ECE 320 - Quiz #2 - Name _____

Semiconductors, pn Junction, ideal diodes - Fall 2020

1a) Silicon diodes have a 0.7V drop across them (approximately). What is the cause of this 0.7V drop?

The potential energy barrier created by the pn junction

The depletion region of the diode. It takes about 0.7V to shrink this down to zero.

1b) Why does the votlage drop across a silicon diode decrease as temperature goes up?

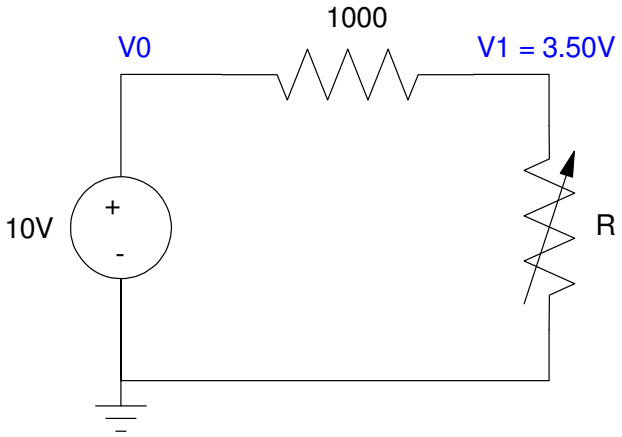
As temperature goes up, you get more and more thermal electrons / holes. This causes the n-type and p-type materials that make up the diode to behave more and more like plain silicon - which would have no voltage drop.

2) The resistance of a thermistor is given by

$$R = 1000 \cdot \exp\left(\frac{3905}{T} - \frac{3905}{278}\right)\ \Omega$$

where T is the temerature in degrees Kelvin (C + 273). Find the resistance and the temperature if the voltage at V1 is 3.50V for the following circuit.

Resistance (R)	Temperature (T)
538.46 Ohms	**290.816K = 17.816C**



$$V_1 = \left(\frac{R}{R+1000}\right)10V$$

doing some algebra...

$$R = \left(\frac{V_1}{10V - V_1}\right)1000$$

$$R = 538.46\Omega$$

Plugging into the thermistor equation

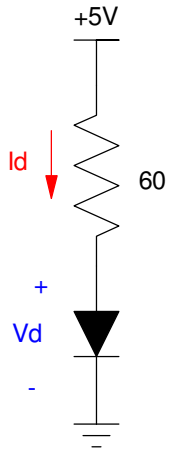
$$538.46 = 1000 \cdot \exp\left(\frac{3905}{T} - \frac{3905}{278}\right)\ \Omega$$

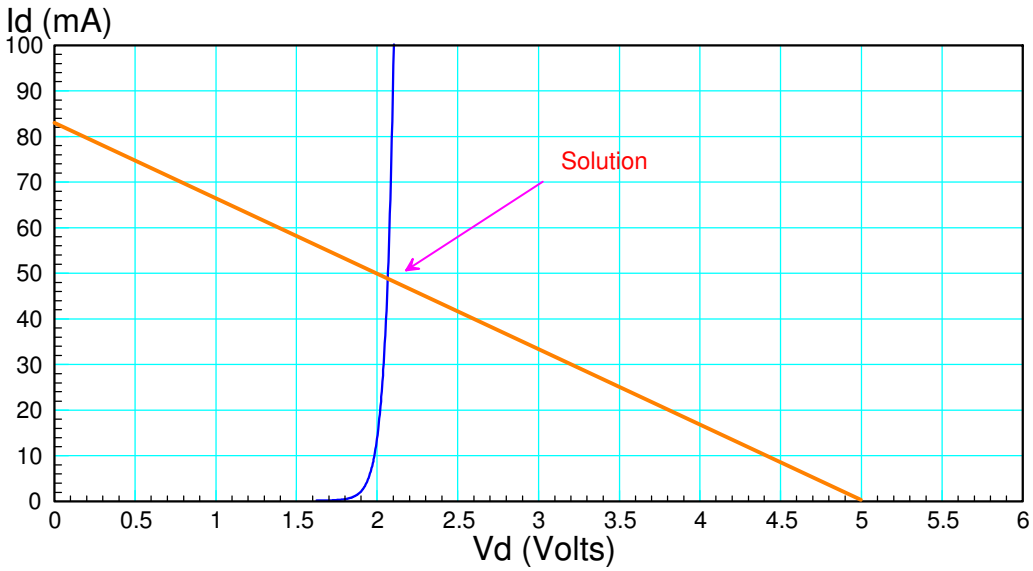
$$T = 290.816K$$

$$T = 17.8C$$

3) Load Lines: Draw the load line for the following circuit and from the graph, determine Vd and Id

