EE 16B Designing Information Devices and Systems II
Summer 2020 S. Kuang, E. Naviasky, F. Laine Lab Syllabus

Introduction

Welcome to 16B lab! We are so excited to have you.

The main goal of lab is for you to gain hands-on experience applying concepts from lecture. You will build your physical intuition and confidence with hands-on problem-solving skills, including critical thinking, design thinking, and tenacity via debugging. If you can't fix a bug right away, stay calm and think through the problem: use what you know to figure out what you expect to be going on at each node of your circuit, and know how to correctly use the lab equipment to test your predictions. This goal subsumes the following subgoals:

1. **Modular thinking:** Know how to break a large problem into small, actionable parts. Though you should plan as much of your approach as you can, you will also need to build the confidence to get started on a problem without necessarily having each step of the solution planned; rather, identify the first thing that needs to be done, do it, and then reevaluate and move on.
2. **Creating effective tests:** Know how to check your work without merely checking each step along the way.
3. **Incremental problem solving:** Know how to simplify a problem and identify its base cases. Be able to identify the simplifying assumptions you can make when solving a particular problem.
4. **Design:** Given a set of components and restrictions, be able to use them efficiently to solve the given problem.

We want lab to be a positive experience for everyone; in fact, the point of lab is to be rewarding and satisfying. However, this does not mean that lab is supposed to be easy. The staff are here to support you and provide you with the resources (including mental schema) you need as you build the perseverance to debug, but we will never do your work for you. That being said, if you are having a hard time or feel that you are falling behind in the class as a whole, please do not hesitate to reach out to your lab GSI: first and foremost, we are here to help you.

Grading and Policies

Lab is worth 20% of your final grade for 16B. We believe it is possible for every student to get a perfect lab score if you work diligently during your lab section and follow the tips outlined in the final section.

- **Attendance is mandatory, and you must come to your assigned lab section as per CalCentral** so that we can allocate staffing resources appropriately.
- Labs are graded on an all-or-nothing basis.* Being checked off on time means that you have received full credit for the lab. Due dates are published on the website. If your lab is late, 50% of the credit will be deducted. Extensions/partial credit are given at the discretion of your lab GSI (partial credit only in extremely rare extenuating circumstances). Checkoffs can be viewed on Gradescope.
- *TAs may accept high-effort, close-to-done labs at their discretion for full credit given thorough understanding of the lab in order to reduce overflow and stress as much as possible.
- Circuits must be as neat as possible so that lab staff can do their best to visually check your circuits over Zoom.

Making Up Labs

If you don't get checked off before the end of your lab section, you can attend another section to complete the lab. **All partners must be present for checkoff, so make sure the section you choose works for everyone in your lab group.** Check the makeup list here (tinyurl.com/16b-lab-makeup-list-su20), choose a section that isn't full, and submit a request using this form (tinyurl.com/16b-makeup-request-su20). The makeup list updates every five minutes, so you might not see your request show up right away. Please do not attempt to reserve spots in multiple different sections at once—to allow fair access to makeup spots, we ask that you hold no more than one makeup reservation at once (i.e., you may submit another request after you attend your makeup section if you still are not finished, but not before that). Within lab, grading is broken into:

Labs (4 total)	40%
Project	60%

In order to encourage spreading out project work throughout the semester, each week will have checkpoints that must be met in order to receive credit for that lab. The project breakdown is as follows:

Checkpoints (4 total)	50%
Integration/Final Demo	25%
Final Report	25%

In order to keep group members accountable now that labs are remote, we also will include a participation multiplier. This will be a number between 0 and 1.25 that will multiply your entire lab grade.

Lab Structure

Labs are 3 hours long, and are led by one GSI and staffed by several lab assistants. Partway through the lab, several more lab assistants and/or GSIs will arrive to help. Every lab will start with a short lecture (approx. 15 minutes in length) given by your lab GSI that will give you an overview of the lab, review the relevant theory, and give you useful tips that will help you avoid common mistakes. After the lecture, you will have the rest of the lab period to work.

