

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.

All administrative and logistical questions should be directed to Piazza. Any personal-related questions should be asked using a private Piazza post or sent to the course email at eeecs16b-sp22@berkeley.edu.

All deadlines are in the Pacific timezone (PT).

COVID-19 Policies

The health and safety of students and staff is of paramount importance to us. Therefore, we will be enforcing the following policies for in-person sections, in accordance to campus and public health guidelines:

1. The pandemic is not over yet. We mandate all students to be wearing well-fitting masks (surgical, N95, KN95, or KF94 are highly recommended) covering BOTH the mouth and nose AT ALL TIMES during in-person lab sections, whether that be in Cory 125 for hands-on or in various campus classrooms for sim. If you fail to comply with this, you will be removed from the section immediately.
2. If you become sick, experience any sort of symptoms, test positive for COVID-19, or come in close contact with someone who tested positive for COVID-19, DO NOT COME TO LAB. Please make a private Piazza post or email the course email and we will always work with you.
3. You must have Green Badge clearance to enter campus buildings, which requires completing a daily screener.
4. For hands-on, there are disinfecting wipes, hand sanitizer, and extra masks available on the TA desk in Cory 125. Please feel free to use them whenever needed. We strongly encourage you to wipe down your lab bench areas, keyboard, and mouse at the start of each section due to them being used by many students every day.

Grading

EECS 16B offers two flavors of lab: **hands-on**, which involves physical circuit building, and **sim**, which simulates circuits through the Tinkercad web software. 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 hands-on labs, attend help sessions for sim labs, and follow the success tips discussed in Lab Note 0.

Within lab, grading is broken down into the following, with each section detailed below:

Pre-Labs (9 total)	5%
Labs (9 total)	60%
Integration/Final Demo	10%
Lab Reports (2 total)	25%

Pre-Labs

There are 9 pre-labs total for each of the 9 labs. Each is worth $\frac{5}{9}\%$ of your lab grade. 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. These will be short assignments to be completed on Gradescope and due on Sundays at 11:59 PM before the start of each week's lab for all students. Questions will be based off the lab note or information within the lab's Jupyter notebook. 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, so please plan your time accordingly.

Labs

Sections for both formats will start on Monday, January 24. Throughout the semester, you will complete 9 labs total, each worth $\frac{60}{9}\%$ of your lab grade. All labs, except Labs 1 and 2 build up to the completion of S1XT33N. Labs 1 and 2 will be completed on Gradescope for all students and graded on correctness. For hands-on, Labs 3-9 and Integration/Final Demo will transition to being checked-off in in-person sections. For sim students, labs will continue to be submitted on Gradescope and graded on correctness.

Integration/Final Demo

At the end of the semester, you will demonstrate your final, completed project, worth 10% of your lab grade. For hands-on, it will be a demonstration of your S1XT33N being able to successfully classify voice commands into instructions for S1XT33N's movement. For sim, it will be a demonstration of the voice commands being correctly classified to affect the car's movement through simulation.

The lab policies are broken down between hands-on and sim labs on the next three pages. After the breakdown, there is a detailed comparison table between the two lab formats to help you make your lab option decision.

Hands-On Lab Policies

Hands-on Lab Structure

- Hands-on lab sections are 3 hours long, led by one TA and staffed by several lab assistants. 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.
- **Attendance is mandatory and you *MUST* come to your assigned lab section.** This is because the class is very full, and lab sections only have enough staff to support the students enrolled in that section.
- You will work in groups of 2 with other students in your section. Groups of 3 will only be allowed under special circumstances for in-person labs only. You have until February 11 to change lab groups. During this week, you will submit your finalized group info to [the form here](#) as part of checkoff. You will receive a group number as a confirmation. Please use that for submitting checkoff requests. Use [@29](#) on Piazza to find partners.
- **Both partners must be present for checkoff.** Each group must have one functional circuit to be able to receive credit, and both partners must have contributed to the lab. Credit will be given on an individual-basis.

Hands-on Lab Grading

- Hands-on labs are graded on an all-or-nothing basis, with the exception of Labs 1 and 2, which are graded on correctness. Being checked off on time means that you have received full credit for the lab. A lab is considered “on time” if you are checked off any time before the start of your next lab section, so you have exactly one week to complete each lab, with the exception of buffer weeks, where you can get checked off for the past week’s lab for full credit. TAs will accept high-effort, close-to-done labs at their discretion for full credit given thorough conceptual understanding of the lab.
- **Extensions:** If you need more time than the start of your next section for the following lab, please fill out the [lab extension form](#), and you will receive an email response indicating approval or denial. Only one member needs to submit the form as extensions apply to the entire group. Extensions for pre-labs will not be given.
- Checkoff credit can be viewed on Gradescope. If you notice any errors, it is your responsibility to report them to us by submitting the [Gradescope checkoff errors form](#).
- Labs are an essential part of the course. Therefore, if by the end of the semester **you miss 4 or more out of the 9 hands-on labs, you will fail the class.** Your final grade will be an F or NP depending on your grading option.

