

## **EGM 6352 Advanced Finite Element Method Spring 2020 syllabus**

### ***Basic Information***

**Catalog Information:** Credits 3, Pre-requisites: EML5526

**Instructor:** Dr. Ashok V. Kumar, Associate Professor, Department of Mechanical and Aerospace Engineering. Office: MAE-A 214, Phone: 392-0816, Email: [akumar@ufl.edu](mailto:akumar@ufl.edu).

**Class time and location:** MWF 7<sup>th</sup> period CSE E107

**Office hours:** Instructor MWF 10:00-11:00 AM

**Teaching Assistant:** TBD

### **Recommended Textbook:**

1) Introduction to Finite Element Analysis and Design  
Authors: Kim NH, Sankar BV and Kumar AV.  
Edition: 2nd Edition  
Publisher: Wiley, ISBN: 9781119078739

2) Introduction to Nonlinear Finite Element Analysis  
Author: Nam-Ho Kim  
Publisher: Springer, ISBN: 978-1441917454

### **Recommended reading:**

- (i) “Nonlinear Finite Elements for Continua and Structures”, 2<sup>nd</sup> edition, by Belytschko, Liu, Moran and Elkhodary, Wiley Publications.
- (ii) “The finite method for solid and structural mechanics”, 6<sup>th</sup> edition, Zienkiewicz O. C. and Taylor R. L., Elsevier.

### ***Course objectives and outcomes***

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
- 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 elements
  - a) Plane stress & Plane strain elements
  - b) Axisymmetric elements
  - c) 3D elements
- IX. Modified Newton method with automatic load stepping
- X. Instability and Buckling
- XI. Constitutive equations for nonlinear material behavior
- XII. Structural elements
  - a) Nonlinear beams
  - b) Nonlinear plates and shells

### ***Course assessment***

Examinations: There will be in-class examinations worth 50% of the final grade

Graded Homework: Homework will be posted online

Projects: Projects involve using a software for finite element analysis

Grading: Exams & Quizzes: 50%, Homework & Projects: 50%.

### ***Other course information***

Reference books:

- a) "A first course in the Finite Element Method", Daryl L. Logan, Thomson Publishers.
- b) "A first course in finite elements" by Fish and Belytschko, Wiley Publications.
- c) "Finite Element Procedures in Engineering Analysis", by K. J. Bathe, Prentice-Hall.

Attendance:

Attendance is very important as there will be frequent unannounced quizzes. If you have to miss a class for 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.

Academic Honesty:

All students admitted to the University of Florida have signed a statement of academic honesty committing them 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.

#### 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/>.

#### 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://www.dso.ufl.edu/sccr/process/student-conduct-honor-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. A violation of the honor code will result in academic sanctions (typically a failing grade assigned for the course) and further disciplinary action. If you have any questions or concerns, please consult with the instructor or TAs in this class.

#### Software Use and Copyrighted Material

All faculty, staff, and students of the University are required and expected to obey the laws and legal agreements governing software use and the use of copyrighted material. 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: <http://registrar.ufl.edu/catalog0910/policies/regulationferpa.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:** <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/>.

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 Resource Center**, Reitz Union, 392-1601. Career assistance and counseling. <https://www.crc.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://www.dso.ufl.edu/documents/UF\\_Complaints\\_policy.pdf](https://www.dso.ufl.edu/documents/UF_Complaints_policy.pdf).

**On-Line Students Complaints**: <http://www.distance.ufl.edu/student-complaint-process>.