Analog Electronics — Preliminary Syllabus

Unofficial Course Title: Electronics

Spring 2026, Deep Springs College, ***Prof. Brian Hill***

Overview

In my mind (and possibly in nobody else's), it is useful to crudely separate three eras of electronics history:

- There was a Frankenstein era going all the way back to the roots of the field where devices were expensive, dangerous, not very capable, and initially not very widespread. As vacuum tubes became mass produced in the 1920s, the Frankenstein era started to close. By the 1950s, radio and television were consumer items, but what was inside these consumer devices was still high-voltage and fussy.
- In the 1960s the transistor was invented from fundamentally new materials called semiconductors, and this ushered in a Goldilocks era, where it became far easier to build circuits, and in the 1970s lots and lots of savvy people went to Radio Shack, bought parts, and taught themselves to do design and build circuits. In rock-and-roll, the wah-wah pedal, the fuzz pedal, the synthesizer, and the flanger are among the many creative products of this era. I call this era the "Goldilocks era" because it is just right: not too primitive to be hard to get started in, but not too advanced to be bewildered by complexity.
- In the 1980s, the success of the semiconductor era ushered in the HAL 9000 era. The discrete transistor was almost completely replaced by miniature versions of itself replicated *en masse* in integrated circuits and silicon wafers, and even in the most mundane circuitry like that in toasters and thermostats, the componentry became hidden in epoxy-coated boxes that the consumer had no way and little reason to tinker with. Digital circuitry and computers became ubiquitous, and the art of designing discrete electronic circuits gave way to the task of programming microcontrollers.

What is the point, today, of going back to the technology of the 1970s and tinkering with circuits containing only discrete components or perhaps some simple integrated circuits, when a general-purpose chip with billions of transistors is already in your pocket, and most anybody with a little computer knowledge can program complicated things with no artistry at all? The point is to actually understand electronics, and be among the few empowered to do genuinely new things with electronics.

Prerequisite

The only prerequisite for this class is very good high school mathematics. When I say "high school mathematics" I am specifically distinguishing it from "college mathematics" even though many students on a college prep track take AP calculus while still in high school. More formally, what I am referring to by "high school mathematics" is the four years consisting of: Algebra I; Geometry (plane geometry with proofs); Algebra II (with trigonometry); and Precalculus (logarithms, exponentials, polynomials, rational functions, and infinite sequences and series). Good high school mathematics will make the mathematical descriptions of analog circuitry readily intelligible.

If your high school mathematics is rusty, do not let that be a deterrent. It just means that you will have to work harder to polish it back up, and actually, this course is the perfect place to do that.

I will pragmatically and intuitively introduce calculus concepts as we need them. Those that already have had calculus may be a little bored during my gentle introductions, or they may find it pleasing to see calculus usefully applied to charges, currents, and voltages.

Materials

In this course, we will return to the Goldilocks era and work through the same materials that countless hobbyists in the 1970s used to learn electronics. This is an incredible sweet spot that is sadly getting lost. The materials of the Goldilocks era were hands-on, accessible, and remarkably educational.

Our course will cover the associated theory, which I learned from Eric Adelberger when I was a college sophomore who used the then-very-new and now legendary, *Art of Electronics,* 1st edition, 1980, by Horowitz and Hill (no relation). I will be referring to the 2nd edition and summarizing the essential theory in detailed handouts. The bulk of your time will be dominated by hands-on work with Radio Shack kits and Workbook 2 of the companion text authored by Forrest Mims. We will spend ten or eleven weeks of the semester building Mims' introductory circuits, and then in the final three or four weeks, we'll have time for each of you to choose and independently build *any* electronics project. If the first ten weeks goes faster than expected I will draw from Workbook 2 of Mims's texts.

Since there is lead time in getting components, you'll need to select your final project and order components for it while we are still working through Mims towards the end of March. Procuring parts will be your responsibility and will depend completely on the circuit you choose, how you need to enclose the circuit, and what switches, knobs, and power supply (etc.) it needs. Some projects may take as little as $25 to build. Others may take $200. You don't save money building your own stuff relative to buying pre-built consumer products. You gain experience and understanding. The only ways to build cheaply are to scavenge used parts, or get into the mass production business, in which case, you would get the same bulk discounts that consumer product manufacturers depend on to create margins.

Unit Outline (rough and will probably have additions!)

- Unit 1: Introduction to the Lab, and to Basic Electronics Concepts
- Unit 2: Discrete Component Types and Inventory
- Unit 3: Circuit Diagrams, Circuit Assembly Techniques
- Unit 4: Troubleshooting
- Unit 5: Controlling Circuits with Switches and Relays
- Unit 6: Using Resistors and Potentiometers
- Unit 7: Capacitors and RC Circuits
- Unit 8: Transformers, Speakers, and Microphones
- Unit 9: Semiconductors I: Diodes and LEDs
- Unit 10: Semiconductors II: Transistors, Amplifers, Voltage Regulators

If the preceding 10 units are sufficiently rapidly digested by the class, including the theory that goes with them, we will launch into Volume II of Mims' books, and that would take us out of mostly analog systems and into digital ones.

Grading (tentative)

- 45% lab assignments (demonstration of working circuity in almost every class)
- 15% written problem sets (where you will practice and demonstrate your understanding of circuit diagrams and theory)
- 30% on two written exams (15% each)
- 10% final project (the last 3 or 4 of our 14 weeks — most or all of April — will be devoted to building any electronics project you choose)

Problem Sets / Handouts / Being Neat and Organized

There will be problem sets, problem set solutions, two exams and their solutions, and many handouts. To be organized, locate a three-ring binder, and file everything chronologically. Actually, reverse-chronological is the most convenient, because then you always open your binder to what you are currently working on.

Problem sets should be on standard 8 1/2 x 11 paper. Multi-page problem sets should be stapled. Corrections should be erased (if done in pencil) or recopied (if done in pen) if necessary to make a neat result. To make nice diagrams and graphs, you will very often need a ruler.

Absences and Late Work

The College's policies on absences and late work are applicable except that I don't require as much advance notice as is specified in the Deep Springs Handbook: specifically, one day's advance notice of an absence (or a need to turn in late work) is acceptable for our class. See the Handbook for additional details.