

ECE 320 - Homework #2

Semiconductors, PN Junction, Ideal Diodes

Semiconductors

- 1) Why does the voltage drop across a pn junction decrease as temperature increases?
- 2) What doping of Boron (p-type) do you need to make an 1206 resistor have a resistance of 2200 Ohms? The dimensions of an 1206 resistor are

$$L = 3.20\text{mm}, W = 1.60\text{mm}, H = 0.95\text{mm}$$

- 3) A thermistor has the following resistance - voltage relationship

$$R = 2000 \exp\left(\frac{3905}{T+273} - \frac{3905}{298}\right) \Omega$$

where T is the temperature in degrees C. What is the resistance at

- -48F Coldest day in Fargo (Jan 8, 1887)
- 0F Recommended temperature of a freezer
- +40F Recommended temperature of a refrigerator
- +114F Hottest day in Fargo (Jul 6, 1936)

Diode VI Characteristics

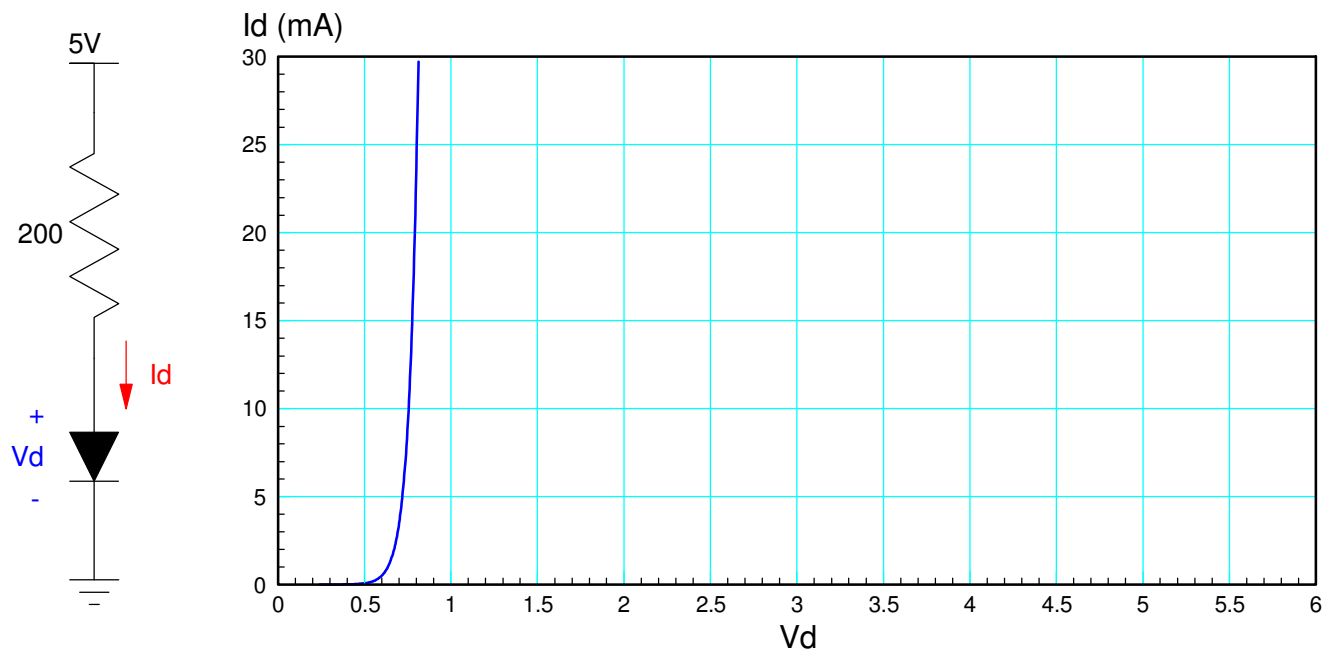
Assume the VI characteristics for a diode are

$$V_d = 0.052 \cdot \ln\left(\frac{I_d}{10^{-8}} + 1\right) \quad I_d = 10^{-8} \left(\exp\left(\frac{V_d}{0.052}\right) - 1 \right)$$

- 4) For the 1-diode circuit (next page - 200 Ohms is red - black - brown)
- a) Draw the load-line for the following circuit (next page). Determine V_d and I_d from the graph.
 - b) Write the voltage node equations and solve for V_d and I_d assuming the VI equations above
- 5) Determine V_d and I_d assuming an ideal silicon diode ($V_f = 0.7\text{V}$)
- 6) Build this circuit in CircuitLab and solve for V_d and I_d . (Use a 1N4004 diode)

