ELEC 313 Lab 2
Diode Characterization

REFERENCE: Appropriate chapters of ELEC 306 text.

OBJECTIVE: The objective of this experiment is to observe the basic operation of a diode.

EQUIPMENT: Diode 1N4002
Resistors 470Ω, 330Ω, 680Ω
Resistive decade box (200 Ω – 100K Ω)
Power Supply (Vdc) , Multi Meter(s)

INTRODUCTION: The theoretical relationship between the voltage and current in a diode circuit is described by the Shockley equation

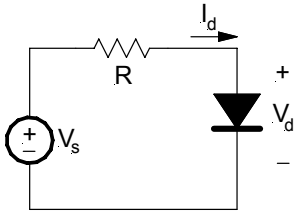
$$I_D = I_s\left(e^{\frac{V_D}{V_T}} - 1\right).$$

In this lab experiment you will measure the diode current and voltage using simple circuits and determine the parameters I_S (reverse saturation current)and V_T (thermal voltage).

Pre-lab

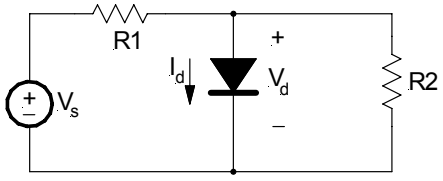
PSPICE Models

1. Model the following circuit using PSPICE. The diode is a 1N4002.



Given V_s=10 V, determine the dc operating point for R= 200, 500, 1K, 2K, 5K, 10K, 20K, 50K, and 100K. Make a table of your results.

2. Add shunt resistor R_2 as shown to the circuit.

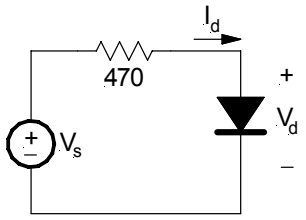


Keeping V_s=10 V, let R_1=330 Ω and R_2=680 Ω . Use PSPICE to compute the diode voltage and current.

Lab Experiment

Part A

1) Obtain the resistor (470Ω) and diode (1N4002) needed to build the following circuit.



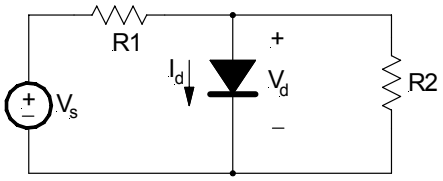
2) Measure the resistor with the multi-meter, record its value, and compute %error from nominal.
3) Build the circuit on a breadboard using the HP power supply for V_s.
4) Initially use the negative supply. Vary V_s from 0 to –5 V in –0.5 V steps, and record both the diode voltage and current at each step.
5) Use the positive supply and vary V_s from 0 to 5 V in 0.25 V steps and from 5 to 10 V in 0.5 V steps. Record the diode current and voltage at each step.

Part B

6) Replace the 470-Ω resistor in the circuit with the decade resistance box set to 200 Ω and adjust V_s to +10 V. **The decade box must never be set below 50 Ω while it is in the circuit in order to prevent burning out the diode**.
7) Measure and record the diode voltage and current for the following resistance settings: 200, 500, 1K, 2K, 5K, 10K, 20K, 50K, and 100K. **Be careful not to inadvertently set the resistance of the box to 0 Ω while changing its value**.

Part C

8) Build the following circuit with V_s=10 V, R_1=330 Ω, and R_2=680 Ω.



9) Measure the diode voltage and current.
10) Remove the diode and measure the open-circuit voltage across the nodes where it had been connected.

Data Analysis

1) Plot the current vs. voltage characteristic data measured in Part A. Type your data points into MATLAB, EXCEL, or any other program of your choice that can be used to make data plots. (The current is on the vertical axis.) Label the axes.

2) Next, plot the natural logarithm of the current vs. voltage characteristic. Plot voltage on the horizontal axis and ln(current) on the vertical axis. The resulting plot should be straight line with slope (m) equal to the inverse of the thermal voltage (V_T).

$$m = \frac{1}{V_T}$$

Compute the thermal voltage from the slope of the line on the semi-log plot. Pick two representative values that fall on the straight line passing through the data plot. Calculate the slope of the line as

$$m = \frac{\ln(I_2) - \ln(I_1)}{V_2 - V_1}$$

3) Calculate the saturation current I_s based on the thermal voltage calculation in step 2, by solving Shockley's equation and plugging in a representative measured (I, V) pair.

Lab report

The lab report should be written in standard format, containing

- Cover page
- Purpose of experiment
- Test configurations
- Circuits tested
- Test procedure
- Measured results
- Comparison of results
- Conclusions

The comparison section should contrast the diode voltages and currents measured in Parts B and C to the PSPICE results obtained in the pre-lab exercise.