# Physics 334, Winter Quarter 2013
# Electric Circuits Laboratory I
# Reading Assignments

**Week 1 Assignment 7-11 January**
Textbook pp. 1-13 (through power transfer), Lab manual pp. 3-23. This is a refresher on the basics of voltage, current and power, plus resistors and resistors in parallel and in series. This reading includes the voltage-divider, probably the single most important resistor circuit you'll need to know, plus voltage and current sources, and the concept of the "Thévenin" and "Norton" equivalent circuit. This section introduces the concept of input and output impedances. The lab-manual reading goes over this material again, and includes how to measure voltages and currents given the imperfect voltage- and current-sources, and imperfect volt- and current-meters. There are no labs this week.

**Week 2 Assignment 14-18 January**
Textbook pp. 13-35 (through power in reactive circuits), Lab manual pp. 32-50. The lectures finish up the "Thévenin" and "Norton" equivalent circuit models and start the overview of resistor and diode circuits. With luck we'll also start a discussion of frequency-dependent circuits with capacitors and simple capacitor circuits. Reading this week anticipates next week's topics of "reactance", including phase shifts and complex-number notation.

**Week 3 Assignment 21-25 January**
Textbook pp. 35-53 (through diodes). Lab manual pp 64-74. This week will focus on tools that allow understanding how circuits process time-dependent input signals. "Reactance" is defined, as is the generalized Ohm's Law using impedance as the generalization of resistance. (See, especially, textbook pp 32-39 and 41-42: the concepts of impedance and reactance, generalized Ohm's law, and simple filters.) We'll apply this to simple circuits containing capacitors and inductors. We'll go over the RC differentiator, and you might want

to look at the similar integrator in the text and in lab. The lab this week will look at simple filters made up of single-capacitor networks.

**Week 4 Assignment 28 January – 1 February**
If complex-number notation is new to you, see the textbook page 31 "voltages and currents as complex numbers". In lecture we'll finish up low-pass and high-pass filters and figure out their response for arbitrary input frequencies. The reading includes textbook pp. 41-42 (resonant circuits "notch" and "bandpass" type), 42-47 (power circuits through section 1.28; this uses diode material from earlier); we won't be covering details of diode power circuits in lecture since they're well covered in the lab 3 and homework. Notice the lab manual has a useful worked example of designing a ½-wave rectifier power supply pp 71-74.

**Week 5 Assignment 4-8 February**
You should begin to look at pp. 61-77 ("bipolar" transistors through section 2.07). The bipolar transistor material will run into next week. Key transistor topics include emitter-follower and common-emitter single-transistor circuits. In Tuesday lecture we'll recap the emitter-follower circuit and apply AC-coupled inputs and outputs. There's an exam on Thursday.

**Week 6 Assignment 11-15 February**
We'll finish up the common-emitter amplifier, the classic voltage amplifier. Along the way we'll remind you this amplifier contains a current source (you saw this last week in lecture). So, take a look at the transistor current source textbook pp 72-74, then the common-emitter amplifier pp 76-77. If you'd like to know how a PN junctions (diodes and transistors) function at a deeper level, you might want to look at the Ebers-Moll model pp 79-81; this would, e.g., tell you how temperature and bias current effects the diode behavior. We'll then move on to Field-Effect-Transistors. FET's are more complicated in some ways and simpler in other ways: look at the FET basics PP 113-122: this discussion will go into next week and will also be covered in lab.

**Week 8 Assignment 18-22 February**
We'll study op-amps in lecture and lab. Look at the introductory idealized op-amp discussion in sections 4.01 through 4.03. The "golden rules" are particularly important. Notice that the two op-amp inputs come to equal voltage if the feedback is properly negative. You should understand the two basic circuits: the inverting amplifier section 4.04 and the non-inverting amplifier section 4.05. The many and various op-amp circuits in later sections are mainly variations of the basic inverting and non-inverting amplifiers; two such useful circuits are the differential and summing amplifier pp 184-185. We'll also look at other variants in lecture.

**Week 9 Assignment 25 February – 1 March**
The Tuesday guest lecturer is Andrew Wagner. This week starts with more op-amps, especially example circuits of all kinds. Then we'll start to look at comparators and oscillators. In lab, you'll be looking at op-amp rectifiers (see textbook section 4.10 on "active rectifier"). You should look at non-ideal op-amp parameters (section 41. "input current", "input offset voltage" and "slew rate"). In lab you'll assemble the "active clamp" 4.17, integrator 4.19 and differentiator 4.20.

**Week 10 Assignment 4 - 8 March**
The Thursday guest lecturer is Jason Alferness. This week is closing out comparators. We'll then look at oscillators and timers. Read the textbook oscillator introduction 5.12. In lab you'll use the "311" comparator: for that, see the comparator overview 4.23, especially the "311" circuit in fig 4.60 and the "311 with hysteresis" fig 4.62. The "311" is a slightly unusual comparator in that the output has two pins consisting of the collector and emitter of a transistor switch driven within the 311 chip at the base by the comparator. This configuration allows, as you'll see in lab, great flexibility in configuring the output-voltage swing. We'll look at the op-amp oscillator in fig 5.29, then we'll start on looking at the classic "555" timer chip 5.14. Figure 5.33 is particularly important as it shows the 555 in its basic oscillator configuration. In lab, you'll configure the 555 as an "equal duty factor" oscillator, and as a saw-tooth and triangle generator.

**Week 11 Assignment 11 - 15 March**

Thursday is Exam 2. The Tuesday lecture is a summary of basic material since the last exam. We covered FETs (symbols & operation, a FET as a variable resistance, a FET as a current source, and a FET as an analog transmission gate). We also covered the concept of FET transconductance. We covered op-amps (2 + 1 golden rules, what is proper negative feedback, and the inverting and non-inverting amplifiers). We covered comparators of the op-amp and "311" kind (including hysteresis). We covered timers (the "555" timer basic operation).

[ver 12mar13 18:15]