

# ASEN 5212 – Composite Structures and Materials

## Spring 2021

The goal of the class is to introduce students to the concepts and tools necessary to analyze and design composite structures, with an emphasis on fiber reinforced composites. At the end of the class, the students will be able to:

- Describe different types of composite architectures and constituents.
- Select the correct combination of matrix and fibers for a given application.
- Perform basic homogenization analysis to estimate lamina properties.
- Differentiate between fiber- and matrix-dominated behavior.
- Calculate the properties of a laminate based on the different lamina.
- Predict the failure mode of a composite as a function of the loading.
- Assess the effect of environmental factors on different composites.
- Describe and compare different experimental techniques to characterize composites.

**Instructor:** Francisco Lopez Jimenez. Office: Zoom (nominally AERO 355)  
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**Lecture Times and Location:** Tuesday and Thursday, 8:30am – 9:45am  
Zoom (nominally AERO 232)

**Office hours Times and Location:** Wednesdays 3:30pm to 4:30pm  
Fridays 11:30am to 12:30pm  
Tuesdays and Thursdays after class, until 10:30am  
Same Zoom link as lectures

**Zoom link for the semester:**

**Prerequisites:** ASEN 3112 or equivalent required. ASEN 5012 is recommended. Matlab will be used in assignments, and coding proficiency is expected.

### Course communication:

- Announcements will be made through Canvas and Slack. Students are required to join both. The instructor will make every possible effort to post all announcements in both platforms; however, in case there is a mishap, students are **strongly recommended to pay attention to both platforms**.
- Grades will be posted to Canvas. However, the final grade in Canvas will not correspond to the real grade, which will be calculated separately.
- Students will also be able to use email to communicate with the instructor. Please, start the subject of each email with “ASEN 5212”. This will make sure that emails can be identified at the end of the course and no regrading request is neglected.

## TEXTBOOK

No textbook is required. Material for the class will be posted in Canvas. Suggested reading includes:

- *Introduction to Composite Materials Design*, Ever J. Barbero, CRC Press.
- *Engineering Mechanics of Composite Materials*, Isaac M. Daniel and Ori Ishai, Oxford University Press.
- *Mechanics of Composite Materials*, Robert M. Jones, Taylor & Francis.
- *Mechanics of Composite Materials*, Richard M. Christensen, Dover.

## GRADING

The final grade will be evaluated based on homework assignments (30%), two midterm exams (20% each) and a final project (30%). All must be written in Word/Latex, or by hand and then scanned, and then submitted to Canvas.

Plagiarism or any other form of cheating in any of the assignments, exams, or the final project will result in failing the course. As a reminder: using someone else's code, or not referencing the source of items (images, formulas, etc.) used in homework or project reports, are also forms of plagiarism.

Requests to regrade any item need to be submitted within two weeks of the date in which the assignment or exam is returned to students. The request needs to be submitted in writing, through any of the available forms of communication. They will include the original problem, a written statement stating what the grading error was, and the suggested correct grade. Note: this procedure can only be used in the case of mistakes during grading, not to argue about the rubric.

## HOMEWORK ASSIGNMENTS

Homework assignments must be turned in before the due time, which will be specified in each homework set. No late assignments will be accepted for credit. The assignment with lowest grade will be dropped when evaluating the final grade. Six homework assignments are expected through the semester, with due dates approximately every other week.

## EXAMS

The exams will be take-home, and will take place on Thursday March 11<sup>th</sup> and Thursday April 22<sup>nd</sup>, unless announced otherwise in CANVAS, Slack, and lectures. The specific material covered on each midterm will be detailed in class and in written announcements.

## FINAL PROJECT

The purpose of the project is to allow students to actively explore a topic they are particularly interested in. The topic should relate to the mechanics of composite materials and have a significant technical component; suitable examples include:

- Solving a technical or design problem, through analysis or finite elements.
- Expanding on analysis techniques presented in lectures (failure analysis, new homogenization techniques, optimization of laminates).
- Design of a composite structure for a given application and set of requirements.
- Discussing new manufacturing and/or experimental techniques, including application and comparison with standard practice.

The project can be completed in groups of up to three students. The expected amount of work will take into account the number of members in the team. It will be graded based on relevance, technical quality, and overall writing and presentation. The project is worth the same percentage of the final grade that all homework assignments combined; as such, a significant effort per student is expected.

