

ECE 320 - Homework #2

Semiconductors, PN Junction. Due Monday, January 23rd

Please submit as a hard copy or submit on BlackBoard

Semiconductors

1) Why does current flow p-to-n but not n-to-p across a pn junction?

2) What doping of Phosphorus (n-type) do you need to make an 1206 resistor have a resistance of 3300 Ohms? The dimensions of an 1206 resistor are

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

3) Determine the parameters for a ERT-D2FGL332S thermistor

- Digikey Part Number: PNT116-ND

$$R = R_{25} \cdot \exp\left(\frac{B_{25/50}}{T+273} - \frac{B_{25/50}}{298}\right) \Omega$$

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

- 0F Recommended temperature of a freezer
- +40F Recommended temperature of a refrigerator
- +68F Temperature of cold tap water (varies)
- +120F Temperature of hot tap water (varies)

Diode VI Characteristics

Assume the VI characteristics for a diode are (1N4004 diode in CircuitLab)

- $n = 1.45$
- $n V_t = 0.0377$
- $I_{dss} = 7.69 \times 10^{-11}$

$$V_d = 0.0377 \cdot \ln\left(\frac{I_d}{7.69 \cdot 10^{-11}} + 1\right) \quad I_d = 7.69 \cdot 10^{-11} \left(\exp\left(\frac{V_d}{0.0377}\right) - 1\right)$$

4) For the 1-diode circuit (next page - use two 100-Ohm resistors in parallel for the 50 Ohm resistor)

- 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 using `fminsearch()` in Matlab

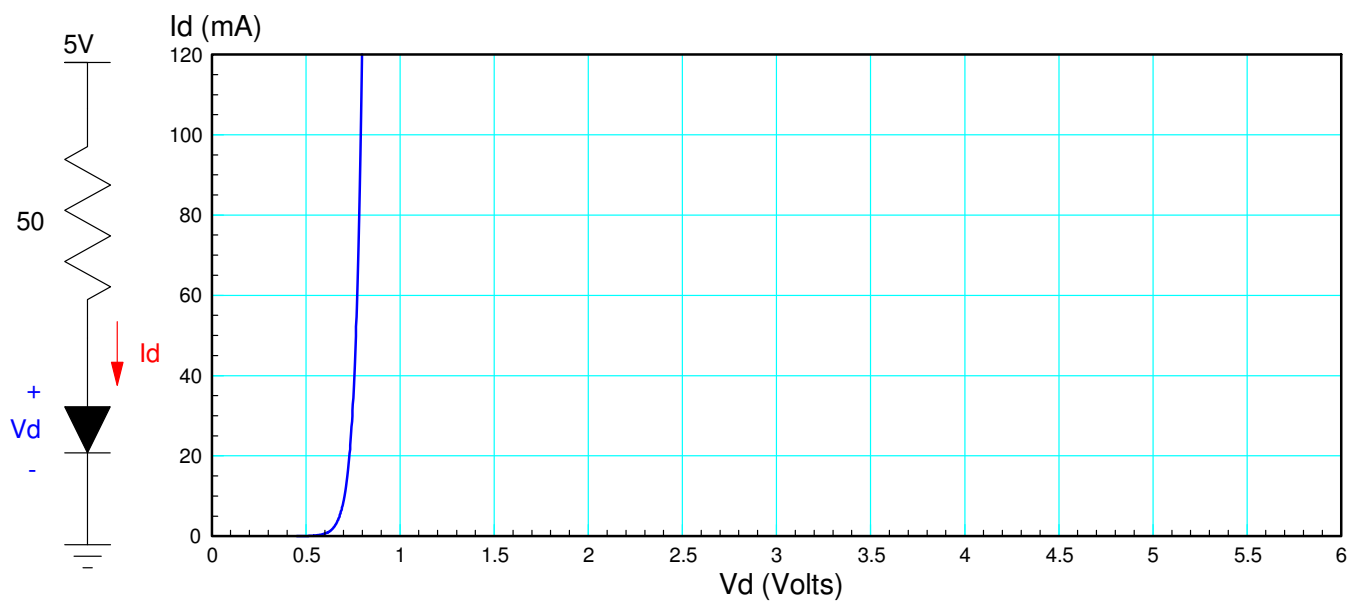
5) Build this circuit in CircuitLab and solve for V_d and I_d . (Use a 1N4004 diode)

