ENME 470 Finite Element Analysis

Spring 2019

Instructor: Prof. Peter W. Chung (pchung15@umd.edu, Glenn L Martin Hall 2135)

Office Hours: Monday's, immediately after class in GLM 2135

Course Description: Over the last half-century, few developments have had as much impact on engineers as the Finite Element Method. Today, software built for the method are *de facto* standard "instruments" for analysis and research. Yet, with anything so powerful, the risk of it being corrupted and misused is great. Without an understanding of what is happening under the hood of FE software packages, users can often produce attractive images of flawed or possibly wrong results.

This class introduces basic concepts of the Finite Element Method using a balance of theory and applications using commercial software. The primary focus will be to learn how FE theory and FE practice work together. The course will use a significant amount of matrix arithmetic and physical concepts for mechanics of materials and transport processes, as well as software packages including Creo, Solidworks and ANSYS. We will learn how to set up and run problems for stress and thermal analysis. At the end of this course, students will have the following primary knowledge:

1. Fundamentals for mathematically formulating mechanics and FEA problems
2. Familiarity with setting-up and solving FEA problems

NOTE: This course will be redesigned starting Spring 2019.

Required Textbooks:

- Clayton & Chung, "Finite Element Analysis: Lecture Notes on Principles and Procedures," ISBN: 9781721867462. (https://www.amazon.com/Applied-Finite-Element-Methods-Principles/dp/1721867465)
- Guangming Zhang,"Engineering Analysis w/Pro-Mechanica and ANSYS". ISBN: 9781935673033

Course Topics:

Topic 1: Introduction to the course and the finite element method, the main components of a finite element analysis
Topic 2: 1D structural mechanics: trusses and beams.
Topic 3: Direct method: Stiffness and Force Matrices, Truss elements and Beam elements
Topic 4: Use of multiple finite element packages
Topic 5: Modeling structural behavior with solid elements, Maximum principal and von Mises stress, Stress concentration factor, Applying boundary and load conditions
Topic 6: Parametric design and Design optimization
Topic 7: FE mechanical analysis using 1D, 2D and 3D elements
Topic 8: Heat Transfer, Thermomechanical FEA
Topic 9: Modal analysis, Dynamics, and Transient FEA

Student Learning Outcomes (ABET):

- Ability to apply knowledge of mathematics, science, and engineering.
- Ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.
- Ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

- Recognition of the need for, and an ability to engage in life-long learning.

Grading:

- Homework assignments: 30%
- Mid-Term Exam: 40%
- Final Exam: 30%

Final grades are determined using traditional 10 point grading scale.

Homework:

Homework will be submitted and graded electronically through gradescope. Students are responsible for submitting the correct assignment, assigning the correct pages to the correct problem, and getting their assignments in on time. Assignments that fail to adhere to these policies will not be graded on time, if at all.

You may elect to re-do your homework after the due date for 50% credit. But this must be done before homework answers/solutions are posted.

Software:

- All software required to complete the assignments is accessible through the Virtual Computing Laboratory (http://eit.umd.edu/vcl)
- Use of software (such as Matlab or Mathematica) is permitted to assist in the development of handwritten or word-processed solutions. However, no raw computer format (such as in Mathematica or Matlab syntax) will be graded.

Additional Book & Reading Resources:

- J. N. Reddy, An introduction to the finite element method (2005).
- K. H. Huebner, D. L. Dewhirst, D. E. Smith, T. G. Byrom, The Finite Element Method for Engineers (2001).
- O. C. Zienkiewicz, R. L. Taylor, J.Z. Zhu, The Finite Element Method: Its Basis and Fundamentals, Sixth Edition (2005).
- T. J. R. Hughes, The Finite Element Method: Linear Static and Dynamic Finite Element Analysis (Paperback) (2000).
- J. Fish and T. Belytschko, A First Course in Finite Elements (Paperback) (2007).
- J. T. Oden, E. B. Becker, G. F. Carey, Finite Elements: An Introduction. Volume I (1981).

Course Policies:

- In-class participation is mandatory. Due to the significant studio time spent in class, absence(s) will significantly stifle learning and result in a poorer grade.
- Absences will be excused per the published allowable types of excused absences in the University official guidance.
- Materials missed due to an absence will be the student's responsibility. Though every effort will be made to post any changes in the deadlines, assignments, or dates of exams on Canvas, most of the time announcements will only be made verbally in class.
- Students who miss a major grading event for any reason must contact the instructor in advance, and upon return to class, provide supportive officially-recognized documentation.
- All students are bound by the honor code and code of academic integrity for all assignments, exams, and projects. The pledge should be written and signed on all submissions for grade. Code of Academic Integrity