

# EECS/BioE/ME C106A/206A

## Final Project Guidelines

Fall 2023

## 1 Overview & Requirements

It's time for final projects! This is a way for you to showcase everything you have learned in class and apply the concepts to new situations. Get creative with it, put in some solid effort, and you will be rewarded (both grade-wise and intellectually)!

Your final projects must include **sensing, planning, actuation, and hardware** which means you must be performing a real robotic task, on real hardware, using real sensors (simulation is not allowed unless approved beforehand). Beyond requiring these four elements, the project is completely open-ended. We have provided some sample project ideas. We even have some research projects for you to choose from if you want to see what's happening at the cutting edge or get involved with a robotics lab on campus.

Most projects in this class utilize the class hardware (or your own design!) to implement something fun or cool. Most of the projects listed as examples on the website fall into this category. If you do something similar to a previous project, we expect you to be able to build off it and do something bigger and better! **It is insufficient to simply replicate.**

Research projects are projects done in conjunction with graduate students or professors in research labs. This is a great opportunity to get involved in robotics research at Berkeley! Be advised that these projects still require all components. We've talked to several grad students in different labs and have provided opportunities below.

To spice things up and keep you engaged, we will be recognizing Showcase Winners and Honorable Mentions. You'll be recognized on the course website and will win prizes! ~~Did someone say C106A swag?~~

## 2 Dates, Deadlines, & Grading Breakdown

Please note: failure to submit a final project will result in an automatic failing grade for the entire course.

### 2.1 Deadlines

<b>Project Proposal</b>	10/13	10%
Proposal Feedback Meetings	Week of 10/15	
<b>Check-In 1</b>	11/9	5%
<b>Check-In 2</b>	11/29	10%
Purchase Request Deadline	11/27	
Software Request Deadline	12/1	
<b>Presentations and Demos</b>	12/7, 12/8	55%
<b>Report (website)</b>	12/15	20%

**No extensions will be given for any final project deadlines.**

### 2.2 Grading Scheme

You might have noticed above that the presentation is the bulk of your grade. Really, your grade depends on the overall quality of your projects. We will use the presentation time to understand your work and score you on scope, design, understanding, implementation, and robustness.

- **Scope:** Does your project contain sensing, planning, and actuation? How ambitious is your project?

- **Design and Understanding:** How thorough and effective is your design? (ex. mathematical concepts, software architecture, etc.)
- **Implementation and Robustness:** Did you implement your design effectively? Does your implementation work? Did you properly test/evaluate your project? How reliable is it?
- **Demo and Presentation:** How was your demonstration/video? How was the presentation quality?

Projects will vary in complexity, and in general, the more complex or risky the project, the less polished we expect it to be. In other words, if your project is very complex, then we don't expect it to work perfectly or reliably. If your project is relatively simple, however, we'll expect it to work reliably and consistently, as you'll have more time to devote to getting it working well. A project that is simple but well done (i.e., very reliable) may receive the same grade as a high-risk project that is functional.

## 2.3 Late Work Policy

In general, **no late project work will be accepted**. If you feel that you will be unable to make any of the deadlines listed above, let us know **before** the deadline explaining your situation, and we will revisit this policy at our discretion.

## 3 Groups

Project groups should consist of **4 people**. If you would like to form a group that is larger or smaller, please talk to us **before** submitting your proposal. Note that expectations will scale with the number of project group members: we will expect more polish, complexity, and reliability from larger teams. We will also of course expect that all members equally contribute to each team. Peer evaluations will be submitted alongside the final report.

If you're having trouble finding a team, please use the project matching thread on Ed!

## 4 Multi-Class Projects

If you are in another project course, you are welcome to complete a single project for both classes, provided the scope of the project is extended appropriately (i.e., you should not simply turn in the same project for both classes — the portion of the project that you turn in for C106A should stand on its own). You may work with team members who are only enrolled in the other class, as long as you complete all the project requirements of C106A as listed here. We may ask to see the report you submit to any other class to ensure that the amount of work completed is sufficient to cover both assignments.

Similarly, if you are building off your own existing research and projects, we will ask you to specify which components were done before starting the final project and what was done for the scope of this project.

## 5 Project Deliverables

### 5.1 Project Proposal (due 10/13)

To kick off the final project, your initial submission will be a proposal. You will write down your plan for the project and submit to Gradescope with your whole group. This will be due on Friday 10/13. A Latex template is provided [here](#). You are not obligated to use it, but please make sure all of the component parts from the template are included!

During the subsequent week, TAs will read through your proposals and arrange meetings with each team to provide feedback and polish the direction you are moving.

## 5.2 Check-In 1 (11/9)

To ensure you are on track for your projects, an initial check-in assignment will be due on 11/9 (the day before Veterans' Day). This will be a short summary (2-3 paragraphs) submitted to Gradescope about any progress you have made along with any evidence of having accomplished this work. We will provide feedback and thoughts at this milestone.

