## ECE 320 - Homework \#2

Semiconductors, PN Junction, Ideal Diode. Due Wednesday, September 9th
Please make the subject "ECE $320 \mathrm{HW} \mathrm{H}^{2}$ " if submitting homework electronically to Jacob_Glower@yahoo.com (or on blackboard)

## Semiconductors

1) Why does the resistance of silicon decrease as temperature goes up?
2) What doping of Boron (p-type) do you need to make an 1206 resistor have a resistance of 1000 Ohms? The dimensions of an 1206 resistor are

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

3) A thermistor has the following resistance - voltage relationship

$$
R=1000 \exp \left(\frac{3905}{T}-\frac{3905}{298}\right) \Omega
$$

where T is the temperature in degrees Kelvin. What is the resistance you'll read at

- 0F Temperature of a typical freezer
- 98.6F Temperature of a healthy person
- 103.0F Temperature with a fever


## PN Junction

4) Why can current flow $p$ to $n$ but not $n$ to $p$ ?

## Diode VI Characteristics

Assume the VI characteristics for a diode are

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

5) For the 1-diode circuit next page)

5a) Draw the load-line for the following circuit (next page). Determine Vd and Id from the graph.
5b) Write the voltage node equations and solve for Vd and Id assuming the VI equations above
5c) Write the voltage node equations and solve for Vd and Id assuming ideal diodes $(\mathrm{Vf}=0.7 \mathrm{~V})$
6) Build this circuit in CircuitLab and solve for Vd and Id. (Use a 1 N 4004 diode)
7) Build this curcuit on your breadboard and measure Vd. From this, compute Id

|  | Vd | Id |
| :---: | :--- | :--- |
| 5a) Graphical solution |  |  |
| 5b) Numeric Solution |  |  |
| 5c) Ideal Diode Solution |  |  |
| 6) Simulation (CircuitLab) |  |  |
| 7) Lab (experimental) |  |  |



Problem 5 to 7
Problem 8-10: Determine V1 .. V3 for the circuit below a) Assuming exponential VI relationships, b) Assuming ideal diodes, c) Using CircuitLab, d) Experimental (build the circuit) note: if your lab kit has different resistors than those in the circuit diagram, change the problem to match the resistors you *do* have.


|  | V1 | V2 | V3 |
| :---: | :---: | :---: | :---: |
| 8a) Numeric Solution |  |  |  |
| 8b) Ideal Diode Solution |  |  |  |
| 9) Simulation (CircuitLab) |  |  |  |
| 10) Lab (experimental) |  |  |  |