6) Build this circuit on your breadboard and measure V_d . From this, compute I_d

- Include a photo to receive credit for this problem

note:

- 100 Ohms = brown - black - brown
- 51 Ohms = green - brown - black



	Vd	Id
4a) Graphical solution		
4b) Numeric Solution		
5) Simulation (CircuitLab)		
6) Lab (experimental)		

Problem 4 to 6

Problem 8 - 10: Pick three resistors for R1, R2, R3 in the range of 100 Ohms to 330 Ohms. They can all be the same.

R1	R2	R3

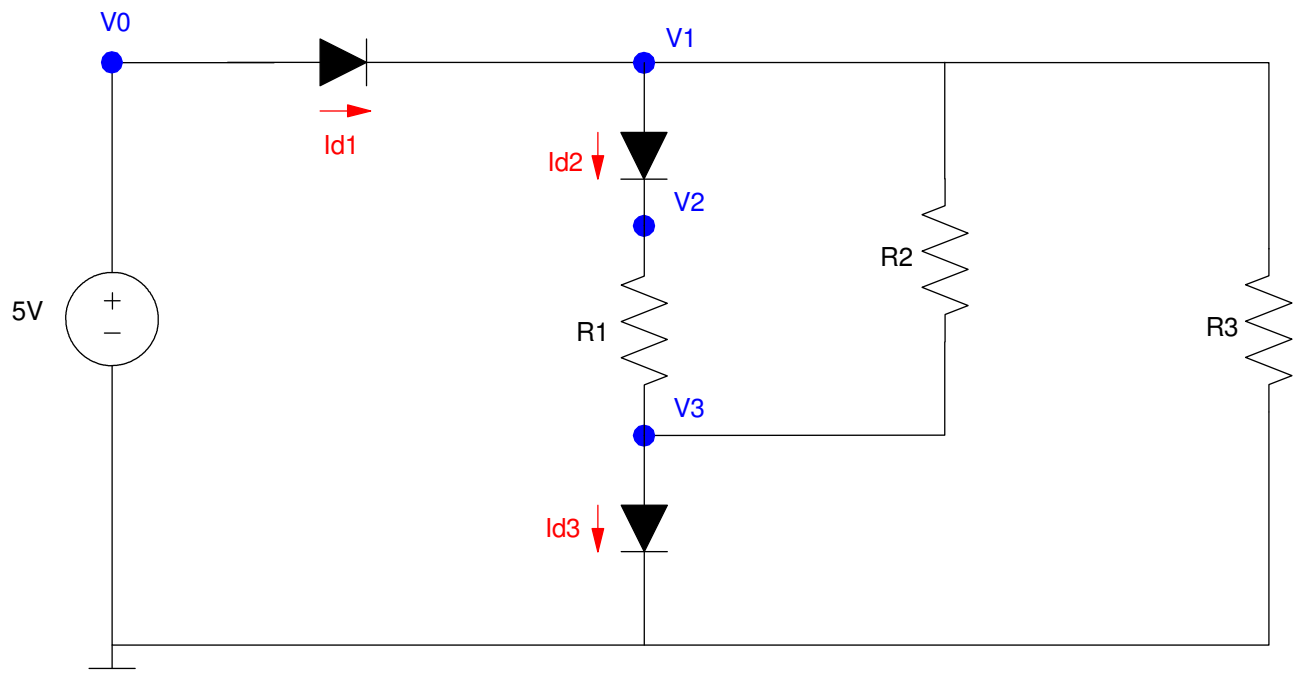
8) Write the voltage node equations assuming nonlinear diodes. Solve for {V1, V2, and V3} using Matlab.

9) Simulate this circuit in CircuitLab to determine {V1, V2, and V3}

10) Build this circuit with your breadboard and measure {V1, V2, V3}

- Include a photo to receive credit for problem #10

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



Problem 8-10. R1, R2, and R3 are in the range of 100-330 Ohms (your pick)