

ASEN 4218/5218 – Large Space Structures Design Spring 2020

The goal of the class is to provide students with the tools necessary to analyze a wide range of large and lightweight space structures, ranging from deployable gossamer structures to high precision rigid space frames. Emphasis will be given to preliminary designs, back of the envelope calculations and scaling laws. At the end of the class, the students will be able to:

- Identify different architectures for deployable structures
- Determine if a bar structure is rigid or a mechanism.
- Calculate the strain energy of a folded thin shell
- Assess the efficiency of different mast and boom designs
- Analyze the deployment of origami folding patterns
- Predict the effect of a tension element in the mechanical response of a structure
- Pre-dimension inflatable structures
- Perform preliminary analysis of the dynamics of a lightweight structure

Instructor: Francisco Lopez Jimenez. Office: AERO 355
Email: Francisco.LopezJimenez@colorado.edu

Teaching Assistant: Buwaneth Yasara Dharmadasa
Email: Buwaneth.Dharmadasa@colorado.edu

Lecture Times and Location: Tuesday and Thursday, 8:30am – 9:45am, AERO N250

Office hours Times and Location: Monday, 2:30pm – 3:30pm, AERO 303
Tuesday, 10:00am – 11:00am, AERO N250
Thursday, 1:00pm – 2:00pm, AERO N453
Friday, 3:00pm – 4:00pm, AERO 303

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

Textbook: No textbook is required. Material for the class will be posted in Canvas.

Grading: The final grade will be evaluated based on homework (30%), two exams (20% each) and a final project (30%).

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.

Plagiarism or any other form of cheating in any of the assignments, exams or the final project will result in failing the course.

EXAMS

The exams will take place during normal lecture hours, in AERO N250, on Thursday March 5th and Tuesday April 22nd. The specific material covered on each midterm will be detailed in class.

FINAL PROJECT

The purpose of the project is to allow students to actively explore a topic they are particularly interested in. It can be done in groups of up to three (for ASEN 5218) or four (for ASEN 4218) people. 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.

Students registered in ASEN 4218 are allowed to consider a literature review providing more detail on one of the topics presented in the course. Students registered in ASEN 5218 need to consider a project with significant technical content (analysis, simulations or experiments). Mixed groups are allowed, but all students will be graded as if registered for ASEN 5218.

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 11th, by 5 pm. It should be a 2-page document describing the topic chosen, including motivation, background, and a detail description of the amount of work expected to be delivered. Students are strongly encouraged to discuss their plans with the instructor before the proposal is due.

The mid-project review is due on March 19th. 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 scientific paper: title, abstract, main text, references.

If time allows, there will be short oral presentations in class of 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.

Bar structures

- Rigidity of structures
- Trusses
- Tessellations
- Space frames

Mechanisms

- Kinematics of linkages
- Pantographs
- Rigid panel structures

Flexible structures

- Foldable booms
- Flexible shells
- Bi-stable structures
- High strain composites

Tension structures

- Balloons and inflatables
- Membrane structures and solar sails
- Tensegrity

Origami

- Rigid foldable origami
- Miura-Ori pattern and derivatives
- Curved folding

Requirements for large space structures

- Optical performance
- Dynamic response of lightweight structures
- Testing on non-zero gravity

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 for further assistance. If you have a temporary medical condition or injury, see [Temporary Medical Conditions](#) under the Students tab on the Disability Services website.

CLASSROOM BEHAVIOR

Students and faculty each have responsibility for maintaining an appropriate learning environment. 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](#).

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); 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 a positive and welcoming learning, working, and living environment. CU Boulder will not tolerate acts of sexual misconduct, intimate partner abuse (including 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. Information about the OIEC,

university policies, [anonymous reporting](#), and the campus resources can be found on the [OIEC website](#).

Please know that faculty and instructors have a responsibility to inform OIEC when made aware of incidents of sexual misconduct, 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.