22.071j/6.071j Electronics, Signals and Measurement

Spring 2011

Professors Anne E White and Ian H Hutchinson
whitea@psfc.mit.edu 3-8667, ihutch@mit.edu 3-8760
Teaching Assistant: William Herrington, wherring@MIT.EDU
(Version: February 1, 2011)

Course Description and Organization

This course provides a practical introduction to electronics focussed on the skills needed in research and industry to understand and design simple circuits, and make measurements. No prior electronics or circuit experience is necessary. A vital part of the course is the hands-on exploration of circuits that illustrate the concepts, using computer-controlled virtual instruments.

Prerequisite: 18.03 or equivalent (linear ordinary differential equations, and linear algebraic equations).

Class Web Site: `http://stellar.mit.edu/S/course/22/sp11/22.071J/`

Location: Lectures NW14-1112. Lab NW14-1310.

Class Times and Attendance: MWF 9:00-11:00. Attendance is a vital part of the course, because it is so hands-on. Gaining practical skills with instruments and circuits is a major objective. The Labs are done in pairs. Each Lab has a set of questions to be answered and handed in at the end of the class. Most days, the Lab is the second hour of the session, sometimes there will be tutorials instead for the second hour.

Grade Basis	Homework	20%
	Quizzes	30%
	Laboratory	25%
	Final Exam	25%

Tests There will be three quizzes in class time and one 3-hour exam in finals week.

Academic Expectations and Ethics

- The lab is a collaborative experience. Consultation of your partner, other students, or instructors is expected. However, you are responsible for understanding the answers you write and hand in.

- You will make mistakes in the lab and quite likely break components or blow fuses. Try not to do so, but don't be fearful of doing so. If you think that has happened, or might have happened, it is essential that you say so when asking for help. The knowledge helps speed the process of sorting out problems. You won't be blamed. However, causing damage deliberately, "for fun", or by gross negligence causes unnecessary cost, work, and delay, and will be blamed.
- You are encouraged to do as much as possible of the homework and problem sets on your own. This is the most effective way to learn, provided that you are not just spending hours and hours stuck.
- You are permitted to consult with other students in the course concerning homework points that you don't understand or when you are stuck. However, it is recommended that you do not develop a collaborative solution to problems. Also it is required that your solutions be written out separately and submitted in your own words.
- You may consult books or journal articles to assist if needed. If you do significantly use such materials, you should give the reference.
- No collaboration or consultation will be permitted on the quizzes or exams. One good reason to get into the habit of doing the work yourself!
- Readings are specified in the schedule, referring to the course text. They will help you develop deeper understanding, but you will not be tested on concepts that appear only in the readings.

Course Goals

1. Become familiar with basic electronic instruments and measurements.
2. Understand and be able to apply basic DC circuit laws, and nodal circuit analysis.
3. Understand and be able to apply linear circuit theorems.
4. Become familiar with elementary use of operational amplifiers.
5. Understand concepts of feed-back and basic automatic control.
6. Understand and be able to analyse first- and second-order AC RLC circuits in terms of transients and differential equations.
7. Understand analysis of AC circuits in terms of complex impedance and hence apply the AC versions of linear circuit theorems.
8. Understand basic semiconductor junction diodes and bipolar transistors and their uses.
9. Be able to calculate the operating point of transistor circuits.
10. Understand elementary filtering and frequency analysis.
11. Be able to design simple active electronic circuits for switching, measurement, signal amplification, and conditioning.

Unofficial Goals

1. Gain confidence that you can function effectively in the laboratory doing experimental work, debug a circuit, and solve problems independently.
2. Solder a component without burning yourself (much).
3. Have fun with electronics and discover that you understand it.

Text Books

We'll hand out notes for the lectures, which are intended to be a decent record of the theoretical content of the course.
A.R.Hambley "Electrical Engineering Principles and Applications" Fourth Edition, Pearson, Prentice Hall, NJ, (2008) is the course text book although we won't cover it all. It sells for about $120. You need regular access to a copy. It has some included circuit analysis software that might be of interest (but is not required).

The Schaum Outline books: J.O'Malley *Basic Circuit Analysis* and J.J.Cathey *Electronic Devices and Circuits* between them cover our material and a little bit more. They contain lots of worked problems, which you might find helpful. Also they are cheap (about $12 each).

Other books to be aware of, probably not buy.
P.Horowitz and W.Hill, *The Art of Electronics* Cambridge University Press, 1989, is a fun book with tons of good ideas and circuits, covering far more than this course. It is more of a handbook than a textbook; great to dip into, less useful for reading to learn the structure and subtleties of the subject.
C.K.Alexander and M.N.O.Sadiku, *Electric Circuits*, McGraw Hill, 2004, covers the circuits part of the course with a bit more depth.
J.Lang and A.Agarwal *Foundations of Analog and Digital Electronic Circuits* is the course text for 6.002. It has a bit more theoretical flavor and uses the MOSFET rather than the BJT as its discrete component example.
D. A. Neamen, *Electronic Circuit Analysis and Design*, 2nd Edition, McGraw-Hill.
James A. Blackburn, *Modern Instrumentation for Scientists and Engineers*, Springer, New York, 2001.