Physics 334  
Notes for Lab 3 – Diodes and Transistors

Lab manual sections 3-4, 3-5, 3-6, 4-1, 4-2, 4-3.

Beginning with this lab you should measure ‘scope signals with the x10 ‘scope probes. These probes increase the input impedance to the ‘scope by a factor of 10. When using these, you refer to the “x10” label on the vertical input gain in order to find the voltage across your circuit.

Important: Make sure that the compensation capacitor on the ‘scope probe is correctly set. See the discussion in the manual, pp. 61–63 on what this statement means and how to set the capacitor.

3-4. Wire up the full wave bridge shown in exercise 3-3 and make sure it is working correctly first. When you connect the capacitors across the output, draw pictures of the resulting waveforms for both the 15µF and 500µF varieties. (Note: if you don’t have a 500µF cap, use 470µF or other similarly large cap.)

You can calculate the predicted ripple voltage by following the method in the manual’s class notes, pp. 68–69. This will tell you if the output “makes sense.”

3-5. Again, draw pictures of the input and output waveforms and discuss: why does the output have the shape that it does?

Further hint on effect of removing 2.2k resistor: The ‘scope is connected to the output. What does this instrument add to the circuit? Draw an equivalent circuit including the ‘scope’s input impedance.

3-6. To estimate the dynamic resistance of the diode, apply a triangle wave to the input and compare the input and output waveforms. The output should show a flattened triangle. The height of the upper piece from the point where it begins to turn downward to the tip gives ∆V across the diode. The difference between the tip of the output wave and the tip of the input wave gives ∆V across the 1k resistor, and hence, the current in the diode. From these you can get the dynamic resistance.

Answer all of the questions in the exercise. “Bypass” in this instance means that some signals are “shunted off to ground”. Try measuring the signal at the cathode end of the diode, with and without the capacitor.

Skip to Lab 4: Transistors 1, p. 94

4-1. Make sure you use the diode test function; measuring with the Ohms setting may damage the transistor. This measurement is an easy way to check if the transistor is good. You should also see “OL” if you try to measure between the E and C leads. Record all voltages.

Also: test a PNP transistor: 2N3906. It should work the same except that the + and − leads will be reversed.

4-2. It is important to connect the ground terminal on the power supply from here on out. For the first part of the exercise, use one of the supply outputs with the − terminal connected to ground. For the second part, you would then add the other supply output with its + terminal connected to ground; then that output’s − terminal will give you “negative” voltages. If you don’t understand this point, ask for help before connecting the power.
To answer the question about why one sees a “poor replica” of the input, think about the “ground rules” on p. 84 of the manual.

The important data from the data sheet is that the specification for maximum reverse $V_{BE} = 6$ volts. This is usually a worst-case number.

4-3. Read carefully the instructions on measuring impedances. Remember, you are looking at how the signal changes, not the DC voltages. If you draw the circuit in terms of Thévenin equivalents, then you can see how to get the impedances by using the voltage divider equation.

To get $\beta$ from these measurements, use the following results proved in class:

$$Z_{\text{out}} = \frac{R_{\text{source}}}{(1 + \beta)}$$  \hspace{1cm} (1)

$$Z_{\text{in}} = R_{\text{load}}(1 + \beta)$$  \hspace{1cm} (2)

Don’t be surprised if you get somewhat different results from the two measurements. Past experience has shown that $\beta$ is usually around 150 for these parts.