EGM6352 (1E75)

Advanced Finite Element Methods

EGM 6352 (Spring 2017)
Instructor: Nam-Ho Kim (nkim@ufl.edu)
Office Hour: MWF 4th (10:40 – 11:30)
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Syllabus

- Credit 3, Prerequisite: EML 4507, EML 5526, or equivalent
- Class time and location: E118 CSE, MWF 7th (1:50 - 2:40)
- **Office hours:** MWF 4th (10:40 – 11:30)
- Text books:
  - "Introduction to Nonlinear Finite Element Analysis" by N. H. Kim (**Required**). Springer, 2014, ISBN-10: 1441917454
  - "Computational Inelasticity", by J.C. Simo and T.J.R. Hughes, Springer, NY. (**Recommended**)
  - "Nonlinear Finite Elements for Continua and Structures", by T. Belytschko, W. K. Liu, and B. Moran, Wiley, NY. (**Recommended**)

Objectives and Outcomes

- **Catalog description**: Advanced topics in finite element analysis, emphasized on nonlinear problems including nonlinear elasticity, hyperelasticity, elastoplasticity (small and large deformation), and contact problems
- The **objective** of this course is to learn advanced topics in FEM so that this tool can be used for analysis, design, and optimization of engineering systems.
- Will focus on **nonlinear structural analysis**. Various nonlinearities in structural problems will be studied in the mathematical and numerical aspects.
- Students will also be exposed in computer programming and use of commercial FE programs.

Outlines

- Preliminary concepts
- Finite element analysis procedure - linear problems
- Introduction to nonlinear FEA procedures
- FEA for nonlinear elastic problems
- FEA for elastoplasticity
- FEA of contact problem
- FEA of dynamic problem (Depending on course progress)

Homework and Exams

- Homework
  - Programming and formulation problems will be assigned on Canvas at https://ufl.instructure.com/courses/335300.
  - Homework needs to be submitted by midnight on Canvas. Late homework will not be accepted
- Exams
  - There will be two mid-term exams and no final exam
  - Tentative schedule: Feb 27, April 12
- Class participation
  - Students can get small extra credits if s/he finds an error in the textbook and report to the instructor first time.
  - Students who asked questions or answered questions in the class should send an email to the instructor to get class participation points. To get full credits (5%), students need to ask/answer 5 times throughout the semester.

Homeworks, Projects, Exams, and Grading

- **Projects**:
  - Two term projects, equally contributing
  - MATLAB implementation of hyperelasticity
  - Solving nonlinear structural problems using Abaqus.
  - **Projects** must be submitted midnight on Canvas. Late projects submitted by the next day will receive 90% credit. Projects received later than that will not be accepted.
- **Grading**: Exam: 40%, Projects: 40%, Homeworks: 15%, Class participation: 5%
  - (A=93~100, A-=90~92.9, B+=87~89.9, B=83~86.9, B-=80~82.9, C+=77~79.9, C=73~76.9, C-=70~72.9, D+=67~69.9, D=63~66.9, D-=60~62.9, E=0~59.9).

Installing Abaqus

- All students are required to install Abaqus SE on their personal computer
- It is not allowed to use lab computer for class assignments
- Use the following link for downloading software: http://academy.3ds.com/software/abaqus-student-edition/
- You will need the software for homeworks and projects
- If you are familiar to other FE software (ANSYS, Nastran, etc), you can use it, but class will follow with Abaqus

Tentative Schedule

Date	Content	Note
1/4 Wed	Course instruction, vector and tensor	Quiz
1/6 Fri	Vector and tensor, stress and strain	Chap1
1/9 Mon	AIAA SciTech conference, no class	
1/11 Wed	AIAA SciTech conference, no class	
1/13 Fri	Stress and strain	
1/16 Mon	Martin Luther King day, no class	
1/18 Wed	Mechanics of continuous bodies	
1/20 Fri	Finite element method (FEM)	
1/23 Mon	MATLAB Code ELAST3D	
1/25 Wed	Introduction to nonlinear FEM	Chap2
1/27 Fri	Nonlinear solution procedure	
1/30 Mon	MATLAB code NLFEA	
2/1 Wed	Nonlinear analysis using Abaqus	
2/3 Fri	Stress and strain measures	Chap3

Tentative Schedule cont.

2/6 Mon	Stress and strain measures	
2/8 Wed	Nonlinear elastic analysis	
2/10 Fri	Variational formulation and linearization	
2/13 Mon	Hyperelastic material	
2/15 Wed	Hyperelastic material	
2/17 Fri	FE formulation for nonlinear elasticity	
2/20 Mon	MATLAB code HYPER3D, FE analysis using Abaqus	
2/22 Wed	Fitting hyperelastic material parameters	
2/24 Fri	1D Elastoplastcity	Chap4
2/27 Mon	Hardening models	Exam 1
3/1 Wed	Elastoplastic analysis using Abaqus	
3/3 Fri	Failure criteria	
3/6 Mon	Spring break, no class	
3/8 Wed	Spring break, no class	
3/10 Fri	Spring break, no class	
3/13 Mon	Multi-dimensional hardening models	
3/15 Wed	Numerical integration for elastoplasticity	
3/17 Fri	MATLAB code PLAST3D	

Tentative Schedule cont.

3/20 Mon	Elastoplastic analysis using Abaqus	Project 1
3/22 Wed	Objective stress rates	
3/24 Fri	Elastoplasticity with finite rotation	
3/27 Mon	Multiplicative decomposition & dissipation	
3/29 Wed	Time integration in principal stress space	
3/31 Fri	MATLAB code MULPLAST	
4/3 Mon	Large deformation plasticity with Abaqus	
4/5 Wed	1D contact analysis	Chap5
4/7 Fri	Constraint methods for contact analysis	
4/10 Mon	2D contact variational inequality	
4/12 Wed	Finite element formulation for contact	Exam 2
4/14 Fri	Contact modeling issues	
4/17 Mon	Contact analysis using Abaqus	
4/19 Wed	Backup class	Pr2 (4/24)