Hands-On Lab Support

- If you need assistance during the lab section, fill out the [help request form](#) and a staff member will join you. The process for checkoff is the same; you will submit a [checkoff request form](#) and a TA or lab assistant will join you once it is your group’s turn on the checkoff queue. **You MUST have both help and checkoff requests submitted at least 10 minutes before the end of section** to give sufficient time buffer in case the queues are long so that staff can get to you before the next section starts.
- Lab questions related to debugging will not be answered on Piazza 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 Piazza and you are encouraged to collaborate with your peers on Piazza and other platforms!
- **Make-ups:** If you did not finish the lab in your section and would like to attend a section you are not enrolled in, please sign up for a section [here](#). Review instructions [here](#)
- Every lab group will have a peer lab group from their section. This group should be your first point of contact in case you are facing debugging issues and it is a group you should closely collaborate with on labs.

Lab Group Formation

We encourage students to use the lab office hours hosted in Weeks 2 and 3 and Piazza thread [@29](#) for finding partners.

For hands-on students, it is important that you submit your group information [here](#) by January 28 at 11:59 PM. This is to enable kit distribution in Week 3. You will be emailed your group number on January 29. Hence, it is important that you finalize some group by January 28. Otherwise, we will not be able to give you a kit. **We will only be giving one kit per group.**

If you or your partner decide to change your groups and/or drop the class, we ask that you return your group's kit to us by going to a section. You should inform the TA in the section that you have returned the kit, so that we can mark it internally. If you are joining another student who too is in a similar situation, then you can request for a new kit by asking your section TA. You also need to submit the group information form again so that you can get a new group number.

If you are joining another group, i.e. making a group of 3, seek your lab section TA's explicit permission and submit the group information form again so that your group can be issued a new group number. Hands-on students **cannot** change groups past February 11.

Lab Kit Distribution

We will be hosting lab kit distribution hours in Week 3 when you can pick up the kit for you and your partner. Please note only 1 kit will be given to each group. We will announce the exact days and times for the distribution shortly on Piazza. Please ensure you follow all campus health and safety guidelines, including wearing a mask, when you go to receive your lab kit.

Sim Lab Policies

Sim Lab Structure

- Sim lab sections are 3 hours long, led by one TA and staffed by lab assistants. 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.
- We strongly encourage you to add a section to your calendar to work together with other students and get guidance from course staff, especially to ensure you have a strong conceptual understanding of lab. However, attendance is not mandatory and you can complete all the labs asynchronously. You will also have the flexibility to attend any of our offered sim lab sections.
- You can work alone or in a group of 2. Please note that the final report will also require a group of 2, so start searching for a partner early! Use [@29](#) on Piazza to find partners.

Sim Lab Grading

- Labs are submitted on Gradescope and are graded on correctness by an autograder that will be run after the lab's deadline. You will have more than a week to complete each lab, and they will be due on Sundays at 11:59 PM. Late submissions will not be accepted.
- **Extensions:** Fill out the [extension form](#), and you will receive an email response indicating approval or denial. Only one member needs to submit the form as extensions apply to the entire group. Extensions for pre-labs will not be given.
- Grades will be released on Gradescope after the lab's deadline, along with Tinkercad solutions on Piazza.
- Labs are an essential part of the course. Therefore, if by the end of the semester **you “miss” 3 or more out of the 9 sim labs, you will fail the class.** Please refer to our definition of “missed” below. Your final grade will be an F or NP depending on your grading option.
- A submission without displayed effort is a missed lab, which is defined as below a 50% **raw** score. We understand that things can get stressful during the semester. Hence, we allow students to make-up “missed” labs through 1:1 checkoffs with a TA in a sim section. Checkoffs are completed by joining the [Lab OH Queue](#). Please note that this checkoff will only ensure that your submission is not considered “missing;” you will not get any credit back, so your score will remain the same. **You can only get checked off for any missing labs during buffer weeks.**
- Some submissions will be selected on the coming Thursday after the lab is due on Sunday. These students will be emailed on Thursday night and they will be asked to get checked off for their understanding of the lab in the Friday section of that week.

Sim Lab Support

- We highly recommend that you set aside time each week to complete the lab and attend one of our scheduled sim sections each week to answer any questions you may have. If you need assistance from lab staff, you can add yourself to the [Lab OH Queue](#) and a TA or lab assistant will join you once it is your turn on the queue. We will be offering hybrid support for our sim sections.
- Lab questions related to debugging will not be answered on Piazza to encourage students to seek debugging help in hybrid sections, where staff is best equipped to help you. However, administrative, logistical, and conceptual questions will still be answered on Piazza and you are encouraged to collaborate with your peers on Piazza and other platforms (as long as you don't post pictures of your work)!

