Electronic Circuit Design & the EDA Toolchain

By Slugbotics

The electronics circuit design module of CRSN-151C will introduce the basic concepts of electricity, circuit design, and circuit building by taking participants through the full manufacturing process of a printed circuit board. Students will initially learn the physics and measurement skills needed to design and troubleshoot their circuit on a breadboard before working through the entire Electronic Design Automation workflow to build a printed circuit board that controls the speed and direction of a motor. In addition, Git version control and the use of soldering for circuit construction are introduced. Taking this class will prepare you to streamline your own personal electronics projects and give you the skills to participate in Slugbotics, UCSC Rocket team, and/or Formula Slug.

Learning Objectives

- Become familiar with electricity, current, voltage, and resistance.
- Be able to perform basic circuit analysis using Kirchhoff's Current and Voltage Laws.
- Observe circuit and component behavior using multimeters and oscilloscopes.
- Demonstrate professional engineering, communication, collaboration, and documentation practices through the use of lab notebooks and peer review.
- Source the appropriate electrical components from online references for a buck converter.
- Understand datasheets for electronic components.
- Demonstrate familiarity with the entire Electronic Design Automation (EDA) workflow by designing a system to control the speed and direction of a motor.
- Perform version control using Git to keep track of EDA files.
- Find or create EDA models and symbols.
- Gain familiarity with EAGLE PCB design.
- Become proficient with soldering and desoldering.

Synchronous Classes

This class is taught entirely in-person. Attending class and in-class participation are strongly encouraged. Lectures will be recorded, but most labs require special equipment that is only accessible in the lab.
Classes will be taught in two locations: E2 581 (computer lab) and E2 585.

Contact Information

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Office Hours

Office hours are offered weekly at regularly scheduled times by appointment on canvas. Sign up using the Canvas calendar. Office hours may or may not be recorded depending on staff preference.

Lab check-offs (if not completed in class) can be completed during office hours. Sign up for these as you would any office hour: by canvas appointment.

In some cases, there will be extended lab hours held in the lab. Students may remotely join these office hours via Zoom, or drop by in person for extra lab time. Check Canvas for the schedule of extended lab hours.

If none of the scheduled times work for you, please message the instructors to set up a time to meet.

Informal discussions will take place on slack, this includes: questions about assignments, project discussion, team formation, etc.

Slack Channel: 151c-edacircuit

Grading and Assignments

This class has 10 lab projects that will be completed over ten weeks, as well as pre-lab activities (e.g quizzes) due most weeks[1]. You must keep a physical paper engineering notebook, which you will scan and submit at regular intervals. All project-related exercises are to be recorded in the laboratory notebook and submitted on Canvas as part of submitting the labs. Quizzes are due by the specified deadline; see the late policy for more information.

Lectures will be recorded, however, labs are required to be done in-person. If you cannot attend a lab or open lab session, please contact the teaching staff ahead of time to schedule an alternative time to access the lab space and materials.

Grade Distribution:

Labs are graded based on the completion of the yellow-highlighted tasks in the lab manual. Physical labs will be turned in directly while computer-based labs will be turned in via the Sustainability Lab Gitlab repository. Commit IDs must also be submitted on Canvas.

[1] Quizzes will generally be assigned on Canvas and will be due the following Tuesday before lab

Quizzes are graded directly on Canvas. You will be given two attempts per quiz up until the due date. Feedback for free-response questions may take additional time for the teaching team to grade.

Engineering Notebooks and content will be graded for adherence to the handout guidelines linked below. We advise that you write notes in your notebook about lectures each week as well as ideas or problems you encounter during quizzes and labs. You can find some guidance on how to use your notebook in the resources linked below:

- How to keep a notebook:
- Standards of good engineering practice:
- Technical documentation:

This class is graded on a point system. Points are earned by completing assignments, notebook check-ins, and other activities.

The rough breakdown of graded assignments are as follows:
Total: 100%

Failure to meet the minimum requirements for any of the labs will lead to a failing grade in the class.

Late Policy

Prelabs and quizzes may not be turned in late. The final lab and accompanying assignment may not be turned in late. During the quarter, Labs and the associated notebook content may be turned in late up until November 30 (Tuesday of week 10) for an immediate penalty of one half letter grade on the assignment and an additional full letter grade per week late after the due date. Notebook check-ins are subject to the same late policy as the labs.

Course Requirements and Recommendations

A lab notebook is required for this class. Lab notebooks should be graph ruled and at least 5” by 7”.

