Student Complaints Campus:** <https://sccr.dso.ufl.edu/policies/student-honor-code-student-conduct-code/>; <https://care.dso.ufl.edu>.

**On-Line Students Complaints:** <https://distance.ufl.edu/state-authorization-status/#student-complaint>