Introduction

Welcome to EECS 16B lab! We are so excited to have you. The main goal of lab is for you to gain experience in applying the concepts you learn from lecture. You will use these concepts to build S1XT33N - a voice-controlled car. S1XT33N implements all the key system components we are developing in EECS 16B: analog sensor interface, classification of collected data, and control. You will develop deeper conceptual understanding of the course material and build your physical intuition and confidence with problem-solving skills, including critical thinking, design thinking, and tenacity via debugging.

EECS 16B labs will be entirely hands-on (**in-person** physical circuit building) in Spring 2024. We believe it is possible for every student to perform well in lab if you put in the effort. This means that you work diligently, read lab notes and complete the pre-labs before section, listen carefully to lab presentations in section, pay attention during checkoffs for labs, and follow the success tips discussed in Lab Note 0.

All administrative and logistical questions should be directed to Ed. Any personal-related questions should be asked using a private Ed post or sent to the course email at eecs16b-sp24@berkeley.edu.

All deadlines are in the Pacific timezone (PT).

Lab Components

You will complete 8 labs over the course of the semester. At the end of the semester, you will additionally complete Integration/Final Demo (colloquially referred to as Lab 9), in which you will demonstrate your final, completed project: your S1XT33N being able to successfully classify voice commands into instructions for S1XT33N's movement.

Each lab is intended to be completed in one week, with the exceptions of Lab 7 and Lab 8, which are each intended to be completed in two weeks.

Before Each Lab Section

Lab Notes

All labs will have a corresponding Lab Note, which goes over some background and concepts necessary to complete the lab. Lab Notes (along with the pre-lab) will be released at least a week before each lab; we strongly recommend that you read the lab note prior to lab section.

Pre-Labs

Prelabs are short assignments to be completed on Gradescope, intended to be completed before the start of each week's lab. They will be **due 11:59 PM on Monday on the week of the corresponding lab section**. For example, lab 1 begins on Tuesday, Jan 23, so prelab 1 is due on Monday, Jan 22.

The purpose of pre-labs is to prepare students with the necessary conceptual understanding needed to successfully complete each lab by ensuring they have reviewed the lab resources before starting labs. You will know immediately whether your answers are correct or not, and can submit as many times as you like until you get the correct answers. Extensions for pre-labs will not be given.

Lab Section

Lab sections occur every week in-person in Cory 125 and are 3 hours long. Every lab will start with a presentation given by your lab TA that will give you an overview of the lab, review the relevant theory and concepts, and provide useful tips that will help you avoid common mistakes. After the presentation, you will have the rest of the section to work on the lab and, when applicable, get assistance from lab staff. Labs will typically be in a Jupyter notebook format.

Labs will be completed in groups of 2, unless you have received an exception to work individually or in groups greater than 2. All labs will be graded on completion via check-off in lab sections, which will be discussed in more detail below.

There will be 7 total lab sections; logistics to sign up for a lab section will be announced on Ed. While attendance is not mandatory, we strongly recommend that you come to your assigned lab section. If you find yourself needing to attend a different lab section due to being unable to make it to section or not finishing lab, please refer to the subsection on make-up labs.

Lab Reports

Each lab will have a corresponding series of conceptual and analytical questions designed to test your understanding of the EECS 16B labs and the S1XT33N car project. Together, these questions will form lab reports, the goal of which is to allow you to look at the labs from a bigger picture and reflect on your design process and choices.

Lab report questions will be released weekly with each lab, and will be located at the end of lab notebooks. These will be grouped into two lab report submissions: the **Midterm Lab Report** will consist of all questions up to Lab 5 (Voice Sensing Part 2), and will be due **Monday, March 4**; the **Final Lab Report** will consist of all questions from Lab 6 (System Identification) onwards, and will be due **Monday, April 29**. We strongly encourage you to complete the questions for each lab as you complete them, while lab concepts are still fresh in your memory.

The lab reports form a very significant percentage of your lab grade. Therefore, we strongly encourage you to think about every lab conceptually throughout the semester. Pay close attention to the connection between concepts covered in lecture and how they are applied in lab. Ask questions during lab presentations and during checkoffs to clear your conceptual gaps. Make sure you understand all the concepts in addition to developing debugging skills.

We expect you to complete lab reports with your lab partner(s), unless you have received an exception to work individually or in a different group.