The project consists of 3 components: a proposal (15% of project grade), a mid-project review (25% of project grade), and a final report (60% of project grade).

- The proposal is due on February 12<sup>th</sup>, by 5 pm. It should be a 3-page document describing the topic chosen, including motivation, background, and a detail description of the expected deliverables. The proposal should also explicitly, and in significant detail, address the learning objectives for the team: what are you hoping to learn (either tools or content), why, and how will the final report show that you have achieved your goals. Students are strongly encouraged to discuss their plans with the instructor before the proposal is due.
- The mid-project review is due on March 19<sup>th</sup>, by 5 pm. It should include substantial preliminary work, and a discussion of the next steps required to complete the project. The maximum number of pages is 6 (12-point font).
- The final report is due the last week of class and should be no longer than 10 pages (12-point font), with appendixes for code, derivations and additional images. It should be written in the format of a technical paper: title, abstract, main text, references, and appendixes.

If time allows, there will be short oral presentations in class for the mid-project review and the final report.

## COURSE CONTENT

The following list of topics is not comprehensive. The instructor reserves the right to adapt the course content to adapt to the progress of the course and the interest of the students.

- Introduction to composite materials
- Constituents and manufacturing techniques
- Micromechanics of lamina – Stiffness
- Micromechanics of lamina – Strength and failure
- Macromechanics of lamina – Stiffness
- Macromechanics of lamina – Strength and failure
- Mechanics of multidirectional composites
- Environmental conditions
- Experimental methods
- Novel composites

## COURSE EXPECTATIONS AND LIFE DURING COVID

This is a graduate course, and as such, professionalism, initiative and self-sufficiency are expected from students. Deadlines (for assignments, for regrading requests, to give notice of conflicts) will be enforced, if nothing else to ensure fairness among students. Students are encouraged to attend office hours and receive all the help needed to complete assignments; however, they will be expected to come with specific questions after having already attempted to solve the assignments.

This is also a course based on previous material (e.g., basics in stress and strain, constitutive laws) that will be reviewed only briefly. Additional material will be suggested when needed, but students are expected to review independently if they need to refresh concepts.

However.

I understand that life happens, particularly during a pandemic, which will certainly still apply to the Spring of 2021. If you have an emergency (loss of job, sickness in family, mental health issues, unforeseen COVID related difficulties), please let me know as soon as possible. Even if you are just overwhelmed by your life situation, please let me know as soon as possible. I expect professional, serious, focused students, not robots. But I can only help you if you give me enough warning, and we can take action when it is still possible to do so (not, say, after the solution for an assignment is posted). So, if something happens, let me know, and we will figure something out.

Let's try to have the best semester possible.

## CLASSROOM BEHAVIOR

Both students and faculty are responsible for maintaining an appropriate learning environment in all instructional settings, whether in person, remote or online. Those who fail to adhere to such behavioral standards may be subject to discipline. Professional courtesy and sensitivity are especially important with respect to individuals and topics dealing with race, color, national origin, sex, pregnancy, age, disability, creed, religion, sexual orientation, gender identity, gender expression, veteran status, political affiliation or political philosophy. For more information, see the policies on [classroom behavior](#) and the [Student Code of Conduct](#).

## REQUIREMENTS FOR COVID-19

As a matter of public health and safety due to the pandemic, all members of the CU Boulder community and all visitors to campus must follow university, department and building requirements, and public health orders in place to reduce the risk of spreading infectious disease. Required safety measures at CU Boulder relevant to the classroom setting include:

- maintain 6-foot distancing when possible,
- wear a face covering in public indoor spaces and outdoors while on campus consistent with state and county health orders,
- clean local work area,
- practice hand hygiene,
- follow public health orders, and
- if sick and you live off campus, do not come onto campus (unless instructed by a CU Healthcare professional), or if you live on-campus, please alert [CU Boulder Medical Services](#).

Students who fail to adhere to these requirements will be asked to leave class, and students who do not leave class when asked or who refuse to comply with these requirements will be referred to [Student Conduct and Conflict Resolution](#). For more information, see the policies on [COVID-19 Health and Safety](#) and [classroom behavior](#) and the [Student Code of Conduct](#). If you require accommodation because a disability prevents you from fulfilling these safety measures, please see the “Accommodation for Disabilities” statement on this syllabus.

