Finite Element Modeling

Syllabus

MET 4203 or MAE 4010
Finite Element Methods

Summer 2017

Professor

Dr. Hitesh D. Vora

Assistant Professor
386, Cordell South, Mechanical Engineering Technology
Phone: (405) 744-9578
Email: hitesh.vora@okstate.edu
Office Hours: To be announce soon

Volunteer Teaching Assistant

To be announce soon

Schedule

Online Classroom (**D2L**) Support

- For help with using OSU Online Classroom (D2L) visit http://itle.okstate.edu/d2l
- For further assistance, contact helpdesk@okstate.edu or call 405-744-4357.

Course Prerequisites

- Machine Design I, Senior Standing in Engineering Technology
- Knowledge of Statics, Dynamics, and Strength of material will be helpful

Course Description

This class teaches the fundamentals of Finite Element Methods (FEM) with hands-on experience in numerical implementation and applications.

Objectives

The students should understand the mathematical and physical principles underlying the finite element analysis (FEA).

- Be able to identify and solve relatively complex engineering problems using commercial FEA code using ANSYS Workbench 16 or higher version
- To provide students with basic skills of FEM programming
- Be able to write FEA technical report to clearly show his/her work

Learning Outcomes

Specifically, you will develop the ability to:

- Understand the general steps of finite element methods.
- Understand the basic finite element formulation techniques.
- Be able to derive equations in finite element methods for 1D, 2D and 3D problems.
- Be able to formulate and solve basic problems in static structural, solid mechanics, and heat transfer
- Be able to analyze complex engineering problems in in static structural, solid mechanics, and heat transfer
- Be able to use ANSYS, a commercial software, to solve basic engineering

Textbook (Required)

Finite Element Simulations with ANSYS Workbench 17 - Theory, Applications, Case Studies, By Huei-Huang Lee, SDC Publications, 608 Pages,

- Need printed copy - ISBN: 978-1-63057-088-0

Style/Mode of Teaching

Generally, there will be a one module (two lectures) per week on FEM fundamentals and demonstration of building FE model (mostly on Monday) followed by lab practice (mostly on Wednesday) for corresponding lab assignment. There will be a one quiz (time enforced) per week on the topic of that particular week. Because of the large content of text material (class notes) encountered in this course, limited time will allow for only portions of this information to be discussed in lecture. The student is expected to study the text material before coming to lecture and be prepared for a discussion of the reading material. This reading material will also be thoroughly covered by the quizzes and Exam.

Software download

Instructions:

- You should be able to install the ANSYS free student license, as described on the CEAT IT website: http://ceat-its.okstate.edu/ansys.
- From this page, you need to click the link that says "*Click Here To Access The ANSYS Installation Instructions*"
- This will bring you to a SharePoint page from which you can download the install files and read about how to install the software.
- You will need to log in to the SharePoint page with the O-key credentials.
- If you have difficulty downloading the software, you can come to EN323 and they will provide you a copy of the install files. CEAT-IT staff is also available to help you install the software.

Two items of note about ANSYS:

- This is a very large software package, so the installation may take several hours.
- In order to use the software, you must either be on campus, or be connected to the campus network via VPN

For more help, contact **Mike Melançon**, IT Supervisor, 323 Engineering North, Oklahoma State University, (405) 744-6646, michael.melancon@okstate.edu

Please do the needful as soon as possible and come ready for first day of the class.

Computing Requirements

For students in the College of Engineering, Architecture and Technology (CEAT), the college requires that all students have several basic tools. Students in the College must have a scientific calculator and a laptop computer. The scientific calculator should be capable of computing trigonometric functions, logarithmic and natural logarithmic functions, basic statistical analysis, and all algebraic functions.

The laptop requirements are published on the college IT website: http://ceat-its.okstate.edu.

Student should have their own laptop with pre-installed running version of ANSYS 16 or higher version during all the meetings (theory and lab classes). Computer application / software courses can become frustrating and tedious. Students are expected to take this in stride without abusing equipment or expressing verbal hostility. From time-to-time you'll lose your work due to a system failure and be required to start over again. You can avoid a lot of frustration by saving your work frequently to your own memory device and your path on the network drive.

Assignments

There will be two course projects. The students are expected to identify their own problems to solve by both hand calculations and computer simulation, a detailed report should be submitted to instructor by deadline. The students will need to present his work in the class. The further detail plan will be communicated soon.

Generally, lab assignment problems should be solved by hand calculations and verified by running FEA software. The lab assignment can be typed and nice and neat hand written homework is acceptable, computer simulation results should be printed out and attached to the homework.

FEM lab assignments will constitute a major portion of the requirements. These assignments will be given after the theory lecture (at the end of Monday class). You should work on your lab assignments during normal scheduled lab periods (after lecture on Monday and during whole Wednesday lab time). If extra time is needed, you may work on your assignments on your own personal computer. Each student must complete each lab assignment as per the teacher's strict requirement. The lab assignments may also be given from the textbook with some changes or completely outside from the book.

