EE 16B Designing Information Devices and Systems II
Spring 2019 A. Sahai, J. Roychowdhury, K. Pister 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. Build the confidence to get started on something when you don't know how it will end.
2. Know how to check your work without merely checking each step along the way.
3. Know how to simplify a problem and identify its base cases.
4. Understand how to try different approaches without knowing whether they will work, and how to recognize when in fact it has or has not worked.
5. Understand how to try these approaches systematically instead of randomly, and be able to explicitly express what tentative assumptions you are making or which possibilities you discover while exploring.
6. Know how to work backwards — assuming that you could somehow by magic get to intermediate point X, how could that help you get to the goal? And, be able to take initiative and explore whether you can in fact get to intermediate point X.
7. Be able to take given components and use them to get the result that you want.

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 30 % of your final grade for 16B (the same amount as the final, or both midterms put together!). Do well in lab, and you will be handsomely rewarded! 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.** This is because this class is very full, and lab sections tend to have few, if any, open stations.
- Labs are graded on an all-or-nothing basis. 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: i.e., you have one week to complete each lab. If your lab is late, 50% of the credit will be deducted. Extensions are given at the discretion of your lab GSI. Checkoffs can be viewed on Gradescope.
- If you did not finish your lab in your section, look at the class schedule, find a section with open seats that works for **both** you and your partner, and email **both** the GSI that leads that section and your normal section's GSI to ask if they have space for you in their section.
- **Both** partners must be present for checkoff.
- **If you do not adequately clean your station before leaving, you will lose 20 % of the credit for said lab after a warning.**
- Treat the lab equipment with respect - any damaged or missing equipment will negatively impact the ability of the course as a whole to complete lab assignments in a timely fashion.
- **Food and drinks are not allowed at lab stations.** No exceptions. This is a safety concern.

Within lab, grading is broken into:

Labs (6 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. Checkpoints must be checked off within **1 week** of assignment for full credit - late labs are accepted for 50% credit. The project breakdown is as follows:

Checkpoints (6 total)	50%
Integration/Final Demo	25%
Final Report	25%

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 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: **try to have your checkoff request submitted 10 minutes before the end of lab** to ensure you have time to clean up, and give you a bit of a time buffer in case the queue is long.

Syllabus

Start Date	Lab	Overview	Goals
1/21	Syllabus Week	No Lab	
1/28	Lab 1: Debugging	Build and debug an inverting amplifier and a logical adder.	Review digital logic, practice good circuit-building and debugging techniques, and refamiliarize yourself with lab equipment.
2/4	Lab 2: DAC/ADC	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
2/11	Lab 3: Mic Board	Build and test the mic board that you will use in your project.	Practice soldering and explore the capacitive time response with differential equations.
2/19	Lab 4: Color Organ I	Use the mic board and filters to illuminate different LEDs depending on sound frequency.	Explore low-pass, high-pass, and band-pass filters.
2/26	Lab 4: Color Organ II	See Color Organ I.	See Color Organ I.
3/5	Project Part 1: Circuits	Filter and add a bias to a sound signal. Then feed that signal to an ADC (MSP430) and display on computer.	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.
3/12	Project Part 2: System ID	Build car, profile motor behavior, and determine operating point.	Explore modeling and linearization using least-squares as a precursor to controls.
3/19	Project Part 3: Open-Loop Control	Test open-loop model and implement closed-loop model.	Explore discrete state-space control via eigenvalue placement.
SPRING BREAK 3/25			
4/2	Project Part 4: Closed-Loop Control	Fine-tune closed-loop model to make car go straight.	See above. Also, practice making block diagrams.
4/9	Project Part 5: SVD/PCA	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.
4/16	Project Part 6: Advanced Controls	Make car turn and implement classification on MSP430.	See above.
4/23	Project Part 7: Integration	Make car respond to voice commands.	Bring everything together and achieve understanding of the complete system.
4/30	Buffer Days 4/30- 5/3	No Lab	Use this time to finish the project
5/6	RRR Week/Finals Week	No Lab	
SYLLABUS IS SUBJECT TO CHANGE.			

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. 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!