EECS/BioE/ME C106A/206A

Final Project Guidelines

Fall 2022

Overview & Requirements

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. Beyond requiring these four elements, the project is completely open-ended. We have provided some sample project ideas. Broadly speaking, we will divide projects into three tracks: classic, research, and industry/design.

Classic projects are just that! Most projects in this class are just for fun, utilizing the class hardware (or making your own!) to implement something fun or cool. Most of the projects listed as references on the website are classic projects. 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 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.

Industry/design projects are a little more embedded than other tracks. In this style of project, you'll work with an industry partner and engage with their work. Often, this will involve identifying a problem, engaging with the community who faces this problem, prototype a solution, iterate on the solution, and provide a report to your partner on what your suggested next steps are. Do not be fooled into thinking that this might be an easier project, especially in terms of time commitment! Good design requires rigorous testing and community engagement.

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

Dates, Deadlines, & Grading Breakdown

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

Mini-Proposal	10/07	5%
Final Proposal & Parts List	10/28	10%
Final Products		
Presentation	12/8, 12/9	20%
Demo	12/8, 12/9	20%
Report (website)	12/16	25%
Video	12/16	20%

No extensions will be given for any final project related deadlines

Grading Scheme

Overall, we will be evaluating your project on its complexity, polish, the participation of all team members, and on the following characteristics:

- **Design**: How original or ingenious is your design?
- **Implementation**: Does your implementation work? How reliable is it?
- **Scope**: Does your project contain sensing, planning, and actuation?

- **Rigor**: Do you properly test/evaluate your project? Are your assumptions reasonable?

These characteristics will be evaluated on the following scale:

Mark	**Description**	**Equiv. Score** (undergraduate)	**Equiv. Score** (graduate)
5	Exceeds expectations	95-100%	90-100%
4	Fully meets expectations	90-95%	80-90%
3	Adequately meets expectations	80-90%	70-80%
2	Barely meets expectations	70-80%	60-70%
1	Does not meet expectations	0-70%	0-60%

We expect most projects to score around 3-4 in each category, but we are not opposed to giving everyone a 5 if all projects are great. **Note that you do not need all 5s to make an A on the project.**

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.

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.

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 mini-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 even after the team-building mixer, feel free to start a thread on Edstem!

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 EE106A 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 EE106A 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.

Mini-Proposal (due 10/07)

A preliminary mini-proposal is due **10/07** at **11:59p** and should be submitted to Gradescope. This document should be about one page and contain the following:

- name and contact information of each team member (full name, SID, email address);

- (brief) qualifications of each group member (department, previous experience, etc.); and
- project idea(s) and a brief description thereof.

In the subsequent week, we will read over your mini-proposals, and the week of 10/18, we will meet with each group individually to discuss your ideas in lieu of regular lab section (information forthcoming).

Final Proposal & Parts List (due 10/28)

Incorporating your project meeting feedback, you will complete a finalized proposal, due **10/28** at **11:59p** to Gradescope. A LaTeX template for this proposal has been provided on the website; you are not obligated to use the template, but all listed components should be present and complete.

An important part of this final proposal is the **parts list**, or **bill of materials**. Each group will be allocated approximately $50 to spend on parts for their project. You are not obligated to use these funds, and all purchased components must be returned to the lab on completion of the project. **If you plan on requesting materials, it's critical that they appear clearly and completely in your final project proposal as well as submitted via a Google form, as that gives us plenty of time to order them for you in time for subsequent project deadlines.**

Showcase: Final Demo / Presentation (12/9, 12/10)

For our end-of-year Showcase, final project demonstrations will occur in the lab space on **12/8** and **12/9** (the Thursday and Friday of RRR week), time TBD. 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 and give 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. Exact expectations will be posted to the website.

Though exact details have yet to be finalized, 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 QA. We highly encourage you to watch as many groups as possible!

Final Project Report (due 12/16)

Final project reports are due **12/16** at **11:59p** (the Friday of finals week), and will take the form of a website. It will also include link(s) to the video(s) of your functional system that make up 20% of your final grade. Exact expectations will be posted to the website.

Additionally, 5% of your grade will be dedicated towards your analysis of where your project fits into the larger picture. What potential social, political, and economic impacts could your project make? Who benefits? Who loses out? Are there any environmental impacts? These are all important questions to ask yourself whenever you work in design and engineering. Nothing exists in a bubble!

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 evaluating both their own and teammates' performances. Exact instructions will be posted to the course website.

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 couple more general ideas.

Past Projects

https://docs.google.com/document/d/14N7CpY1_PrgFYW8GDvGPqgR98pmg4LYwQyk8bezuSQQ/edit?usp=sharing

General Ideas

- Make robot art! And enter it https://robotart.org/here (if they ever hold another competition)
- Have Sawyer play a board game! Chess and Checkers are overdone, but something a bit more complicated would be very cool. (Former TAs are partial to https://boardgamegeek.com/boardgame/51/ricochet-robotsthis)
- Collaboration between multiple robots. Have two Sawyers collectively pick up an object or implement some searching algorithms on Turtlebots.
- Track the surface of an object 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 https://www.youtube.com/watch?v=sj1t3msy8dcAmazon 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.
- Track the surface of an object using position control and determine its curvature, using both vision and kinematic tools to control the manipulator.

Research Projects

If you're interested in a research project, express interest to Riddhi and state your interest in your mini-proposal so we can get you in touch with the sponsor. However, please also provide a backup project, since most of these projects can only support one group, and we want to ensure a good fit between you and your sponsor.

https://docs.google.com/document/d/1UbSXLP92A9p7qqGsQRNDeAaxEDXb90hK5VTXlFz2_ak/edit?usp=sharing

Available Hardware

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

- Sawyer (5x)
- Turtlebot (6x)
- Ridgeback (1x). The ridgeback has a LIDAR and Cartesian control.
- Realsense 3D Cameras (many). We have several types, including ones with integrated IMUs and SLAM.
- Kinect 3D camera (2x). Some packages work better with Kinect than Realsense.
- Logitech C922 Cameras. (6x) High resolution wide-view webcams. 1080p at 30fps or 720 at 60fps.
- Four fingered hand

- 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.
  - 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.
  - Dynamixel Servos (many). Dynamixel servos are like RC hobby servos, but give you much more sensor information. They're great for control projects.
  - Microsoft Lifecams. (4x) Middle-of-the-road webcam. 720p at 30fps.

Many teams have bought supplementary equipment that is still left in the lab! Before you consider purchasing or if you're just in need of some inspiration, take a look at what we have available.