## 5.3 Check-In 2 (11/29)

One week before your final presentations, we want to conduct another check-in to ensure you've continued to make progress on your projects. We also want to deincentivize procrastination and thereby reduce stress as much as we can! This submission will also be a few paragraphs on what you've done so far with evidence to back it up. We will check to see that you have progressed since the first check-in.

## 5.4 Showcase: Final Demo / Presentation (12/7, 12/8)

For our end-of-year Showcase, final project demonstrations will occur in the lab space on **12/7** and **12/8** (the Thursday and Friday of RRR week). We expect that **all team members are present** for the demos. Final project demonstrations will occur in blocks with multiple groups, and we expect you to be present for the full block to see what others have been working on, support your classmates, and provide feedback. If you have a conflict, let us know ASAP, and we will do our best to accommodate you as we develop the final schedule. Logistics will be posted closer to the date, but expect free food and cool robots!

You can expect to have a 13 minute slot. 10 of those minutes will be used to present your project, and the remaining 3 minutes will be used for Q&A. We highly encourage you to watch as many groups as possible! Also come prepared - this is your chance to really show off a semester's worth of work.

## 5.5 Final Project Report (due 12/15)

Final project reports are due **12/15** at **11:59p** (the Friday of finals week) and will take the form of a website. They should also include link(s) to the video(s) of your functional system. Exact expectations will be posted closer to submission time.

You can think of the websites as a chance to share your projects with a broader audience. The text and videos present allow you to describe your work to friends, family, colleagues, recruiters, and future generations of 106A students!

## 5.6 Teamwork / Peer Grading

To help ensure fair project grades, final scores will be modified based on peer evaluation. Each student will fill out a form in conjunction with the final report evaluating both their own and their teammates' performances.

# 6 Example Projects & Ideas

A list of past projects has been posted to the website. The teaching staff has collated a number of research projects for groups to attempt. If you're interested in getting involved in undergrad robotics research or start involvement with another lab, this is a great way to get your foot in the door. We've also provided a few more general ideas.

## 6.1 Past Projects

[Past Projects](#)

## 6.2 General Ideas

- Make robot art!
- Have Sawyer play a board game! Sensing state, planning the game logic, and controlling the movements makes for great projects.
- Track the surface of an object or measure its curvature using position control using vision and/or force feedback.
- Make a Turtlebot carry your stuff! Have it follow you around using image tracking. (Is this—a DIY [Amazon Astro?](#))
- Measure an object’s hardness, compliance, or coefficient of friction.
- Have Sawyer copy a human’s motions. IMU or Kinect based tracking is overdone and a bit too easy, so don’t do that. There was a lot of work done circa 2005-2010 on estimating human 3D kinematics from their 2D poses, so combining this with a modern 2D pose tracker like OpenPose could be a cool project. You could also try building your own skeleton tracker or using a novel sensor.
- Make the robots do things you don’t want to do or are not great at (ex. folding shirts)! Artificial general intelligence is coming.

## 6.3 Research Projects

Getting involved in research is a great way to go deeper into the field! If you’re interested in a research project, please reach out directly to the sponsors. They will form groups, and together with everyone else expressing interest, you will submit a final proposal.

This year’s research project proposals are in this [doc](#). Please reach out to the project contacts **by Friday, 9/6** so that you can arrange a meeting and form groups before the proposal deadline the following week.

# 7 Hardware and Software

## 7.1 Available Hardware

We have some hardware that you may use, depending on your proposal.

- Sawyer (5x)
- Turtlebot (6x)
- Realsense 3D Cameras (10x). We have several types, including ones with integrated IMUs and SLAM.
- Kinect 3D camera (5x). Some packages work better with Kinect than Realsense.
- Logitech C922 Cameras. (11x) High resolution wide-view webcams. 1080p at 30fps or 720 at 60fps.
- The following are either a) things we’re pretty sure we have but need to find, or b) equipment that will be only made available on a case-by-case basis.
  - Crazyflie Drones. (6x) The Sastry group has a set of Crazyflie drones that can be made available for projects we deem good enough. We also have some larger drones, though we’d need you to have pretty extensive experience before we’d consider letting you use them. Keep in mind that these drones are fairly difficult to control.
  - Motion Capture Room. The Sastry group has a motion capture room you can use for HRI projects.
  - Haptic Device (1x). The Sastry group has a 6-DOF haptic feedback joystick. You could possibly use this for impedance control or some other human feedback project.
  - Microsoft Lifecams. (4x) Middle-of-the-road webcam. 720p at 30fps.

## 7.2 Additional Hardware or Software

We will also have an optional \$55 budget per team for you to buy materials! We have a [form](#) to fill out for you to request purchases (ESG will do the actual ordering because reimbursement requests are infeasible). The final day for purchase requests will be November 27th.

If you have any software requests for the lab computers, please follow instructions posted [on Ed](#) to request installation. The deadline for software requests will be December 1st.