A personal laptop or desktop computer is recommended for this class. Please ensure that the computer is compatible with Autodesk EAGLE.

- Slack: For class announcements and asynchronous communication.
- Git on a personal computer: For submitting computer-based labs.
- Zoom: For remote office hours and as a fallback lecture method.

Camera: For scanning and submitting notebook check-ins.

If your personal computer does not satisfy the requirements, please reach out to a student-instructor and we will provide alternative arrangements.

Schedule

Week	Content	Tasks
0 9/23	Thursday: <<E2-585>> • Joint meeting • Class intro and overview	• Select section to enroll in • Obtain a graph ruled lab notebook • Join Slack for communication
1 9/28 9/30	Tuesday: <<E2-585>> • Detailed class intro • Syllabus • Lab notebook and documentation • Lab safety Thursday: <<E2-585>> • Electrical Physics • Electrical Theory • Components	• Set up engineering notebook • Start safety training (Getting Started with S-Lab) • Prelab 1 assigned, due Tuesday next week
2 10/05 10/07	Tuesday: <<E2-585>> • Basic electrical circuits • Equivalent Circuits	• Prelab 1 due this Tuesday • Lab 1 due before 10/12

	• Intro to the Multimeter • Lab 1: Component Behavior Thursday: <<E2-585>> • Advanced components • Circuit analysis (KVL & KCL) • Voltage divider • Circuit simulators	• Prelab 2 assigned, due Tuesday next week
3 10/12 10/14	Tuesday: <<E2-585>> • Intro to the Oscilloscope • Breadboards • RC RL RLC circuits • Buck converter circuit Thursday: <<E2-585>> • Lab 2: Circuit Testing	• Prelab 2 due this Tuesday • Lab 2 due before 10/19 • Prelab 3 assigned, due Tuesday next week • Safety training due this Thursday
4 10/19 10/21	Asynchronous: • Command line • Git • Lab 4: Git Repositories Tuesday: <<E2-585>> • Soldering theory • Soldering demo Thursday: <<E2-581>> • Soldering review • Lab 3: Soldering Techniques	• Prelab 3 due this Tuesday • Lab 3 due before 10/26
5 10/26 10/28	Tuesday: <<E2-581>> • Autodesk EAGLE • Libraries • Lab 5: First Schematic Thursday: <<E2-581>> • Board view • Creating libraries in EAGLE • Lab 6 practice	• Lab 4 & 5 due Sunday 10/31 • Prelab 4&5 due this Tuesday • Prelab 6 assigned, due Tuesday next week

6 11/02 11/04	Tuesday: <<E2-581>> ● Component search & selection ● Bill of materials (BoM) ● Lab 6: Buck Converter Schematic Thursday: <<E2-581>> ● Turn schematic into a PCB ○ Board view ○ Placement ○ Gerber file ● Board manufacture ● Demo arranging components in board view	● Prelab 6 due this Tuesday ● Lab 6 due before 11/09 ● Prelab 7 assigned, due Tuesday next week
7 11/09 11/11	Tuesday: <<E2-581>> ● Lab 7: Buck Converter Board Thursday: <<HOLIDAY>> ● Holiday (Veteran's Day)	● Prelab 7 due this Tuesday ● Lab 7 due before MIDNIGHT. ● Prelab 8 assigned, due Tuesday next week
8 11/16 11/18	Tuesday: <<E2-581>> ● Transistors ● Relays ● H-bridges ● Switches ● Lab 8: Motors and H-bridge Thursday: <<E2-581>> ● Intro to ICs ● 555 Timer and PWM	● Prelab 8 due this Tuesday ● Lab 8 due before 11/23 ● Prelab 9 assigned, due Tuesday next week ● Assignment: Convert H-bridge to schematic and board
9 11/23 11/25	Tuesday: <<E2-581>> ● Review 555 Timer IC ● Lab 9: LED control Thursday: <<HOLIDAY>> ● Holiday (Thanksgiving)	● Prelab 9 due this Tuesday ● Lab 9 due before 11/30 ● Prelab 10 assigned, due Tuesday next week
10 11/30	Tuesday: <<E2-585>>	● Prelab 10 (exit survey) due this Tuesday

12/02	• Lab 10: Assembly of Motor Control System Thursday: <<E2-585>> • Lab 10 extra time • Extra topics • Peer review for final assignment	• Lab 10 due at the end of class on Thursday. • Final assignment assigned, due 12/08 @ 10:30 PM
Finals week	Final assignment instead of final exam	• Final assignment due by Dec 8 @ 10:30 PM