

# 16/18-873: Spacecraft Design-Build-Fly Lab

Fall 2023 – Spring 2024

## Course Description

Spacecraft design is a truly interdisciplinary subject that draws from every branch of engineering. This capstone design class brings together the material from prior classes in a way that emphasizes the interactions between disciplines and demonstrates how some of the more theoretical topics are synthesized in the practical design of a spacecraft. The class will design, build, and test a small satellite that addresses objectives and requirements posed at the beginning of the course sequence. Students will work in subsystem teams, each focusing on some aspect of the spacecraft, but exposed to many different disciplines and challenges. Practical, hands-on engineering skills will be emphasized, along with fabrication and testing of physical hardware and the creation of thorough documentation.

## Instructors

Prof. Zac Manchester	<b>Email:</b> <a href="mailto:zacm@cmu.edu">zacm@cmu.edu</a>
Prof. Brandon Lucia	<b>Email:</b> <a href="mailto:blucia@cmu.edu">blucia@cmu.edu</a>
TA: Brad Denby	<b>Email:</b> <a href="mailto:bdenby@cmu.edu">bdenby@cmu.edu</a>
TA: Neil Khera	<b>Email:</b> <a href="mailto:nkhera@andrew.cmu.edu">nkhera@andrew.cmu.edu</a>
TA: Paulo Fisch	<b>Email:</b> <a href="mailto:pfisch@andrew.cmu.edu">pfisch@andrew.cmu.edu</a>

## Learning Objectives

The goal of this course is to give students hands-on experience designing and building small spacecraft subsystems and integrating them into a CubeSat. Throughout this course, students will:

1. Understand how the design and integration of a system whose performance depends on the success of many interacting subsystems.
2. Work within a small team to fabricate, and test hardware and software through rapid design iteration.
3. Coordinate with other teams to integrate subsystems into a complete spacecraft.
4. Gain exposure to the complete life cycle of a small satellite mission.

## Logistics

The course will involve designing and building hardware in small teams. Class time will be used primarily for weekly team meetings and consulting time to meet with the instructors.

- Lectures on selected topics will be held at 3:30 on Mondays, followed by consulting hours.
- All-hands meetings will be held at 3:30 on Wednesdays, followed by consulting hours.
- Sub team meetings will be held once per week at times coordinated with the instructors.
- Attendance of weekly team meetings is mandatory.
- Slack will be used for coordination between teams and instructors. All students will be added to the “SpacecraftDesignBuildFlyLab” slack channel.
- GitHub will be used to manage project files for all teams.

## Assignments and Exams

There will be no exams in this course. Evaluation will be based on participation, contribution to design and fabrication work, and final documentation from each team.

## Grading

Grading will be based on:

- 25% Participation and attendance of team meetings
- 25% Individual technical contributions quantified by git commit history and peer surveys
- 25% Completeness and quality of team documentation
- 25% Outcome of design review

## Learning Resources

There is no textbook required for this course. Video recordings of lectures and lecture notes will be posted online. Additional references for further reading will be provided with each lecture.

## Course Policies

**Attendance:** This is a team-based course. In order to coordinate work among teams, participation in weekly meetings is required. If you are unable to be present at a meeting, you must notify the instructors and ensure that your teammates are prepared to present your work.

**Accommodations for Students with Disabilities:** If you have a disability and are registered with the Office of Disability Resources, I encourage you to use their online system to notify me of your accommodations and discuss your needs with me as early in the semester as possible. I will work with you to ensure that accommodations are provided as appropriate. If you suspect that you may have a disability and would benefit from accommodations but are not yet registered with the Office of Disability Resources, I encourage you to contact them at [access@andrew.cmu.edu](mailto:access@andrew.cmu.edu).

**Statement of Support for Students’ Health & Well-Being:** Take care of yourself. Do your best to maintain a healthy lifestyle this semester by eating well, exercising, avoiding drugs and

alcohol, getting enough sleep, and taking some time to relax. This will help you achieve your goals and cope with stress.

If you or anyone you know experiences any academic stress, difficult life events, or feelings like anxiety or depression, we strongly encourage you to seek support. Counseling and Psychological Services (CaPS) is here to help: call 412-268-2922 and visit <http://www.cmu.edu/counseling>. Consider reaching out to a friend, faculty, or family member you trust for help getting connected to the support that can help.

*If you or someone you know is feeling suicidal or in danger of self-harm, call someone immediately, day or night:*

*CaPS: 412-268-2922*

*Re:solve Crisis Network: 888-796-8226*

*If the situation is life threatening, call the police:*

*On campus: CMU Police: 412-268-2323*

*Off campus: 911*

## Tentative Fall 2023 Schedule

Week	Dates	Topics
1	Aug 28 Aug 30	Course Overview & Logistics Team Selections and Kickoff
2	Sep 4 Sep 6	No Class (Labor Day) All-Hands Meeting: Review Requirements and ICD Drafts
3	Sep 11 Sep 13	Classical Spacecraft Subsystems All-Hands Meeting
4	Sep 18 Sep 20	Orbital Edge Computing Overview All-Hands Meeting
5	Sep 25 Sep 27	Spacecraft Dynamics and Simulation All-Hands Meeting
6	Oct 2 Oct 4	Machine Vision in Space (Brad) All-Hands Meeting
7	Oct 9 Oct 11	Navigation (Guest Lecture) All-Hands Meeting
8	Oct 16 Oct 18	No Class (Fall Break) No Class (Fall Break)
9	Oct 23 Oct 25	Spacecraft Communication All-Hands Meeting
10	Oct 30 Nov 1	Attitude Determination and Control All-Hands Meeting
11	Nov 6 Nov 8	TBD All-Hands Meeting
12	Nov 13 Nov 15	TBD All-Hands Meeting
13	Nov 20 Nov 22	TBD No Class (Thanksgiving Break)
14	Nov 27 Nov 29	TBD All-Hands Meeting
14	Dec 4 Dec 6	Design Review Design Review