Load Line	Vd (Votls)	Id (mA)
shown on graph	**2.1V**	**48mA**





4) The VI characteristics for a diode are

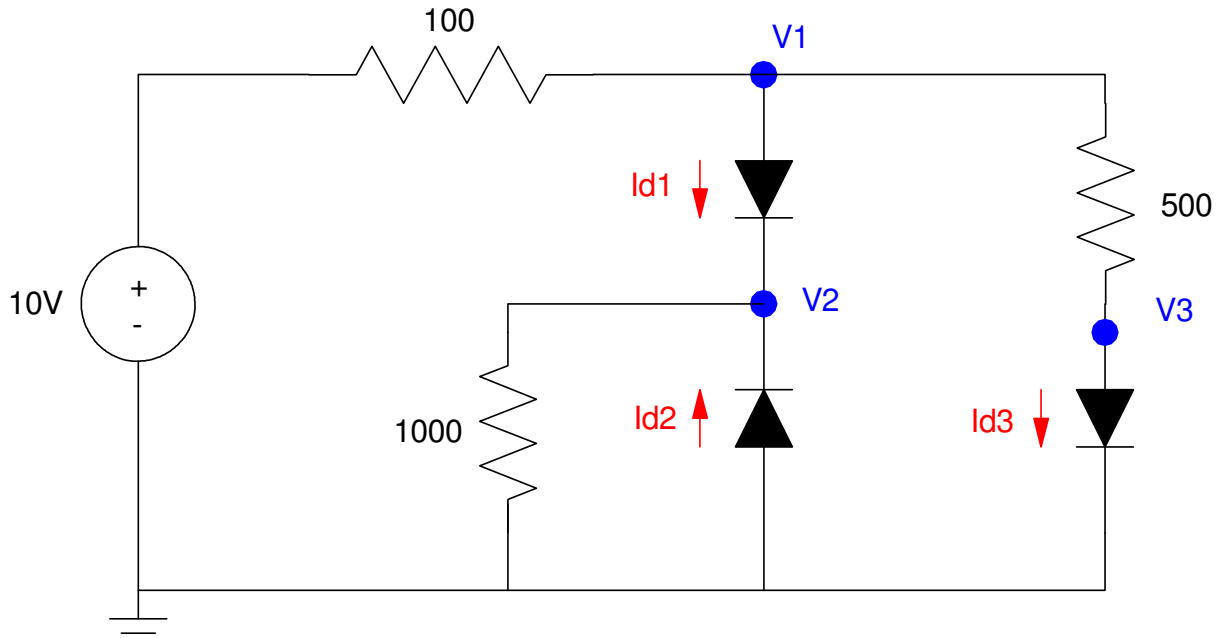
$$V_d = 0.052 \ln(10^8 \cdot I_d - 1) \text{ Volts}$$

$$I_d = 10^{-8}\left(\exp\left(\frac{V_d}{0.052}\right) - 1\right) \text{ Amps}$$

Write the voltage node equations for the following diode circuit. (you don't have to solve - just give the equations)

Note: You should end up with six equations:

- Three for the diodes: {Id1, Id2, Id3} in terms of {V1, V2, V3}, and
- Three for the voltage nodes