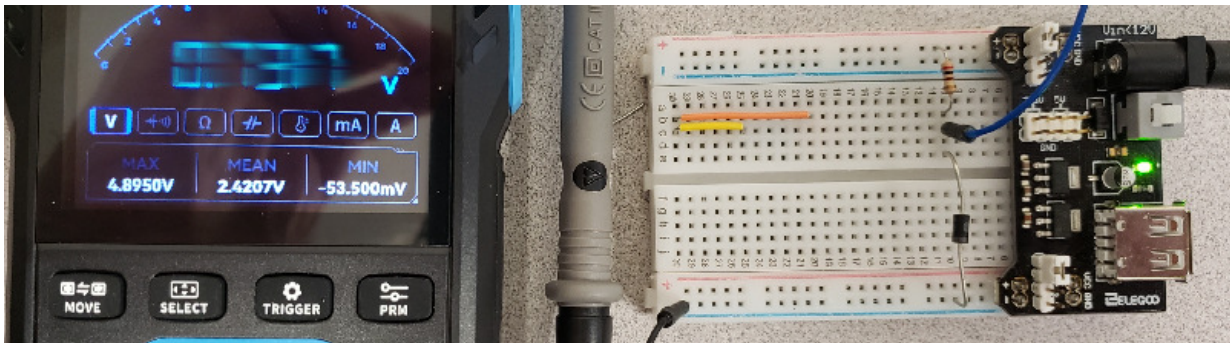
Lab (part 1)

- 7) Build this circuit on your breadboard and measure V_d . From this, compute I_d
- Include a photo to receive credit for this problem



	V_d	I_d
4a) Graphical solution		
4b) Numeric Solution		
5) Ideal Diode		
6) Simulation (CircuitLab)		
7) Lab (experimental)		

Problem 4 to 7



Exxample of what your circuit might look like

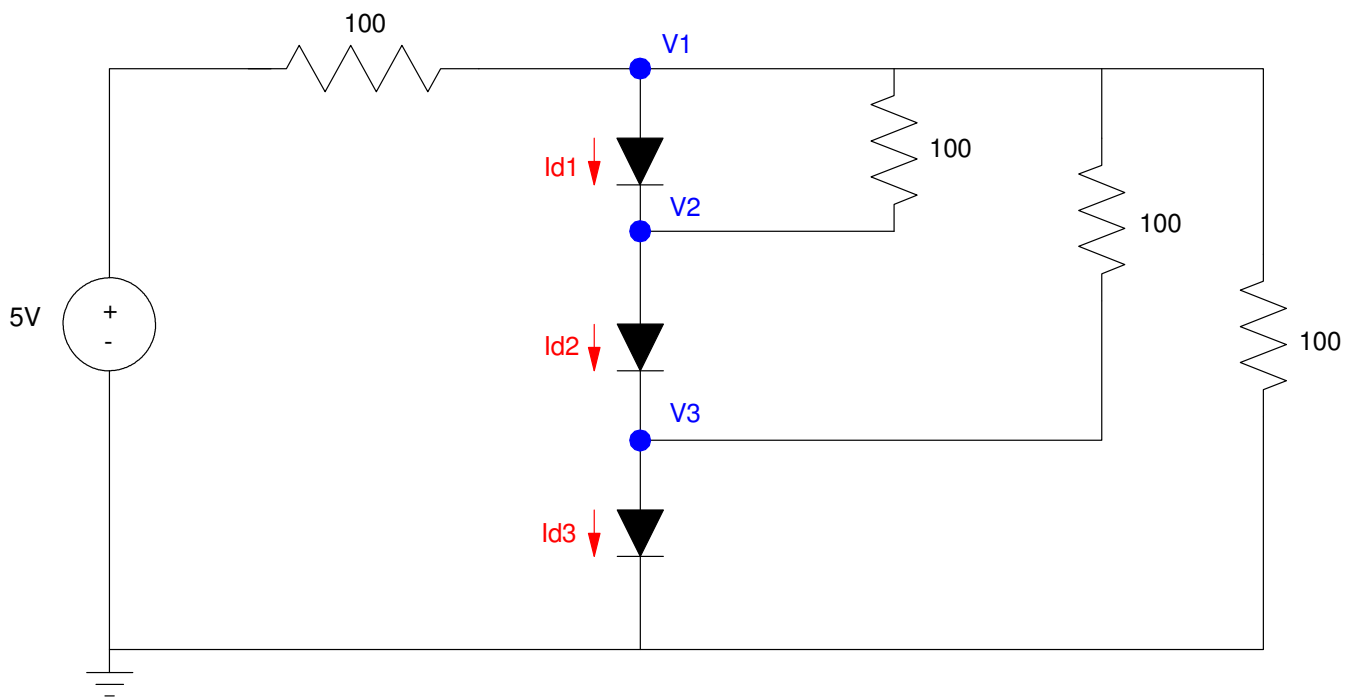
Problem 8 - 10:

