ME 461 Finite Elements in Engineering  
Spring 2019

Lecture Schedule: M W F 9:05 am – 9:56 am, Keller 115
Instructor: Dr. Jing Du, jingdu@psu.edu, (814) 863-1043. Office hour: Th 10:00 am – 12:00 pm, 316B Leonhard
Teaching Assistant: Wei Zhang, wxz128@psu.edu, Office hour: Th 1:00 pm – 3:00 pm, 337 Reber

Text: Introduction to Finite Elements in Engineering, Chandrupatla/Belegundu, 4th Ed

Prerequisite: E MCH213, E MCH210H, or E MCH210; CMPSC200, CMPSC201 or CMPSC202

Introduction:
This is an introductory course in the Finite Element Method (FEM). Through this course, students gain knowledge in finite element theory and problem modeling. The mathematical formulation of the method is presented and then applied to problems in elasticity and heat transfer. Projects are assigned to demonstrate the finite element method in simplified problems using hand-calculations and computer programs such as Matlab. The use of commercial FEM programs is introduced and problems of increased complexity are assigned to demonstrate their use. Finally, problems of realistic complexity are assigned such that students can practice solving, documenting and presenting their use of commercial FEM programs.

Objectives:
After completing this course, the students will be able to:
1. Understand fundamentals of FEM theory. This includes generalized Hook’s law, Rayleigh–Ritz method with energy functional, shape functions and derivation and assembly of FE matrices
2. Simplify mechanics problems and build model to analyze them. These include rigid body motion, symmetry and multipoint constraints.
3. Hand-calculate 1-D and 2-D problems
4. Understand and write FEM code
5. Use commercial FEM software
6. Interpret results through improved understanding of mechanics

Tentative Schedule:

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<th>Week</th>
<th>Topic</th>
<th>Reading</th>
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<td>1</td>
<td>Elasticity Review</td>
<td>Ch 1</td>
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<td>2</td>
<td>Elasticity Review</td>
<td>Ch 1</td>
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<td>3</td>
<td>Potential Energy and Galerkin’s Methods</td>
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<td>4</td>
<td>Potential Energy and Galerkin’s Methods</td>
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<td>5</td>
<td>1D Elasticity Problems</td>
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<td>1D Elasticity Problems</td>
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<td>Truss Problems</td>
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<td>8</td>
<td>Beams/Frames</td>
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<td>9</td>
<td>Spring Break. No class.</td>
<td>Ch 5</td>
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<td>10</td>
<td>Beams/Frames. Midterm Exam #1.</td>
<td>Ch 6</td>
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<td>11</td>
<td>Triangular Elements.</td>
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<td>Quadrilaterals Elements.</td>
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<td>13</td>
<td>Quadrilaterals Elements. Midterm Exam #2.</td>
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<td>14</td>
<td>Three Dimensional Problems. Axisymmetric Solids.</td>
<td>Ch 7, 9</td>
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<td>15</td>
<td>Structural Dynamics. Heat Transfer.</td>
<td>Ch 10, CH11</td>
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<td>16</td>
<td>Advanced applications of FEM. Final project due on Friday</td>
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Grading Policy:
Homework: 4% × 8 = 32%  Midterm exams: 20% × 2 = 40%  Final project: 30%
< 60% = F, 60%-65% = D, 65%-70% = C, 70%-75% = C+, 75%-80%= B-, 80%-85% = B, 85%-90% = B+, 90%-95% = A-, 95%-102% = A.

• Study groups on HWs are encouraged. In the study group, discussions are encouraged. However, directly sharing your work is not allowed. The solution will be discussed in class.
• HWs must be submitted during class. For late submission, 20% grade per day will be reduced for each day it is late.
• Any issues regarding grades, including missing grades, must be resolved within a week of the assignment return date (except due to illness).
• Students must bring their graded papers when requesting a review.
• Access to Matlab and Abaqus is needed for the homework and final project.
• Midterm exams are open book and open notes. Calculator is allowed. No cellphone. No electronic device of any other kind.
• Final project report is due on the last day of class through file submission on CANVAS. Late submission is not accepted. Page number <= 9. Font size >= 9. References must be cited. Help from other people must be acknowledged.

**Attendance:**
• Abaqus software will be taught in a “hands-on” fashion where the instructor will do it from scratch. Attending class is needed to learn use of the software.
• Many discussions related to HW solutions will take place in class; while emails will be sent on some aspects, these discussions are best understood in class

**Supplementary materials:**
http://www.mathworks.com/academia/student_center/tutorials/
http://www.mathworks.com/moler/exm/chapters.html


Class accounts: [http://rcc.its.psu.edu/resources/accounts/class/](http://rcc.its.psu.edu/resources/accounts/class/)
Exceed on demand: [http://rcc.its.psu.edu/user_guides/remote_display/exceed_on_demand/](http://rcc.its.psu.edu/user_guides/remote_display/exceed_on_demand/)
Abaqus at PSU [http://rcc.its.psu.edu/resources/software/abaqus/](http://rcc.its.psu.edu/resources/software/abaqus/)

**Academic integrity:**
Academic integrity is the pursuit of scholarly activity in an open, honest and responsible manner. Academic integrity is a basic guiding principle for all academic activity at The Pennsylvania State University, and all members of the University community are expected to act in accordance with this principle.

Penn State University Academic Administrative Policies and Procedures Manual
G-9: ACADEMIC INTEGRITY
[http://www.psu.edu/oue/aappm/G-9-academic-integrity.html](http://www.psu.edu/oue/aappm/G-9-academic-integrity.html)

**Disability Access:**
Penn State welcomes students with disabilities into the University's educational programs. Every Penn State campus has an office for students with disabilities. The Student Disability Resources Web site provides contact information for every Penn State campus: [http://equity.psu.edu/student-disability-resources/disability-coordinator](http://equity.psu.edu/student-disability-resources/disability-coordinator). For further information, please visit the Student Disability Resources Web site: [http://equity.psu.edu/student-disability-resources](http://equity.psu.edu/student-disability-resources).

In order to receive consideration for reasonable accommodations, you must contact the appropriate disability services office at the campus where you are officially enrolled, participate in an intake interview, and provide documentation: [http://equity.psu.edu/student-disability-resources/applying-for-services](http://equity.psu.edu/student-disability-resources/applying-for-services). If the documentation supports your request for reasonable accommodations, your campus's disability services office will provide you with an accommodation letter. Please share this letter with your instructors and discuss the accommodations with them as early in your courses as possible. You must follow this process for every semester that you request accommodations.

**Counseling & Psychological Services (CAPS):**
CAPS can help students resolve personal concerns that may interfere with their academic progress, social development, and satisfaction at Penn State. Some of the more common concerns include anxiety, depression, difficulties in relationships (friends, roommates, or family); sexual identity; lack of motivation or difficulty relaxing, concentrating or studying; eating disorders; sexual assault and sexual abuse recovery; and uncertainties about personal values and beliefs.

You can contact CAPS by calling the Main CAPS number/Appointment Scheduling: 814-863-0395 (Please call between the hours of 8am and 5pm, Monday-Friday to schedule an appointment) or visit us at our office location, 5th Floor Student Health Center.