$$I_{d1} = 10^{-8}\left(\exp\left(\frac{V_1 - V_2}{0.052}\right) - 1\right)$$

$$I_{d2} = 10^{-8}\left(\exp\left(\frac{0 - V_2}{0.052}\right) - 1\right)$$

$$I_{d3} = 10^{-8}\left(\exp\left(\frac{V_3}{0.052}\right) - 1\right)$$

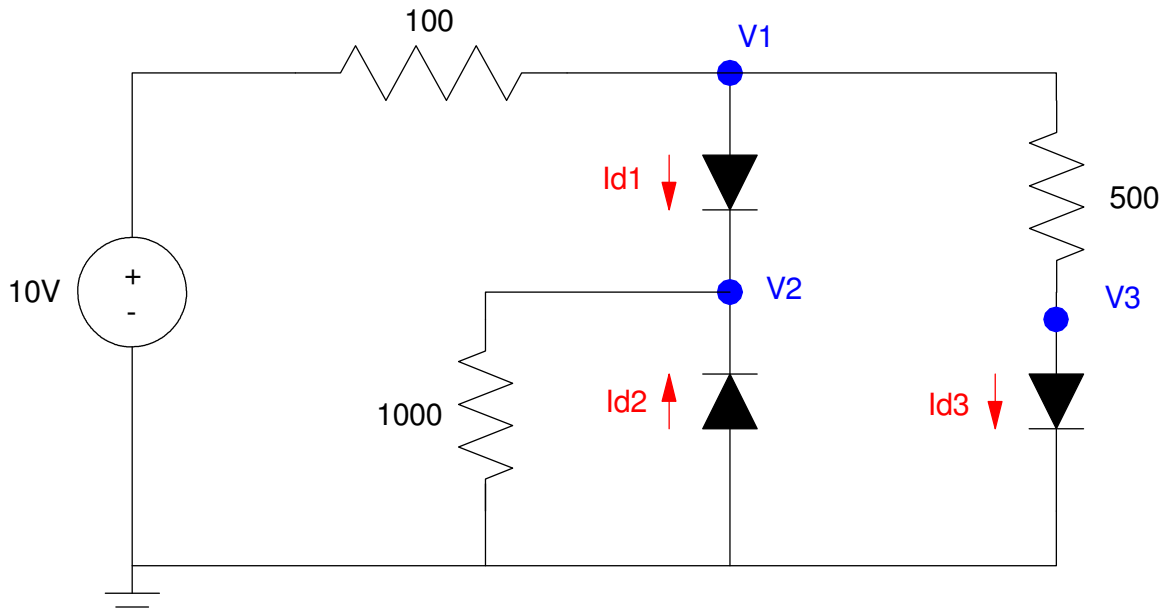
$$\left(\frac{V_1 - 10}{100}\right) + I_{d1} + \left(\frac{V_1 - V_3}{500}\right) = 0$$

$$-I_{d1} - I_{d2} + \left(\frac{V_2}{1000}\right) = 0$$

$$\left(\frac{V_3 - V_1}{500}\right) + I_{d3} = 0$$

5) Assumd ideal diodes. Determine the voltages and currents assuming ideal silicon diiodes (Vf = 0.7V)

V1	V2	V3	Id1	Id2	Id3
7.8538V	7.1538V	0.70V	7.1538mA	0mA (off)	14.30mA



$$V_3 = 0.7$$

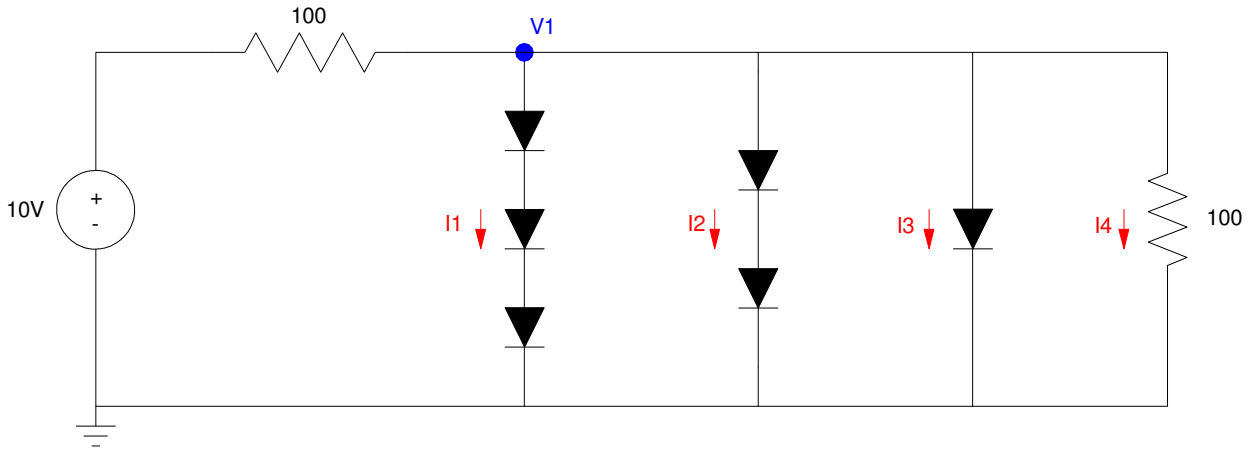
$$V_2 = V_1 - 0.7$$

$$\left(\frac{V_1 - 10}{100}\right) + \left(\frac{V_1 - 0.7}{1000}\right) + \left(\frac{V_1 - 0.7}{500}\right) = 0$$

$$V_1 = 7.8538V$$

6) Assume ideal siliicon dioes. Determine the voltage, V1, and the currents, I1..I4

V1	I1	I2	I3	I4
0.70 V	0 (off)	0 (off)	86.0 mA	7.0 mA



Bonus! Where is the error in the following proof that 1 = 2?

Assume: $a = b = 1$

$ab = b^2$ 1 = 1

$a^2 - ab = a^2 - b^2$ 1 - 1 = 1 - 1

$a(a-b) = (a+b)(a-b)$ 1(1 - 1) = (1 + 1)(1 - 1)

$a = a + b$ <<< error is here: can't divide both sides by zero

$1 = 2$