Grading

As outlined in the course syllabus, labs are worth 60 total course points, or 20% of your overall course grade. Within lab, grading is broken down into the following:

Pre-Labs (9 total)	5% (3 points)
Labs (8 total)	60% (36 points)
Integration/Final Demo	10% (6 points)
Lab Reports (2 total)	25% (15 points)

The 9 pre-labs and 8 labs have equal weighting within their categories, with each being worth 0.55% and 7.5% of your lab grade respectively. The final lab/demo will be worth 10% of the lab grade. The two lab reports are also weighted equally, worth 12.5% each.

In order to ensure that both partners are contributing equally to the project, we will scale your lab final score by the feedback factor from your partner *only if there is a significant discrepancy between contributions amounts*. Partner feedback forms will be sent out during the midterm lab report and the final lab report.

Etiquette

While feedback and criticism about labs, lab content, staff decisions, or the course in general are welcome (if not encouraged), disrespectful behavior towards course staff will not be tolerated. In any incidence of verbal, physical, or sexual harassment against our staff, we reserve the right to dock points, give 0's in labs, and/or assign a failing course grade.

Similarly, if you see any staff members behaving unprofessionally or inappropriately, please submit to this anonymous form here.

Lab Policies and Logistics

Lab Support

If you need assistance during the lab section, fill out the help request form and a staff member will help you as soon as possible. When you have finished lab and want to check off, instead submit to checkoff request form. These forms will also be linked within each week's lab presentations and lab notebooks.

Lab questions related to debugging will not be answered on Ed to encourage students to seek debugging help in in-person sections, where staff is best equipped to help you. However, administrative, logistical, and conceptual questions will still be answered on Ed, and you are encouraged to collaborate with your peers on Ed and other platforms.

From this semester, we will be enforcing **planar and tidy circuits**–that is, there are minimal unnecessary circuit components, the components are cut and stripped to appropriate lengths, and the entire circuit is easy to read at first glance. If the section is busy, the TA or lab ASE may refuse to help debug your circuit unless it is planar–therefore, we **strongly** encourage you to keep your circuit board neatly organized every lab.

Lab Checkoffs

Labs will be graded by completion on an all-or-nothing basis via a checkoff, which will consist of demonstrating your completed circuit(s) and answering conceptual questions about the lab. **Both partners must be present for checkoff**, and both partners must have contributed to the lab. If one partner is unable to make it to checkoff, both partners may checkoff individually.

We expect most students to complete lab and get checked off within the 3-hour duration of a lab section. In the event that you do not finish lab, you will have until the end of your next lab section (a week) to complete the lab for full credit. Please refer to the Make-Ups and Extensions section for more details about what to do in this case.

If staff deems that your circuit is not sufficiently complete or your conceptual understanding of the lab is insufficient, they will decline your checkoff and ask that you reattempt checkoff later in section. While there is no hard limit to how many times you can attempt checkoff, we will prioritize helping other students over subsequent checkoff attempts. In the event you face some unsolvable issue, TAs may accept high-effort, close-to-done labs at their discretion for full credit given a thorough conceptual understanding of the lab.

Checkoff credit can be viewed on Gradescope via the assignment titled *Lab Checkoffs*, which is typically updated at least once a week. If you notice any errors, you may report them to us by submitting the Gradescope checkoff errors form.

Buffer Weeks, Make-Ups, and Extensions

Buffer Weeks

There are 3 buffer weeks built into the lab schedule in Week 6, 7, as well as Week 16 (RRR Week). There is no dedicated lab during buffer weeks; however, we will still hold sections, where you can work and catch up on previous labs.

Make-Up Labs

If you could not make it to your assigned section or could not finish lab in section, you may choose to temporarily attend a different lab section to finish the lab. Last semester, we piloted having no formal sign up process for choosing a different lab section. This policy seemed to work well in reducing student stress for sign ups and we will continue with this policy this semester! Keep in mind that the TAs will prioritize students in their assigned section over students attending a section for makeup for help and checkoff requests.

Extensions

If you find yourself requiring more time to complete a lab, you may request an extension in the course's extension form. You will receive an email response indicating approval or denial; we will automatically approve your first extension

of up to a week. Only one member needs to submit the form, as extensions apply to the entire group. Extensions for pre-labs will not be given.

Lab Groups

Labs will be completed in groups of 2 with other students in your section. If you have special circumstances which would necessitate working alone or in a group of 3, email us and seek your lab section TA's explicit permission to confirm the change.

