## Physics 3150 Problem Set 3 Due Wednesday, March 2, 2016

- 1. Eggleston 3-3. The diode with extra wiggles on the bar is a Zener diode, designed to be used at its reverse breakdown threshold, which is accurately controlled to be at the specified reverse voltage.
- 2. Eggleston 4-1. This is easy, apart from having to take measurements from a printed plot, but it makes an important point. If the idea of using a ruler bothers you, consider scanning or photographing the plot and then using a freeware program like Plot Digizer to read off some (x,y) points.
- 3. Eggleston 4-9.
- 4. Design a circuit using diodes and transistors to control a pair of solenoids that supply cold and hot water to a washing machine. One switch, A, should power both solenoids to supply warm water, whereas switch B powers only the cold water solenoid. Assume that a 24 V dc power supply is available and that the solenoids require about 100 mA at 20–24 V. The solenoids do not necessarily need to be directly grounded at either terminal. In your design, make sure that the diode currents do not exceed 10 mA. This can be done by using transistors as saturated switches to drive the outputs.
- 5. Use the PartSim SPICE simulator to analyze the common-emitter amplifier that you studied in Part IV of Lab 4. Because the 2N4401 transistor is not directly available in PartSim, use the generic npn transistor (actually a 2N2222), which is quite similar. Your schematic should look something like the figure below.

(a) Define a square-wave pulse as the input, as shown, with a 100 mV amplitude and a 100  $\mu$ s period. Run a transient simulation from 0-3 ms with a 1  $\mu$ s step size, and measure the gain based on the size of the pulses at Vout. Compare with the gain that you measured and calculated in the lab.

(b) In the graph of Vout, you will notice two imperfections: (i) the dc level at Vout is not constant at first, slowly drifting towards its final value. (ii) the output is not quite a square wave, exhibiting a small but noticeable droop on each pulse. Explain what causes each of these effects.



(c) Devise a modification to reduce the droop. Does it work in your simulation? Does this make the other problem with the drifting baseline better, or worse? This is the real strength of using simulation for design — you can immediately see the effects of design tradeoffs and optimize your choices.