Physics 48 01X

Lab #5 – Diodes

The purposes of this lab are

- to measure the voltage-current characteristics of several types of diodes and compare them
- to construct simple circuits with diodes, noting how the output depends on the diode characteristics
- to introduce two special diodes: the LED and the Zener.

Equipment at each station:	Centrally available:
digital oscilloscope	wire and wire cutters/stripper
2 multimeters	red and black banana plug cables
2 power supplies	alligator clips
signal generator	assorted resistors
standard breadboard	selection of diodes
potentiometer	

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1. Current-Voltage Characteristics

- The instructor demonstrates how to infer the I-V characteristic of a diode using a series resistor and an oscilloscope.
- Measure the I-V characteristics of the various types of diodes (silicon, germanium, Zener, and LED). You should measure the "turn-on" voltage V_{PN} as well as the forward and reverse conductances.
- Compare your results for the different diodes.

2. Clipping

- Put an AC voltage with no DC offset into back-to-back diodes (silicon or germanium). Be sure to use an appropriate resistor to limit the current. (What happens if you choose this resistor too big? too small?) Measure the clipped output waveform. Try using silicon, germanium, or one of each and note the differences in the output waveforms. Can you explain the differences in terms of the characteristics you measured in the first part of the lab?
- Now add a DC offset to your AC input and explain the result.
- Optional: Try pushing to high frequencies and see what happens. Can you make the diodes fail?

3. Zener Diode

- Measure the "breakdown" or Zener voltage V_Z, if you haven't already.
- Build a simple voltage regulator using a Zener diode, series resistor, and your DC power supply (see Fortney or the instructor if it has not yet been covered in class). Initially assume infinite load resistance and design the series R so that you are certain not to fry the Zener. Choose your input voltage not too much above the Zener voltage at first.
- Apply different loads and record for each 1) whether you get good regulation by the Zener and 2) whether the Zener gets hot.
- If you have time you might consider how the design would change for an input voltage much larger than the Zener voltage.

4. LEDs

- Apply a square wave across an LED in series with an R to limit the current. Observe the output while varying the frequency and amplitude of the square wave. Observe how the brightness of the emitted light depends on the current through the diode.
- See whether shining light on the LED causes it to generate a current using your ammeter.

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5. Additional Exercises (if time permits)

- Design a more complicated circuit involving the LED, e.g., an RC filter that turns on an LED when you are in the pass band.
- Construct a voltage doubler and verify that it works (e.g., Fortney Figure 5-21a, p. 180).
- A diode has capacitance. This property is best demonstrated by rigging up a diode in series with an AC source and an R ($\sim$4.7 kΩ) and measuring the waveform across the diode as the frequency increases. In addition to the normal diode behavior you should observe the characteristics of a low-pass filter. (This C arises not just from the diode but also from the breadboard, scope leads, etc.). The diode C varies with voltage, a fact that is exploited in a type of voltage-controlled capacitor called a "varactor diode".