More specifically, labs will be run as follows:

1. Get in contact with your partner(s) and start a Zoom call together. You will submit the link to this call in the checkoff and help queue forms (when you're ready to be checked off or you need help): when it's your turn to be helped, a staff member will join your call using the the link you submitted.
2. Join your lab lecture Zoom call from the link posted on Piazza ($@XXX$). Your TA may use a poll in the chat to verify attendance or collect opinions or responses to questions.
3. Your TA will give a short lecture outlining the lab and reviewing the concepts used. **After the TA ends this call,** you may begin working and/or submitting help/checkoff requests. If you're making up a lab, the preceding sentence does not apply to you, but you may find it helpful to listen to the lecture anyway.
4. 5-10 minutes before the end of a section (depending on the length of the queues), the checkoff and help queues will close, and staff will help as many of the groups already in the queues as they can before the end of the section.

Syllabus

Dates	Lab	Overview	Goals
6/22-6/23	Lab 1: Debugging/Power Released	Build and debug an inverting amplifier and your power supply.	Practice good circuit-building and debugging techniques, and refamiliarize yourself with lab equipment.
6/24-6/25	Lab 2: DAC/ADC Released	Build a 4-bit DAC using the MSP430 and a resistor net. Modify the DAC to build a 4-bit SAR ADC by adding a comparator and implementing binary search.	Review superposition and continue familiarizing yourself with the MSP430.
6/29-6/30	**Lab 1: Debugging/Power Due**		
7/1-7/2	Lab 3: Color Organ I Released	Use the mic board and filters to illuminate different LEDs depending on sound frequency.	Explore low-pass, high-pass, and band-pass filters.
7/6-7/7	Lab 4: Color Organ II Released; **Lab 2: DAC/ADC Due**	See Color Organ I.	See Color Organ I.
7/13-7/14	Project Part 1: Circuits Released **Labs 3 and 4 (Color Organ I and II) Due**	Filter and add a bias to a sound signal. Then, feed that signal to an ADC (MSP430) and display on computer. Build car and test motor behavior.	Build the front-end circuitry for the car (neatly, to minimize chances of wires coming loose later) and denoise the sound signal to improve classification later on.
7/20-7/21	Project Part 2: SVD/PCA Released; **Project Part 1: Circuits Due**	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 make your car correctly respond to voice commands.
7/27-7/28	Project Part 3: System ID Released; **Project Part 2: SVD/PCA Due**	Profile motor behavior and determine operating point.	Explore modeling and linearization using least-squares as a precursor to controls.
8/3-8/4	Project Part 4: Controls Released; **Project Part 3: System ID Due**	Implement and fine-tune closed-loop model to make car go straight and turn.	Explore discrete state-space control via eigenvalue placement.
8/10-8/11	Project Part 5: Integration Released; **Project Part 4: Controls Due**	Make car respond to voice commands.	Bring everything together and achieve understanding of the complete system.
8/17-8/18	**Project Part 5: Integration Due** (potentially an optional lab released)		
SYLLABUS IS SUBJECT TO CHANGE.			

Lab will be held Monday-Thursday every week, even if no specific lab is released or due that day.

LPTs: Lab Pro Tips

Following these tips will ensure you succeed in and get the most out of lab.

1. Read through the lab note and lab notebook before coming to lab. Think carefully about what possible bugs you may encounter, or which parts of the lab will take longest, and have a plan for avoiding those bugs and staying on-track time-wise.

2. If there is a lab problem on the homework, make sure you do it prior to your lab section. We put these problems on the homework to save you as much time as possible in lab and perhaps even help you finish early. This and tip number 1 are the top tips for making sure that you finish on time and get the most out of lab — if you follow these tips, you won't be scrambling to finish and will have the time to develop a deep understanding of the lab.

3. Talk to the other students in lab, not just your partner. If you overhear someone talking about a bug that sounds similar to yours, ask them what they have tried to fix it. Or, if you've already fixed that bug, offer them some pointers.

4. As you're working through the lab, formulate sanity-check questions that allow you to quickly check if there is something wrong with your circuit. Ex: *What should VDD and VSS be? What voltage do I expect at this node? What do I expect the signal at this node to look like?*

5. Get to know your lab partner(s). You will be working with them all semester, including the entirety of the project. This also extends to the other students in your section. It's much easier to work with friends!