Physics 345/545  Electronics Lab  Spring 2015

Instructor: Fred Ellis, (Rm. 231, x 2046)  TA: Will Setzer

Lab Times: Thursday 1:10 pm to 4:00 pm

Format: Most of your laboratory time will be spent doing hands-on inquiry through a series of exercises designed to take you through the basic principles of electronics. We will often break for short lecture sessions when I feel that there is enough collective need to clarify certain ideas. In order to get the most out of this inquiry based lab, you need to go well beyond getting your circuits to work. You need to understand each component and tool so that you clearly understand why they work, and so that you can modify them to do something new when you wish. Each week there will be homework assignment due at the beginning of the lab to get you thinking about the topic at hand. Toward the end of the semester, your homework will be working on your projects.

Most labs have more exercises than you will all be able to complete in that lab. This puts a burden on your shoulders to work efficiently but not to move past things that you do not fully understand. Both the TA and I will help you appraise your understanding through our interactions. The major ideas we will cover are listed below with subtopics.

Topics:

Passive Components
   Resistors, Capacitors and Inductors: Working in frequency space
   Diodes: The usefulness of nonlinearity
Input and Output Impedance
   Thevenin’s theorem
Transistors
   Bipolar Junction Transistors: One week to master the building block of everything else
Operational Amplifiers
   Basic Configurations: The beauty of negative feedback
   Limitations: When the golden rules break down
   Useful Op Amp circuits: How to build most analog circuits you will need
   Oscillators: Output with no input
Digital Circuits
   Combinational Logic: Circuits that think
   Sequential Logic: Circuits that count
   Analog to Digital Conversion: Bringing it all together
Projects
Text: Basic Electronics: An Introduction to Electronics for Science Students, by C. A Meyer. This text walks through the practical fundamentals of electronics with a healthy dose of physical principles backing up many of the rules of thumb. The text is not available at the bookstore, but only from lulu.com. If you don't have the book yet, Chapter 1 may be downloaded for free from http://www.curtismeyer.com/index.php/chapter1.

Grading: Grading in this course is CR/U. I will review your performance through your homework, attendance, motivation, depth of inquiry, and your project. Prompt arrival is expected. Although minor lapses in these measures will not necessarily lead to a failing grade; the absence of other more concrete documentation, such as lab write-ups, requires that you take these measures seriously. You should maintain a notebook to record various sketches, calculations, and other observations associated with your investigations.

Projects: Each of you will choose some interesting or useful electronic circuit that you want to build for your project finishing off the semester. You are welcome to work individually or with your lab partner if you wish. A one page plan for your project is due on Thursday March 27 (the first week back after spring break) describing what the purpose or function of your circuit will be along with a general statement about how it will be implemented. Be sure to talk with me about your ideas during the first half of the semester. I will try to help direct you towards projects that you can obtain materials for and can succeed during the time available.
**Equipment:** There is a cabinet of shared components in the front right corner of the lab. These are the circuit parts and should be returned when you are done with them. Your lab bench is also equipped with some of the more common components and other tools needed to support and diagnose your circuits:

**Instruments**
- breadboard/power supply
- digital oscilloscope
- function generator
- digital multi-meter (DMM)
- logic probe

**Tools**
- pliers
- wire stripper
- screw driver
- IC puller

**Components**
- resistor kit
- capacitor kit
- BNC-banana plugs (4)
- alligator clips (10)
- meter probe leads (2)
- BNC coax probe
- banana plug cables (4 red 4 black)
- BNC cables (2, one 3 ft. and one 6 ft.)

I expect you to take good care of your bench equipment and treat the components gently. Please bring faulty equipment to my attention promptly. Avoid bending of metal pins--sharp bends easily break the pins, and this is the most common way that components are destroyed. Components that are damaged should be removed from the pool and discarded. Do not put suspicious components back into the pool, but only throw them out if you are sure they are bad. There is no other section using the equipment, so you may leave your breadboard wired up between classes. For your own efficiency, keep your benches neat.