- 8) Write the voltage node equations assuming nonlinear diodes. Solve for $\{V_1, V_2, \text{ and } V_3\}$ using Matlab.
- 9) Assume ideal silicon diodes. ($V_f = 0.7V$). Determine $\{V_1, V_2, \text{ and } V_3\}$.
- 10) Simulate this circuit in CircuitLab to determine $\{V_1, V_2, \text{ and } V_3\}$

Lab (part 2)

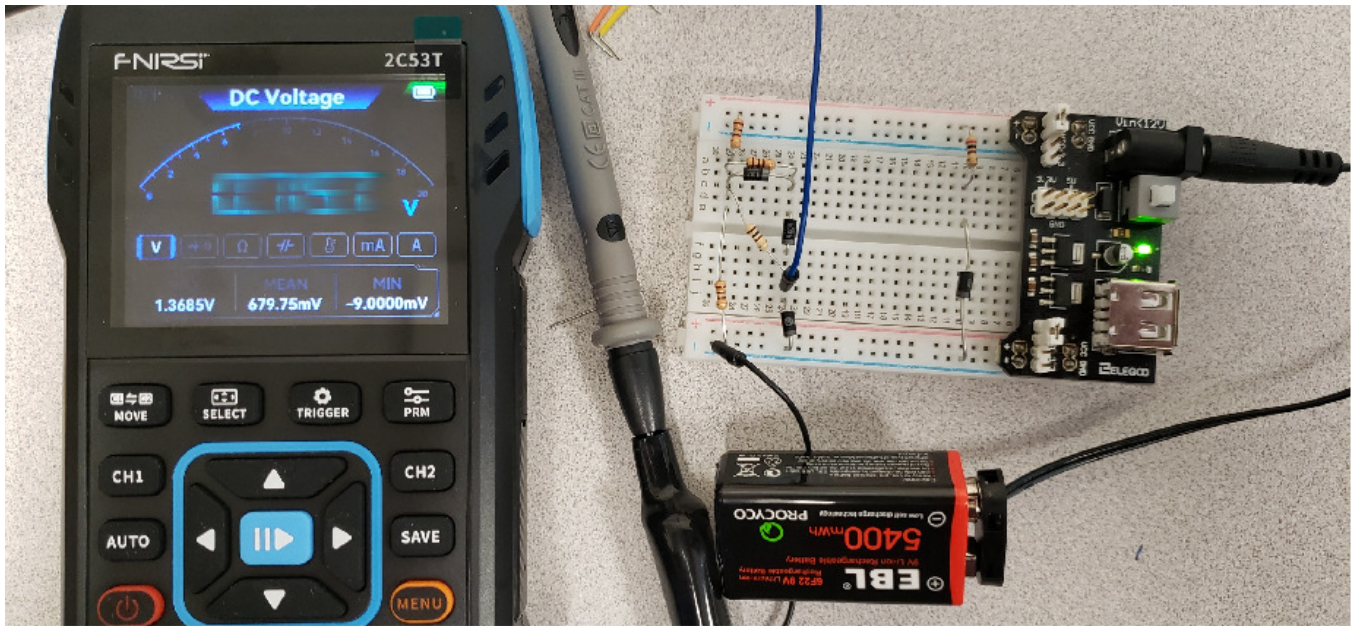
- 11) Build this circuit with your breadboard and measure $\{V_1, V_2, V_3\}$
 - Include a photo to receive credit for problem #11

	V1	V2	V3
8) Numeric Solution			
9) Ideal Diode			
10) Simulation (CircuitLab)			
11) Lab (experimental)			



Problem 8-11. Change the resistors if you don't have four 100 Ohm resistors available

(over)



Example of what your circuit might look like

Notes:

- Use a breadboard
- Use the 5V power supply (black circuit to the right)
 - +5V (red strip top and bottom))
 - Ground (blue strip, top and bottom)
- Keep the circuit neat
- Take a photo of your circuit and one of the readings