The assignment is due PROMPTLY at the beginning of class of the first period the following week (on Monday). If your assignment is incomplete, submit the partially completed assignment for partial credit. Late work, due to tardiness, will be accepted for a 10 % reduction in grade until the end of the first class period of the week (Monday class). No work will be accepted after that unless I've previously received voice mail, written word or e-mail from you and have approved your absence. Your work will be graded based on the accuracy of the model and hand calculations, steps you followed, neatness of lab report, proper interpretation of instructions. It must be done on an independent basis, so DO NOT COPY or downloaded from other sources in any way.

Quiz & FEM Projects

There are ~15 labs and ~8 quizzes during the semester. These quizzes are on D2L. There is **NO MIDTERM OR FINAL EXAM** for this course. However, there will be a FEM projects

that will be considered as final exam. The FEM final exam project is due on August 4th 2017 before 5p CST on D2L.

There will be a one quiz per week on the topic of that particular week. Each of the quiz is enforced by the time limit and valued at different points. The quiz may be consisting of some multiple choice questions generated from your reading assignments and class notes or on a FEM problem. Make-up Quiz will not be given therefore it is necessary for you to be present at all quizzes. If you must miss quiz, you will need an excused absence from me prior to the exam or quiz.

The students are expected to identify their own problems for course project. Project will be evaluated based on the creativity, challenge, and analysis of the problem. The project should extend the scope of the course. The technical report (procedure-free) should be submitted before deadline given above. The good Technical report should explain the problem, describe the results, interpretation and conclusions, and provide detail about the time utilization.

Course Milestones

- What's the format? (the plan)
- First few lectures emphasize how FEA works
    - lightweight, short presentation of the theory
- Move right into ANSYS, cover the process of running your first basic analysis
    - I will do the problem for you and record all steps
    - I will provide examples of all the basic analysis assignments
    - You will modify the geometry and learn by doing a unique but similar problem
- To keep the course within the confines of ANSYS Workbench, we will concentrate on 2-D stress analysis covering a wide range of continuum problems. We will work in ANSYS Workbench:
    - you can draw and import from your preferred software and use either of these environments
    - We will do one nonlinear material problem
    - Also at least one nonlinear contact analysis
    - There will be a project
        - requiring independent work extending the coverage of the course and a short format report
- How do I Earn my grade?
- Participation
    - You wanted a course where we DO finite element problems
    - It seems logical to get credit for doing the work
    - No further reminders
    - Paper copies of output plots (low tech = low failure rate)
- Lab assignment and lab report
    - Weekly hand-written title sheet and problem statement
    - Given

    - Find
    - Model, sketches
    - Results
    - Conclusion/application/summary
- Project
    - Extend the scope of the course
    - technical report (procedure-free)
        - Explain the problem
        - Describe the results
        - Interpretation and conclusions
        - Time Utilization?
- Outside of class work load:
    - **Speedy the multi-task-er** gets all his work done in class, simultaneously surfs ebay for motorcycle parts as I present each week's work. Once and done, but often hurries to miss the point.
    - **Average learner** takes some notes and can get thru with neighbor's help over detail-ridden hurdles. Outside class 1 hour per week makes all the difference especially in the beginning.
    - **Conservative employee-type** writes everything down and gets every detail right, needs minor detail help on one screen. Gets through once, but likes to re-do the project independently without distractions 2 hours per week to build confidence.

Office Hours

Virtual office hours. We are more than happy to address our queries and concerned over the email or D2L discussion forum. Please prepare yourself for visit prior to such discussion forum so that it is easy for us to answer it precisely. We will help you providing more info and clear any doubt on fundamentals that you may missed during the lecture and that may be important to solve homework. However, as per the OSU academic policy, **we will not check your FEM program or grade** before submission. So, please don't ask such direct questions (*e.g. Is my answer is correct? Is drawing looks ok? Can you check that everything looks good?*) while you meet us. We follow an open door policy but visiting in allocated office hours are highly recommended.

Virtual Office Hours for online discussion: To Be Announce Soon.

Electronic Device Policy

Electronic devices (laptops, tablets, and cell phones) are useful tools in engineering, but can be a distraction from learning for the user as well as the surrounding students. As such, it is the policy of the MAE/ MET department that such devices shall not be used during class/lecture time. Cell phones may be ON, but should be in silent mode and stowed in a bag or pocket. Students who violate this policy will be asked to leave class immediately and will be counted as absent.

Academic Integrity

Copying is simple to accomplish in a computer course. I rely on the HONOR system and on your personal integrity NOT TO CHEAT. Since you're partially competing for grades, if someone cheats then that person is stealing someone else's grade. If you suspect someone of cheating, please anonymously leave me word of your suspicions. There are a number of methods that then can be used to monitor for cheating. Copying or cheating in any way is prohibited and will result in a failing grade for the assignments, exams, and/or the course.