If you already have a lab partner, sit tight! If not, you may use the follow-ups in the Welcome to EECS 16B Labs Ed Post or the first week of lab section to find a partner. You have until February 5 to change/finalize lab groups, during which you will fill out the lab group form as part of checkoff for Lab 2.

Lab Kit Distribution

Lab Kits will be distributed during the second week of lab, after groups are formed. **Please note only 1 kit will be given to each group.** If you are unable to make it to your lab section during this time, please reach out to us on Ed.

If you or your partner decide to change your group, please ensure that each group ends up with a lab kit. If you or your partner drop the class, inform the TA in the section and, if applicable, form/join another group. If your new group ends up with an extra lab kit, please return it. You will also need to submit the group information form again so that you can get added to the group or receive a new group number.

Miscellaneous

Design Contest

In past semesters, we've typically held the *Design Contest* during RRR Week, which gave students an opportunity to add additional functionality to S1XT33N in order to elevate its use and impact in society, with the opportunity to win monetary prizes and global extra credit points. More logistics about this will be announced later into the semester.

Other Forms

We expect both partners in lab to have contributed to the lab. If you feel that your partners have not contributed to labs (or lab reports) to the extent they should have, please fill out the non-contributing group member form linked here.

If you have any feedback or complaints about labs or lab staff, you may fill out the anonymous feedback form here.

Recap: Important Links

As a recap, here are all of the important links:

Help Request: https://eecs16b.org/lab-help

Lab Checkoff Request https://eecs16b.org/lab-checkoff

Lab Group Form https://eecs16b.org/lab-groups

Lab Non-contributing Group Member Form: https://links.eecs16b.org/lab-noncontributing

Lab Anonymous Feedback Form: https://eecs16b.org/lab-anon-feedback

Lab Gradescope Checkoff Error Form: https://eecs16b.org/lab-checkoff-error

16B Extensions Request: http://eecs16b.org/extensions

Schedule

This is a very rough lab schedule; for a more detailed weekly schedule, please see the Welcome to EECS 16B Labs Ed Post.

Week	Lab	Overview	Goals
1	Syllabus Week	No Lab	
2	Lab 1: Introduction to SIXT33N	Build circuits physically, become familiar with equipment	Practice building circuits
3	Lab 2: Analog & Digital Interfaces	Build a Digital to Analog Converter (DAC) and an Analog to Digital Converter (ADC)	Review superposition, R2R ladder, comparators, and continue familiarizing yourself with Arduino
4	Lab 3: Motion	Setup a motor-controller circuit for S1XT33N's motors; Install and setup speed sensors to measure S1XT33N's velocity	Explore the use of transistors and encoders to build utility circuitry for S1XT33N; Set up a 5V regulator
5	Lab 4: Sensing Part 1	Setup a mic-board to record voice samples for giving instructions to S1XT33N; Generate a low-pass filter to attenuate higher frequencies	Understand the concepts of amplification, classification, and filtering of voice samples
6	Lab 5: Sensing Part 2	Create a color-organ by building high-pass and bandpass filters and utilizing the low-pass filter from the previous lab.	Explore filters and voltage amplifiers further
7	Buffer Week	Buffer Week Midterm Exam 1	Catch up on any leftover labs Study for Midterm
8	Lab 6: System Identification	Profile motor behavior and determine operating point	Explore modeling and linearization using least-squares as a precursor to controls
9	Lab 7: Controls Part 1	Implement and fine-tune closed-loop model to make the car drive straight or turn	Explore discrete state-space control via eigenvalue placement
10	Lab 7: Controls Part 2	Modify controls equations to implement turning for S1XT33N; Re-tune mic-board for voice classification	Use basic circle geometry combined with controls to implement turning
11	No Lab	Spring Break	
12	Buffer Week	Midterm Exam 2	
13	Lab 8: Classification	Record voice samples, find PCA vectors, and implement cluster classification algorithm for samples projected onto PCA subspace	Explore SVD and PCA as they relate to data science in order to distinguish different commands
14	Lab 8: Classification (continued)		
15	Integration/Final Demo ("Lab 9")	Make the car drive in response to voice commands	Bring everything together and achieve understanding of the complete system
16	Buffer Week	Buffer Week/Design Contest RRR Week	Finish Integration/Final Demo
SCHEDULE IS SUBJECT TO CHANGE			