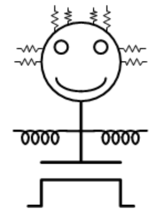
E84: Introduction to Electrical Engineering



Lab Guidelines

Welcome to E84. Each week's assignment will typically involve a written warm-up exercise and a lab component, due at the same time. You may hand-write or type your solutions to the warm-up exercise.

Lab Report

Turn in a typed lab report. The report should be comprehensible to somebody knowledgeable about electronics who is unfamiliar with the lab, and it should convince a skeptical reader that your design meets the requirements. Some of the following elements may not be applicable to some labs and can be skipped if they are inappropriate.

- Design a circuit. Draw a neat and orderly schematic in MultiSim.
- Analyze the circuit. Derive equations describing its behavior and show that they meet the requirements.
- Simulate the circuit in MultiSim if appropriate. Compare the simulation results to analysis and resolve any discrepancies.
- Build the circuit. Take a photograph.
- Measure the circuit. If it is supposed to operate over some range of parameters, gather sufficient data to show that it does so. Compare the measurements to analysis and simulation and resolve any discrepancies.
- Optional extra credit component.

Tools:

You will need LabView and MultiSim to do the labs. These come on the CD with your lab kit (Windows only – Mac users may wish to install Windows under VMWare or Parallels), and are also installed in the ECF.

We recommend Microsoft Word, Google Docs, or LaTex for reports. MultiSim or Visio are good for drawing schematics. Word users may like Equation Editor for setting math, while LaTex has good but cryptic math capabilities built in.

Schematic Hints

- Readability matters!
- Use standard circuit element symbols.
- Where applicable, place high voltages near the top and low voltages near the bottom, with a logical flow of current from top to bottom. Another sensible layout has inputs on the left and outputs on the right, with a logical flow between. Only arrange components opposite of this flow when you intend to convey feedback.
- Minimize crossing lines when it can be avoided with a bit of care.

Lab Hints

- Thoroughly understand your circuit before you build it. If you don't understand it, the thing you build probably won't do what you hoped and you won't be able to debug it.
- You should mostly be able to build the labs using the components in your kit and some labs assume that you do. However, if your design calls for resistor and capacitor values not in the kit, you can find them in the stockroom or approximate them using series or parallel combinations.
- Neat breadboarding will generally save you time in the long run. However, there's no need to be obsessive unless you enjoy it.
- Running wires over a chip often leads to grief when you suspect the chip is bad and need to swap it out.
- Unnecessarily long wires can pick up interference and introduce subtle and confusing errors.
- Know whether a component is polarized and use the correct polarity. Most small capacitors are nonpolarized, while electrolytic and tantalum capacitors are polarized and marked.
- Learn to read resistor codes. There are many phrases to help remember the colors, most of which are too crude to reprint here. "**B**etter **b**e **r**ight **o**r **y**our **g**reat **b**ig **v**enture **g**oes **w**est" is fit for polite company.
- Small capacitors are often labeled with three digits similar to resistor codes but in units of picofarads. For example, 223 indicates 22×10^3 pF = 22 nF.
- Remember that component values are approximate and vary due to manufacturing tolerances as well as temperature and nonlinear characteristics. Design your circuits to accommodate uncertainty.
- When something doesn't behave as you expect, debug in a systematic way. Confirm that your inputs are correct and that your outputs are wrong. Predict what to expect in the middle and check with a multimeter or scope. If it is correct, the problem is later; otherwise, it is earlier. Work recursively until you isolate the problem. Most of the time, it is a wiring mistake or simple misunderstanding. Sometimes, you'll be lucky to have a more subtle bug that requires time and thought to uncover, especially when your mental model of the world oversimplifies or conflicts with nature. Although this is frustrating, it is also tends to be when the deepest learning occurs.
- There are no intentional gotchas in these labs, but plenty of places where you are solving real problems and where it is easy to make mistakes.