Phys 586 Laboratory

Lab 11

Goal: In this lab you will make measurements with a photodiode. While not the same type of diode used in diode arrays for radiation planning or microstrip detectors in high energy physics, many of the basic device characteristics are the same. Additionally, photodiodes are used in x-ray imaging (along with a scintillator layer) and avalanche photodiodes find application in high energy physics.

Reading: See Photodiode Characteristics handout in the Readings.

Lab:

1. Look over the data sheet for the photodiodes we are using. What is the maximum reverse voltage? What is the typical dark current? What is the response time?

2. Construct the LED circuit shown in Figure 1. Is the LED forward or reverse biased? What is the purpose of the resistor? Vary the voltage and convince yourself the brightness of the LED changes. Note the longer leg on the LED is the anode.

3. Measure the current through the LED and the voltage across the LED for LED supply voltages of 2.5, 5, 8, 10, 13, 15, 18 and 20V.

4. Construct the photodiode circuit shown in Figure 2. The LED should be made to illuminate the photodiode. What mode of operation does this circuit correspond to? Note the longer leg on the photodiode is the anode.

5. Measure the voltage across R_2 with the room lights on and room lights off with no voltage across the LED. With the room lights off or using the dark box measure the voltage across R_2 for LED supply voltages of 2.5, 5, 8, 10, 13, 15, 18 and 20V.

6. Plot the I_{LED} versus the voltage across R_2. Comment on these results.

7. Construct the circuit shown in Figure 3. The LED should be made to illuminate the photodiode. What mode of operation does this circuit correspond to? Note the longer leg on the photodiode is the anode.

8. With the lights off and with the voltage to the LED off, make a measurement of the voltage across R_3 for photodiode supply voltages of 0, 0.1, 0.2, 1, 2, 5, 10, and 15V. Also measure the voltage across the photodiode for each supply voltage setting. You should do this latter step separately. Does the photodiode current agree with your expectations? Explain.

9. Repeat this procedure using 5V and 10V for the LED supply voltage. Plot the photodiode current (y) versus the voltage across the photodiode (x) for all three data sets on the same plot.

10. Set the photodiode voltage to be 10V. Make a measurements of the voltage across R_3 for LED voltages of 2.5, 5, 8, 10, 13, 15, 18 and 20V. Plot the photodiode current (y) versus the LED current (x). Comment on your results.

11. Construct the circuit shown in Figure 4. Illuminate the photodiode using the LED circuit shown in Figure 1. Use a superbright LED here. Leave space between the LED and photodiode to place your finger.

12. What is the purpose of this op-amp? What is the relation of the output voltage to the input current? You can answer the latter by recalling the simple rules for op-amps: the inputs draw no current and the output adjusts itself so that the inputs have equal voltage.

13. Connect the digital oscilloscope across the load resistor R_L. Compare the observed pulse rate with that taken in the usual way. Print the waveform seen on the digital oscilloscope.

14. This circuit forms the basis of a pulse oximeter. Briefly what does a pulse oximeter measure and what is the principle of the measurement. An application of photodiodes!

In your lab writeup, please include:

1. Answers to the questions embedded in the lab procedure above.

2. Plot of the voltage across R_2 versus the LED current for circuit 2.
3. Plot of the V-I curve of the photodiode using circuit 3.
4. Plot of the photodiode current versus LED current for circuit 3.
5. Printout of your pulse on the digital oscilloscope.