Experiment 8 -- Supplement
Plotting the Diode Equation

In part A of experiment 8, you must plot the data from a real diode in a circuit against the theoretical equation for the diode. Here are some details on how to get a meaningful plot of these two quantities. The following is the description directly from the experiment handout. I have added footnotes to try and clarify what it means.

- Match the diode equation to your data
  - Eliminate all points from your data except for one upward ramp of the input voltage. This represents a single DC sweep from -10V to +10V. [1]
  - You can now use this data to plot the i-v characteristic of the diode. You need to plot the voltage across the diode against the current through the diode. [2]
    - The voltage across the diode is equal to $V1\text{-}V_{out}$. Create a row to take the difference between the two voltages.
    - Since the circuit is in series, the current through the diode is $V_{out}/R2$.
  - Now that you have a set of points corresponding to the behavior of the diode (i_D and v_D), you can use Excel and your PSpice plots to plot the behavior curve of the diode. [3]

$$i_D = I_s\left(\exp\left(\frac{v_D}{nV_T}\right) - 1\right)$$

    - VT is a constant: V_T = 0.0259 V at 300 K
    - Use you PSpice plot of the diode characteristic curve to pick a good guess for I_S.
    - Guess values of n between 1 and 2 (and possibly modify I_S slightly) until the theoretical curve fits your data**.**
    - <u>Include a copy of this plot in your write-up.</u>

Footnotes:

[1] You can eliminate the data before and after simply by deleting the points from the excel file. Locate the point at which the voltage is about -10V and then find when it reaches +10V. You can eliminate all but the points in between these two values. If you have only a few points in this range, you may want to retake the data using more data points in Agilent or fewer cycles displayed on the scope.

[2] This is a plot of your data from the circuit. You should plot this data as one series on a scatter plot. The x-axis of the data should be a column created by subtracting the two voltages (V1-Vout). The y-axis should be a column found by dividing the output voltage (vout) by the value of the resistor in the circuit.

[3] Now you need to add another series using the equation. Although you could use your experimental data points for v_D (V1-Vout), these probably will not give you enough points to get a good curve. Recall the process that you used to plot your data when you were finding the mass of the beam. You found an estimation for your constants, chose x values, and calculated y values. You can do the same here.

- *Choosing values for V_D to use in your calculations*: If you try to calculate the current for voltages all the way up to +10V, you will get current values so much bigger than the experimental data that you will not have any means of comparison. Try calculating points for voltages from -1V to 1V in increments of 0.01. (200 points)
- *Apply the equation:* You can now plug the values you chose for v_D into the diode equation. You can find an estimate for I_S from your PSpice data. Guess some value for n between 1 and 2. VT is the given constant
- *Limit the maximum calculated current:* Note the maximum current you get from the experimental data (the first series). After you have calculated the current using the diode equation, you probably will have to eliminate all points that exceed the experimental current by a significant amount in order to compare the two sets of data effectively.
- *Plot the curve for the equation*: Add a second series to your plot with the values you chose for v_D on the x-axis and the calculated values for i_D on the y axis.
- *Adjust the equation to get a good match.* Now you can adjust n and/or I_S until the curve gives a good match to the data points.