E40M An Introduction to Making: What is EE?

Spring 2020
MWF 3:00-4:00 Pacific Time

Welcome to E40M! This course provides an introduction to the broad field of electrical engineering through a series of hands-on projects. Countless devices use electronics, from cars to clocks to cameras to cell phones, but the way they work is usually hidden and often mysterious. Our objective is to demystify the world of electronics. We'll find that not only do many devices contain some electronics inside, but most of them contain small processors as well. Once you grasp the power of adding computing to physical devices and understand how a processor interfaces with other circuitry, you can use this knowledge to construct programmable electronic devices on your own.

The online E40M this quarter will necessarily focus on theoretical analysis of circuits, which you'll learn through online quizzes and homework assignments. We will also include examples of circuit design and debugging on the homework, some of which will be drawn from the electronics projects from E40's lab projects:

- A solar-powered cell phone charger, while learning about batteries, solar cells, power, and efficiency.
- A programmable "useless box", which is a silly toy to play with on your desk. While building this project, you will use switches, motors, transistors, digital logic, and learn to control physical things with software.
- An LED display, which uses the idea of multiplexing to control more lights than your microcontroller has outputs.
- An electrocardiogram (ECG) to measure your heartbeat. You will learn how to build an amplifier capable of magnifying the tiny electrical signal from your heart into something your microcontroller can measure.

By the end of the course, you will have the theory for analyzing the behavior of simple analog and digital circuits and have been exposed to programming, and debugging electronic devices of your own, and the ability to explain some of the countless ways electronic circuits are used in the modern world.

Specifically, you will be able to:

- Predict the behavior of electrical circuits containing resistors, capacitors, inductors, transistors, diodes, switches, and motors.
- Give examples of how the circuit elements and techniques from the course are used in real products.

Instructors: Roger T. Howe (rthowe@stanford.edu) and James D. Plummer (plummer@stanford.edu)

Course Assistants and Section Leaders:

Amy Fritz (Co-Head CA)	avfritz@stanford.edu
Chuan-Zheng Lee (Co-Head CA)	czlee@stanford.edu
Polo Contreras	jcontr83@stanford.edu
Erin Kunz	ekunz@stanford.edu
Michael Oduoza	mcoduoza@stanford.edu
Akwasi Owusu-Akyaw	akwasio@stanford.edu
Meera Radhakrishnan	mradhak@stanford.edu
Varun Srivastava	vsriva@stanford.edu
Andre Turati	amturati@stanford.edu
Sarah Woodard	sarah21@stanford.edu

Instructor and CA/SL office hours are posted on the course's Canvas webpage.

Lectures: Monday, Wednesday, and Friday from 3:00 pm to 4:00 on Zoom.

The lectures will last about 50 minutes, leaving 10 minutes for discussion and questions. All lectures will be captured as video files of the lecture slides, with audio and annotations.

Prerequisites: Although E40M normally requires some prior experience with algorithmic thinking, such as is covered in CS106A, this experience is not required this quarter. E40M also does not require any previous knowledge in physics, specifically in electricity and magnetism. We'll cover voltage, current, power, etc., from the bottom up, and there will be extra opportunities for review on this core material if it went too fast.

You do not need to have taken calculus or differential equations to succeed in this course; the assignments and tests will not require you to take integrals or derivatives. However, we will use calculus to provide a mathematical grounding for many concepts throughout the course, so knowing it will be helpful.

Units: 3 units since there is no laboratory.

Canvas: Course materials and announcements will be shared on the canvas webpage for Sp20-ENGR-40M-01: https://canvas.stanford.edu/courses/116203

Piazza: Please post your questions there rather than emailing the instructors or CAs; you'll get a faster response and others will also be able to benefit from the exchange: https://piazza.com/stanford/spring2020/engr40m

Gradescope (http://gradescope.com) will be used for homework submission.

EveryCircuit (http://everycircuit.com) is a simple circuit simulation and visualization tool that runs in your browser or as an app on your phone or tablet. The access code to unlock the full version is on a slide in Lecture 1.

Quizzes: A new feature of E40M is the use of on-line tutorial exercises (called "Quizzes" on the Canvas page) that will reinforce the application of the concepts covered in lectures. These will be released on Sunday, starting April 4, and due the following Sunday at 7:00 pm. You can retry the quiz as many times as you like – they count as part of your course grade.

Problem sets: Released every Wednesday and due at 7:00 pm the following Wednesday. Submission will be online via Gradescope. We will publish solutions when you turn in each assignment, so late work will not be accepted. However, you can drop your lowest problem set score.

The problem sets are intended to give you practice applying the circuit analysis concepts from class, as well as a virtual introduction to design and debugging skills. If you thoroughly understand the material, each weekly assignment should take around 2½ hours. If you are spending more than 3½ hours on it, we hope you'll reach out to the teaching staff through their Zoom office hours, or through Piazza, so we can help.

You are encouraged to work together on the problem sets, but each individual needs to write-up and upload his or her own answers. Likewise, you're allowed and encouraged (even required!) to use EveryCircuit on problems as a way to check your answers. Many times, being able to visualize the behavior of the circuit will help you gain a deeper understanding of what's going on. In general, answers that don't show appropriate supporting work will not be given credit.

If you haven't used Gradescope before, make sure you allocate a little extra time to turn in your first assignment. We don't want you to miss an assignment just because you had difficulty scanning your work or trouble logging into the site.

Grading: S/CR. In a normal letter graded class, homework, exams and other elements of student performance are weighted according to a defined rubric. Then a class distribution of total scores is created and at least to start, a curve is generated to assign letter grades. Students who have elected to take such a class S/NC get a satisfactory grade if they fall at a C- (or higher) grade level in the class distribution. What score defines a C- in the distribution is at the discretion of the instructor and among other things depends on the overall class performance in an absolute sense.

For this quarter, there are no letter grades. We intend to follow the general procedure outlined above. However, we do not want to encourage any students to simply do the minimum required to achieve some point score corresponding to a C- letter grade, since that defeats the learning goals of the course. Therefore, we intend to pass every student who completes satisfactorily all the homework assignments (with the lowest score dropped) and all the exams and self-assessment quizzes.

Quizzes:	**10%:**	these can be retaken, with modified questions; your highest score will be recorded.
Homework:	**30%:**	your lowest score will be dropped.
Exams:	**60%:**	three equally weighted exams on April 24, May 15, and June 10, 3:00-4:00 pm*

* arrangements will be made for students in different time zones, with other conflicts.