Deciding Between Hands-on and Sim Labs

You will be completing either **hands-on lab** or **sim lab**, as described below. In any given week, both labs will emphasize the same lecture concepts and design goals.

You can sign up for your lab option the week classes start through a SignUpGenius that opens on Tuesday, January 18 at 12 PM and closes on Friday, January 21 at 11:59 PM. Please note that this is different from the initial preference forms released on Piazza. You will receive an email confirmation for your lab option and/or section by Saturday, January 22. **Please note that you cannot change your lab option later in the semester, so please make your decision carefully.**

	Hands-on	Sim
Overview	Hands-on lab involves physical circuit building and debugging. You will gain hands-on experience with circuit building and debugging. You have an assigned 3-hour lab section each week, where attendance is required.	Sim lab builds an understanding of circuit building concepts in a software format, through simulation and analysis. There will be no physical circuit building required. Help is offered in 3-hour hybrid lab sections.
Materials	You will receive a lab kit during Week 3, which you will need to bring to lab section each week.	You need a computer with stable Internet connection and a free Tinkercad account to complete sim labs.
Support	Each 3-hour lab section will be staffed by the same TA and ASEs each week, so you can build relationships with lab staff. You must attend your scheduled lab section each week. We will not be answering any debugging questions on Piazza or other course office hours.	3-hour sim lab sections will occur in a hybrid format. It's highly encouraged (but not required) that you join the same section each week to build relationships with lab staff. We will not be answering any debugging questions on Piazza or other course office hours.
Grading	After labs 1 and 2 (which are graded for correctness on Gradescope), checkoffs will be graded on an all-or-nothing basis. TAs will accept high-effort, close-to-done labs, at their discretion. If you miss 4 or more hands-on labs, you will automatically fail the class.	The Gradescope autograder will be run after the deadline. By nature of using an autograder, your score will be based on correctness. If you miss 3 or more sim labs, you will automatically fail the class.
Collaboration	Every student must participate in the group checkoff. Every group will have one functioning hardware, but everyone must have contributed to it. Each lab group will be 2 students.	Students must submit labs individually or in groups of 2 on Gradescope. You can work with other students in the class.

Remote Instruction Policies for Weeks 1 to 3

These are specialized policies for EECS 16B labs to account for the 2-week remote instruction at the start of the semester announced by the University.

1. EECS 16B labs will run completely remotely for the first 3 weeks, with the following exception: for hands-on students, Week 3 will be partially remote, as lab kit distribution and lab equipment training will occur during that week. More details on kit distribution and equipment training will come on Piazza soon.
2. There will be no lab during the first week. However, students will still finalize their lab option by the first week.
3. Lab 1 occurs on Week 2 and Lab 2 occurs on Week 3, and both labs will have pre-labs as well.
4. All students (irrespective of their format) will complete the same labs and Gradescope assignments for Labs 1 and 2. Both labs will be graded on correctness for all students. However, the assignments will be separate on Gradescope for each format.
5. There will be lab office hours during Weeks 2 and 3 to help students with Labs 1 and 2. This will happen remotely using the [Lab OH Queue](#), where students can receive support on these assignments from lab staff. No debugging questions will be answered on Piazza.
6. All students can either work individually or in pairs for Labs 1 and 2. You can work with different students for Labs 1 and 2 as your partners.
7. Hands-on students will be required to attend equipment training during Week 3 for 1 hour. This will be the first hour of their assigned section. Note that this is **mandatory** and there will be some questions on using lab equipment on Lab 2's Gradescope assignment for hands-on.
8. We request all enrolled students to fill out this [survey](#) indicating their lab option preference. This is NOT a sign-up form, and lab section sign-ups will take place starting the first day of instruction on January 18. We simply want students to update their preferences and see if they have changed given new health conditions. **Please submit the form by Thursday, January 13 by 11:59 PM.**

Lab Reports

The lab reports test your understanding of the EECS 16B labs and the SIXT33N car project, with an emphasis on conceptual and analytical understanding. It also allows you to look at the labs from a bigger picture and reflect on your design process and choices.

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.

All students will complete two lab reports, one during the middle of the semester and one at the end of the semester. The midterm lab report will be due during the second week of March and will cover all content up to Lab 5 (Voice Sensing Part 2). The final lab report will be due at the beginning of RRR week and will cover all lab content. There may be questions on Labs 1-5, but emphasis will be placed on content from Lab 6 (System Identification) onwards.

The lab reports must be completed in groups of 2, except if you have received an exception to work individually or in groups greater than 2. If you feel your partners have not contributed to the report to the extent they should have, please fill out the non-contributing group member form linked [here](#).