All students who are new to campus must complete the [COVID-19 Student Health and Expectations Course](#). Before coming to campus each day, all students are required to complete the [Buff Pass](#).

Students who have tested positive for COVID-19, have symptoms of COVID-19, or have had close contact with someone who has tested positive for or had symptoms of COVID-19 must stay home. In this class, if you are sick or quarantined, email the instructor to discuss possible extensions on assignments and other measures, and follow the lectures through Zoom or recorded lectures.

## ACCOMMODATION FOR DISABILITIES

If you qualify for accommodations because of a disability, please submit your accommodation letter from Disability Services to your faculty member in a timely manner so that your needs can be addressed. Disability Services determines accommodations based on documented disabilities in the academic environment. Information on requesting accommodations is located on the [Disability Services website](#). Contact Disability Services at 303-492-8671 or [dsinfo@colorado.edu](mailto:dsinfo@colorado.edu) for further assistance. If you have a temporary medical condition, see [Temporary Medical Conditions](#) on the Disability Services website.

## PREFERRED STUDENT NAMES AND PRONOUNS

CU Boulder recognizes that students' legal information doesn't always align with how they identify. Students may update their preferred names and pronouns via the student portal; those preferred names and pronouns are listed on instructors' class rosters. In the absence of such updates, the name that appears on the class roster is the student's legal name.

## HONOR CODE

All students enrolled in a University of Colorado Boulder course are responsible for knowing and adhering to the Honor Code. Violations of the policy may include: plagiarism, cheating, fabrication, lying, bribery, threat, unauthorized access to academic materials, clicker fraud, submitting the same or similar work in more than one course without permission from all course instructors involved, and aiding academic dishonesty. All incidents of academic misconduct will be reported to the Honor Code ([honor@colorado.edu](mailto:honor@colorado.edu)); 303-492-5550). Students found responsible for violating the academic integrity policy will be subject to nonacademic sanctions from the Honor Code as well as academic sanctions from the faculty member. Additional information regarding the Honor Code academic integrity policy can be found at the [Honor Code Office website](#).

## SEXUAL MISCONDUCT, DISCRIMINATION, HARASSMENT AND/OR RELATED RETALIATION

The University of Colorado Boulder (CU Boulder) is committed to fostering an inclusive and welcoming learning, working, and living environment. CU Boulder will not tolerate acts of sexual misconduct (harassment, exploitation, and assault), intimate partner violence (dating or domestic violence), stalking, or protected-class discrimination or harassment by members of our community. Individuals who believe they have been subject to misconduct or retaliatory actions for reporting a concern should contact the Office of Institutional Equity and Compliance (OIEC) at 303-492-2127 or [cureport@colorado.edu](mailto:cureport@colorado.edu). Information about the OIEC, university policies, [anonymous reporting](#), and the campus resources can be found on the [OIEC website](#).

Please know that faculty and graduate instructors have a responsibility to inform OIEC when made aware of incidents of sexual misconduct, dating and domestic violence, stalking, discrimination, harassment and/or related retaliation, to ensure that individuals impacted receive information about options for reporting and support resources.

## **RELIGIOUS HOLIDAYS**

Campus policy regarding religious observances requires that faculty make every effort to deal reasonably and fairly with all students who, because of religious obligations, have conflicts with scheduled exams, assignments or required attendance. In this class, students must let the instructor know of any such conflicts within the first two weeks of the semester so that reasonable arrangements can be worked out

See the [campus policy regarding religious observances](#) for full details.

## **SPRING PAUSE WEEK**

The week of March 22-26 will be used in this class as a spring pause to provide us all with a safe and supportive way to promote health, wellness and learning without leaving campus. There will not be lecture on Thursday March 25<sup>th</sup>, which is a wellness day. In addition, there will not be any assignments due that week. However, we will still have class on Tuesday March 23<sup>th</sup>, and I expect you to attend. We all wish we could take a regular spring break, but public health concerns prevent us from doing so. Please behave responsibly. Do not use the week to travel or engage in risky behavior that could result in an outbreak on campus after we all return.