AAE 69000: Multiscale Structural Mechanics

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Course Information
Fall, 2018, TR
4:30-5:45 PM, ARMS 3115
Course website
https://cdmhub.org/groups/msm2018

Course Description

This course covers fundamentals of micromechanics, structural mechanics needed for design and analysis of composite structures capturing microstructural details including fiber/matrix and other constituent materials. This course assumes an introductory background in elasticity and finite element method, and aims to provide students a unified framework for multiscale structural mechanics. This course emphasizes concepts of mechanics through formulating and solving typical problems of anisotropic, heterogeneous structures, and helps foster an in-depth understanding of the subject. Students not only gain knowledge of the fundamental principles needed for multiscale simulation but also gain an integrated and consistent understanding of multiscale structural mechanics based on Continuum Mechanics.

Learning Outcomes

On completing this course the student shall be able to:

1. Identify distinct features of composites and challenges associated with modeling and simulation of composites.
2. Critically evaluate major theories in the literature and explain their strengths and weaknesses.
3. Exam and explain simulation results for composite structures.
4. Apply mechanics of structure genome to derive new models for composite structures.
5. Design and analyze composite structures using SwiftComp and other commercial composite simulation software.

Prerequisites:

Knowledge of linear elasticity, mechanics of composite materials, and finite element method. If you are not sure about your background, please check with the instructor.

Textbook:

No required textbook. Lectures notes will be provided.

Topics to be covered

1. Introduction: characteristics of composites, challenges of composites modelling, traditional approaches to composite models.
2. Review of anisotropic elasticity and mechanics of composites.

3. Variational methods: calculus of variations and Ritz method, variational asymptotic method.
4. Fundamentals of micromechanics: RVE, Hill condition, boundary conditions, mean field theories, RVE analysis, method of cells and its variants, asymptotic homogenization theory.
5. Fundamentals of structural mechanics: theory of beams and theory of plates.
6. Failure of composite structures.
7. Mechanics of structure genome.
8. Use of SwiftComp for multiscale constitutive modeling of composite structures.

Grading

Weighs: Biweekly homework assignments (50%); Course projects (40%); Quizzes (10%)
Grades: A: 90-100%; B: 80-89%; C: 70-79%; D: 60-69%; F: <60%

Homework: Homework is *essential* for understanding and reinforcing what has been taught in class as well as applying learned concepts to real-world problems.

1. Approximately one homework set will be assigned every two weeks to practice what you have learned in class.
2. Homework will be due at the beginning of Tuesday lecture and graded homework will be returned the following week unless otherwise specified.
3. Label each assignment with Name, Assignment #, and date clearly.
4. Homework should be done on 8 ½" × 11" paper; "Engineering Pad" sheets are preferred.
5. Homework must be done in a structured, logical, and orderly manner enabling grader to readily verify steps, equations, and methods used.
6. Show your work to explain your answers. No credit will be given for correct answers without explanation.
7. We will try to accommodate late submittals, but we can only do this if you ask instructor's approval 24 hours in advance if you are facing an extraordinary situation that prevents you from completing an assignment on time.
8. Collaboration on the homework is permitted, as learning from peers is a valuable addition to the educational experience. However, each student is responsible for completing his/her own work. Submitted work must be demonstrably independent from that of other students.

Projects: Students will be required to complete a mid-term project and a final project closely related with modeling of advanced structures and materials.

Quizzes: As an incentive for promptness, reading ahead, and alert attendance, unannounced quizzes will be given in class. Please prepare your own paper (index card is preferred) and pen for the quizzes.

Reading: Reading ahead facilitates comprehension and maximizes use of the lecture time. The schedule indicates the material to be covered on a weekly basis.

Course Forum: We will use cdmHUB as the major platform for our communications. Rather than emailing questions, you are encouraged to post your questions on cdmHUB.org. Find our class page at: https://cdmhub.org/groups/msm2018.

Academic Dishonesty
Purdue prohibits "dishonesty in connection with any University activity. Cheating, plagiarism, or knowingly furnishing false information to the University are examples of dishonesty." [Part 5, Section III-B-2-a, University Regulations] Furthermore, the University Senate has stipulated that "the commitment of acts of cheating, lying, and deceit in any of their diverse forms (such as the use of substitutes for taking examinations, the use of illegal cribs, plagiarism, and copying during examinations) is dishonest and must not be tolerated. Moreover, knowingly to aid and abet, directly or indirectly, other parties in committing dishonest acts is in itself dishonest." [University Senate Document 72-18, December 15, 1972]. **Academic dishonesty will be reported to the university and result in grade F for the class.** All students need to adhere to Purdue's honor pledge "As a boilermaker pursuing academic excellence, I pledge to be honest and true in all that I do. Accounta-ble together - we are Purdue." You can go to Purdue's Honor Pledge to understand more about this pledge. Student guide for academic integrity for more details: www.purdue.edu/odos/aboutodos/academicintegrity.php.

Use of Copyrighted Materials
Among the materials that may be protected by copyright law are the lectures, notes, and other material presented in class or as part of the course. Always assume the materials presented by an instructor are protected by copyright unless the instructor has stated otherwise. Students enrolled in, and authorized visitors to, Purdue University courses are permitted to take notes, which they may use for individual/group study or for other non-commercial purposes reasonably arising from enrollment in the course or the University generally.

Attendance
Students are expected to be present for every meeting of the classes. Only the instructor can excuse a student from a course requirement or responsibility. Complete policy is at www.purdue.edu/odos/services/classabsence.php.

Violent Behavior Policy
Violent Behavior is prohibited in or on any University Facility or while participating in any university activity. See www.purdue.edu/policies/facilities-safety/iva3.html.

Students with Disabilities
If you have a disability that requires special academic accommodation, please make an appointment to speak with me within the first three (3) weeks of the semester in order to discuss any adjustments. It is important that we talk about this at the beginning of the semester. It is the student's responsibility to notify the Disability Resource Center (http://www.purdue.edu/drc) *of an impairment/condition that may require accommodations and/or classroom modifications.*

Emergencies
In the event of a major campus emergency, course requirements, deadlines and grading percentages are subject to changes that may be necessitated by a revised semester calendar or other circumstances beyond the instructor's control. Relevant changes to this

course will be posted onto the course website or can be obtained by contacting the instructors or TAs via email or phone. *You are expected to read your @purdue.edu email on a frequent basis.*

Disclaimer: This syllabus is subject to change as class progresses.