

MCEN 4228/5228
Mechanics of Composite Materials
Spring 2016 – January 11 to April 29

Lectures: Tuesday & Thursday 12:30-1:45 ECCR 105
Please note that the Lecture on February 23 (Tuesday) will be cancelled due to travel arrangement of Dr. Long

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Office hours: Tuesday & Thursday 1:45-2:45 or by appointment

Course Description: This course will start with a brief review on the fundamentals of solid mechanics and then introduce the concepts required to analyze composite materials. Topics to be discussed include: elastic behavior and strength of composites, failure analysis, uni-directional lamina and multi-directional laminate, effects of temperature and humidity, and experimental testing methods.

Textbook: No textbook is required. Lecture notes will be based on the textbook: I.M. Daniel, O. Ishai, *Engineering Mechanics of composite materials*, Second Edition, Oxford University Press. Lecture notes and homework assignments will be distributed online through D2L.

Grading: The final grade will be evaluated based on three components: homework assignments (30%), in-class quizzes (30%), and a final project (40%).

- *Homework assignments (30%):* 7 assignments throughout the semester (every two weeks). Assignments must be turned in before the due time specified in each assignment set. No late assignment will be accepted. The percentage grades of the best 6 out of 7 assignments will be used for evaluating the final grade.
- *In-class quizzes (30%):* The purpose of the in class-quizzes is to test your knowledge of the content of the class and to provide feedback as we progress through the course. There will be 5 quizzes and the tentative dates are: 1/28, 2/11, 2/25, 3/10, 4/7.
- *Final project (40%):* Students are required to work in groups and complete a final project at the end of the semester. Details of the project are described in the Page 3 of the syllabus.
- *Make-up policy for quizzes:* If you miss any of the quizzes for a valid excuse, the weight of the missing quiz will be transferred to other quizzes. The maximum number of missing quizzes that can be transferred is 2. Acceptable excuses are serious medical conditions and urgent family matters. No make-up quizzes will be provided.

Online resources: Lecture notes, assignments, and solutions to assignments and quizzes will be posted on D2L.

Course Outline

1: Introduction and Preliminaries

- Multi-axial stress components and stress transformation
- Multi-axial strain components and strain transformation
- Stress-strain relation
- Introduction to composite materials

2: Elastic behavior of uni-directional composite lamina

- Micro-mechanics: properties and geometric characteristics of fiber and matrix, relation to overall elastic property of lamina.
- Macro-mechanics: stress-strain relations for anisotropic materials; transformation of stress, strain and elastic parameters for lamina.

3: Strength of uni-directional composite lamina

- Micro-mechanics: failure mechanism under longitudinal or transverse tension loading and shear loading.
- Macro-mechanics: failure theories for strength prediction.

4: Elastic behavior of multi-directional laminates

- Lamination theory: layup arrangements for laminates and implications for elastic property of the composite
- Sandwich plates

5: Failure analysis of multi-directional laminates

- Stress analysis for first ply failure
- Progressive and ultimate failure
- Design considerations

6: Hygrothermal effects

- Thermal and moisture expansion of lamina and laminates
- Hygrothermoelastic stress analysis

7: Experimental methods (if time allows)

- Methods for mechanical and physical characterization of composites.

Final Project

Students in this class are required to work in groups to complete a final project (40% of the final grade). Graduate students must work in **groups of 2** and undergraduate students **can** work in **groups of 3**. The purpose of the project is to encourage active learning of composite materials and provide training in technical writing and reporting.

Format and Timeline: The project consists of 3 components: a proposal (10% of final grade), a written report (20% of final grade) and an oral presentation (10% of final grade).

- *Proposal* (by 5pm February 12): the students must form groups and submit a 1-page proposal describing the topic chosen for the project. This proposal should provide enough motivation and background information to make the chosen topic compelling. Feedbacks will be provided from Dr. Long.
- *Written report* (by 5pm April 19): each group needs to submit a written report for the project. It should be written in the format of scientific papers: a title, a brief abstract, sections of main texts and references. The maximum number of pages is 8 (with 12-point font).
- *Oral presentation* (during the last 3 classes at the end of April): each group needs to make an oral-presentation (15 minutes + 5 minutes question time). The presentation time will be assigned in advance. The speakers should present their project in a clear and concise manner. Clarity and organization of the presentation will be the main considerations for grading.

Scope: The project topic should be focused and be related to the mechanics of composite materials. It can be solving a technical problem, or describing a phenomenon (e.g. elasticity, failure) of a certain class of composite materials, or introducing an application of composite materials and the associated design process. The key idea is to actively learn more about composite materials based on the concepts taught in class.

Grading: The project will be graded based on the following components: relevance to this course, technical quality, writing, and clarity of presentation. It is assumed that every member of one group will contribute equally and thus will receive the same grade. Plagiarism is strictly prohibited and will lead to a zero for the entire project (40%).

University Policies:

Academic Integrity “All students of the University of Colorado at Boulder are responsible for knowing and adhering to the academic integrity policy of this institution. Violations of this policy may include: cheating, plagiarism, aid of academic dishonesty, fabrication, lying, bribery, and threatening behavior. All incidents of academic misconduct shall be reported to the Honor Code Council (honor@colorado.edu; 303-735-2273). Students who are found to be in violation of the academic integrity policy will be subject to both academic sanctions from the faculty member and non-academic sanctions (including but not limited to university probation, suspension, or expulsion). Other information on the Honor Code can be found at <http://www.colorado.edu/policies/honor.html> and at <http://www.colorado.edu/academics/honorcode/>.”

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Policy regarding Discrimination and Harassment “The University of Colorado at Boulder Discrimination and Harassment Policy and Procedures, the University of Colorado Sexual Harassment Policy and Procedures, and the University of Colorado Conflict of Interest in Cases of Amorous Relationships Policy apply to all students, staff, and faculty. Any student, staff, or faculty member who believes s/he has been the subject of sexual harassment or discrimination or harassment based upon race, color, national origin, sex, age, disability, creed, religion, sexual orientation, or veteran status should contact the Office of Discrimination and Harassment (ODH) at 303-492-2127, or the Office of Student Conduct (OSC) at 303-492-5550. Information about the ODH, the above referenced policies, and the campus resources available to assist individuals regarding discrimination or harassment can be obtained at <http://www.colorado.edu/odh>.”