TI Design Contest

TI Design Contest is an opportunity for students to add additional functionality to SIXT33N in order to elevate its use and impact in society. The contest will be held towards the end of the semester. The main requirement is that your SIXT33N should have all functionality up to the Controls Part 2 lab. The classification lab is not necessary to be eligible for the contest, however it is definitely recommended.

As the contest is sponsored by Texas Instruments, we will be offering very generous prizes and extra credit to the winners and participants. Past winners have received priority consideration for 16B Lab Staff. You are free to add any functionality to your SIXT33N. For more examples, watch the past winning entries below:

- SIXT33N On Mars By Inga Zhuravleva - [Writeup](#), [Webapp+Video](#)
- Golden Kiwi Bot by Walker Browning, Ayush Gupta, and Krischan Jung - [Writeup](#), [Video](#)
- Lightning SIXT33N by Philip Ha - [Writeup](#), [Video](#)
- Futbol SIXT33N by Gaurav Shah - [Writeup](#), [Video](#)
- Sahai's SIXT33N By Shrey Aeron, Mingyang Wang, Wilson Wu - [Writeup](#), [Video](#)
- Their SIXT33N is truly bad by Noah Lee Cindy Lin - [Writeup](#)
- The Crash-Alert Vehicle by Sarina Sabouri - [Writeup](#)
- Classy Classification by Megan Zeng - [Writeup](#)
- COVID-NINT33N by Shayan Islam and Kamyar Salahi - [Writeup](#)
- Operation SIXT33N by Viren Khandal - [Writeup](#)
- SIXT(Wii)N by Dylan Reimer and Allison Husain - [Writeup](#)

Schedule

Hands-on and sim labs will both follow the same schedule and teach the same concepts each week. Sim students will not complete hardware components of the labs described below.

Week	Date	Lab	Overview	Goals
1	1/18	Syllabus Week		No Lab
2	1/24	Lab 1: Introduction to Simulation	Build a circuit virtually on TinkerCad.	Practice simulating circuits.
3	1/31	Lab 2: Analog & Digital Interfaces	Build a Digital to Analog Converter (DAC) and an Analog to Digital Converter (ADC) to understand the functionality of the Launchpad/Arduino micro-controller.	Review superposition, R2R ladder, comparators, and continue familiarizing yourself with the Launchpad/Arduino.
4	2/7	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.
5	2/14	Lab 4: Sensing Part 1	Setup a mic-board to record voice samples for giving instructions to S1XT33N. Setup voltage-regulators to produce a variety of voltages from 9V.	Understand the concept of amplification and classification/filtering of voice samples.
6	2/21	Buffer Week	Buffer Lab	Finish Lab 4.
7	2/28	Lab 5: Sensing Part 2	Build a low-pass filter to remove noise from voice samples. Build a band-pass filter to enhance noise filtering.	Explore low-pass and band-pass filters.
8	3/7	Lab 6: System Identification	Profile motor behavior and determine operating point.	Explore modeling and linearization using least-squares as a precursor to controls.
8	3/7	MIDTERM LAB REPORT DUE		
9	3/14	Buffer Week (Midterm Week)	Buffer Lab	Finish Lab 6.
10	SPRING BREAK 3/21 - 3/25			
11	3/28	Lab 7: Controls Part 1	Implement and fine-tune closed-loop model to make the car go straight.	Explore discrete state-space control via eigenvalue placement.
12	4/4	Lab 8: Controls Part 2	Implement turning for S1XT33N. Re-tune mic-board for voice classification.	Use basic circle geometry combined with controls to implement turning.
13	4/11	Lab 9: 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	4/18	Lab 9: Classification (continued)		
15	4/25	Integration/Final Demo	Make the car respond to voice commands.	Bring everything together and achieve understanding of the complete system.
16	5/2	Buffer Week	RRR Week	Finish Integration/Final Demo.
16	5/2	FINAL LAB REPORT DUE		
SCHEDULE IS SUBJECT TO CHANGE.				

Watch S1XT33N in action!!

Here are some final demo videos recorded by students in Fall 2021, demonstrating their S1XT33N following their commands.

1. [Elijah Littman and Kendall Schubert](#)
2. [Sarah Taylor and Rithu Paramesh](#)
3. [Kevin Cai and Connor Dang](#)
4. [Aayush Dave and Bilguun Amarbayar](#)
5. [David Spitz and Benny Feinberg](#)
6. [Yiming Ni and Ziyue Deng](#)
7. [Herbert Tompkins and Bernard Chan](#)
8. [Shruteek Mairal and Katherine Wang](#)
9. [Zheng Zhang and Jacky Chen](#)
10. [Irene Geng and Amanda Wong](#)
11. [Kathleen Kong, Kevin Oh, Xujia Dong, Zhenyi You](#)