Quiz, Lab Assignments, and Final Project:

In this course each student must do his/her own work on quizzes and lab assignments as explained below. Handing in the work of others and claiming it to be your own work is cheating. Mainly, student work independently for their own lab assignment. Each student must turn in homework that he/she has done and not the work of someone else. Students are not allowed to exchange their copies of FE models among themselves. A student must not copy another student's lab report. Submitting homework that is copied from others, from files, or from solution manuals is plagiarism and will lead to a reduction in the course grade. However, learning through discussions with fellow students can be a positive learning experience. If you start a problem yourself, then discuss it with others, you are learning; if you look at a file or another student's work before beginning the problem, you are engaging in unethical conduct. After trying the homework on your own, you may discuss the approach to solving problems with other students but do the detailed work yourself. If there is any question about this policy, the student should contact me.

Email

Email communication with the instructors in this class should be considered formal, similar to other business-style email correspondence:

- Be specific about the subject of the email in the mail subject heading.
- The course number and the days your class meets (MAE 4010 or MET 4203).
- Title (brief description) of your email.
- Your email should address your instructor by title and name (Dr. Vora or Professor Vora).
- Use appropriate capitalization, spell out words completely, and sign your complete name.
- Expect faculty to respond to emails between 9am and 5pm on Monday through Friday with a 48-hour lag time.
- For any concerns about grades, meet with your professor or TA face-to-face.
- Before sending questions via email, make sure that your question is not answered on the course syllabus or website.

- No assignment will be accepted through email (for CAD models or any documents).

Course Grade

In establishing final grades, I generally begin by following the grading criteria shown below. The percent you earn will never be reduced. However, sometimes grades are improved because of curving. I cannot predict the possible curve during the semester. You may get a rough idea of your grade status from finding your accumulated score on D2L. Final grades will be subjectively improved (but not guaranteed) in borderline cases by observed class participation and attitude.

Grades for lab assignments and exams will be posted on-line (D2L) as early as possible. If a grade has been posted incorrectly, please inform me by submitting the graded copy of the assignment in question as soon as possible. Therefore, it is very important that you maintain a file of your returned graded assignments.

The final course grade will be determined by a strict percentage per the class grade structure. Percentages correspond to grades as:

- A = Superior, 90-100%
- B = Good, 80-89%
- C = Average, 70-79%
- D = Minimum Passing, 60-69%
- F = Failure, Below 60%

The tentative (subject to change) grade structure for the course is as follows:

- 10% - Participation on discussion forum, and viewing course content on D2L
- 10% - Quizzes
- 40% - Lab assignments
- 50% - Course Project

Grades will not be discussed over email. If you wish to discuss grades with me, it must be in person.

Special Accommodations

According to the Americans with Disabilities Act, each student with a disability is responsible for notifying the University of his or her disability and to request accommodations. If any member of a class thinks that he/she has a qualified disability and needs special accommodations, he/she should notify the instructor and request verification of eligibility for accommodations from the Office of Student Disability Services, 315 Student Union. Please advise the instructor of such disability as soon as possible, and contact Student Disability Services, to ensure timely implementation of appropriate accommodations. Faculty have an obligation to respond when they

receive official notice of a disability but are under no obligation to provide retroactive accommodations. To receive services, you must submit appropriate documentation and complete an intake process during which the existence of a qualified disability is verified and reasonable accommodations are identified.

Summer 2017 Tentative Schedule

Every week - Two chapters per module

Module / Week #	Topic	Text Reading	Due Dates
# 1 06/12/17	Chapter 1: **Introduction**	Chapter 1	Lab # 1 & 2 06/19/17 @ 5pm CST
	Chapter 2: **Sketching**	Chapter 2	
# 2 06/19/17	Chapter 3: **2D Simulations**	Chapter 3	Lab # 3 & 4 06/26/17 @ 5pm CST
	Chapter 4 & 5: **3D Solid Modeling and Simulations**	Chapter 4 & 5	
# 3 06/26/17	Chapter 6: **Surface Models**	Chapter 6	Lab # 5 & 6 07/03/17 @ 5pm CST
	Chapter 7: **Line Models**	Chapter 7	
# 4 07/03/17	Chapter 8: **Optimization**	Chapter 8	Lab # 7 & 8 07/10/17 @ 5pm CST
	Chapter 9: **Meshing**	Chapter 9	
# 5 07/10/17	Chapter 10: **Buckling and Stress Stiffening**	Chapter 10	**Proposal - FEM Project** Lab # 9 & 10 07/17/17 @ 5pm CST
	Chapter 11: **Modal Analysis**	Chapter 11	
# 6 07/17/17	Chapter 12: **Transient Structural Simulations**	Chapter 12	Lab # 11 & 12 07/24/17 @ 5pm CST
	Chapter 13: **Nonlinear Simulations**	Chapter 13	
# 7 07/24/17	Chapter 14: **Nonlinear Materials**	Chapter 14	Lab # 13 & 14 07/31/17 @ 5pm CST
	Chapter 15: **Explicit Dynamics**	Chapter 15	
# 8 07/31/17	**One-on-one discussion for FEM project**	-	**FEM Project Report** Lab # 15 08/04/17 @ 5pm CST
	No Final Exam – FEM project will be considered as final exam	-	

Thank You