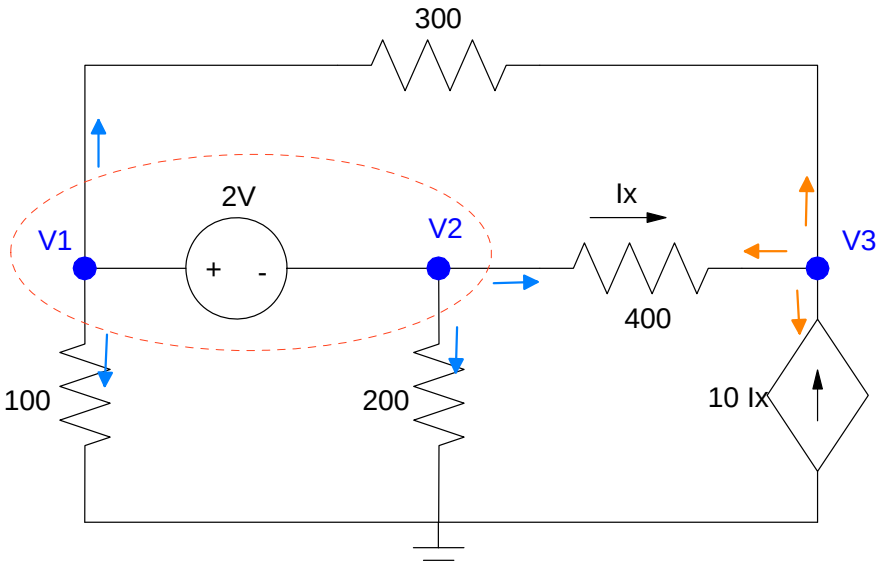
ECE 320 - Quiz #2 - Name _____

pn junction, diodes. September 8, 2017

1) Give N voltage node equations N unknown voltages in this circuit

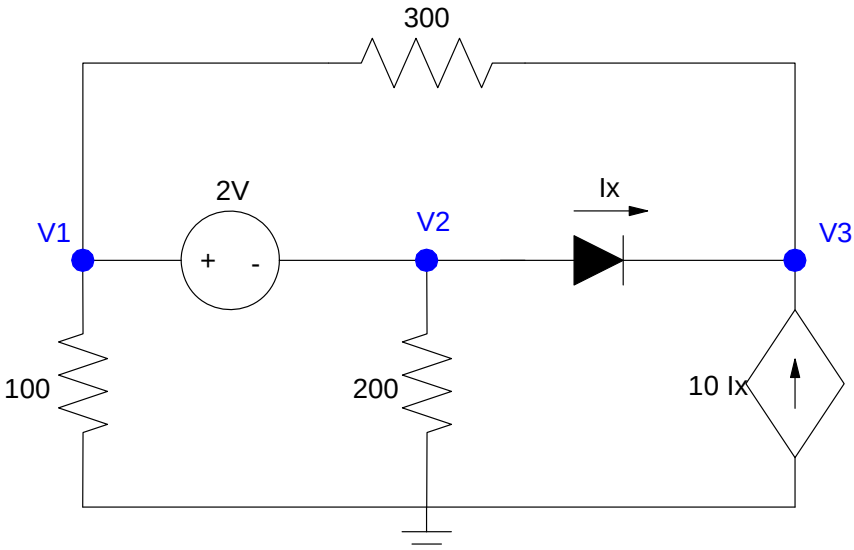


$V_1 - V_2 = 2$
$\left(\frac{V_1}{100}\right) + \left(\frac{V_1 - V_3}{300}\right) + \left(\frac{V_2}{200}\right) + \left(\frac{V_2 - V_3}{400}\right) = 0$
$\left(\frac{V_3 - V_2}{400}\right) + \left(\frac{V_3 - V_1}{300}\right) - 10\left(\frac{V_2 - V_3}{400}\right) = 0$

2) Assume the VI characteristics for a diode are:

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

Give N voltage node equations which allow you to solve for the N unknown voltages in this circuit.

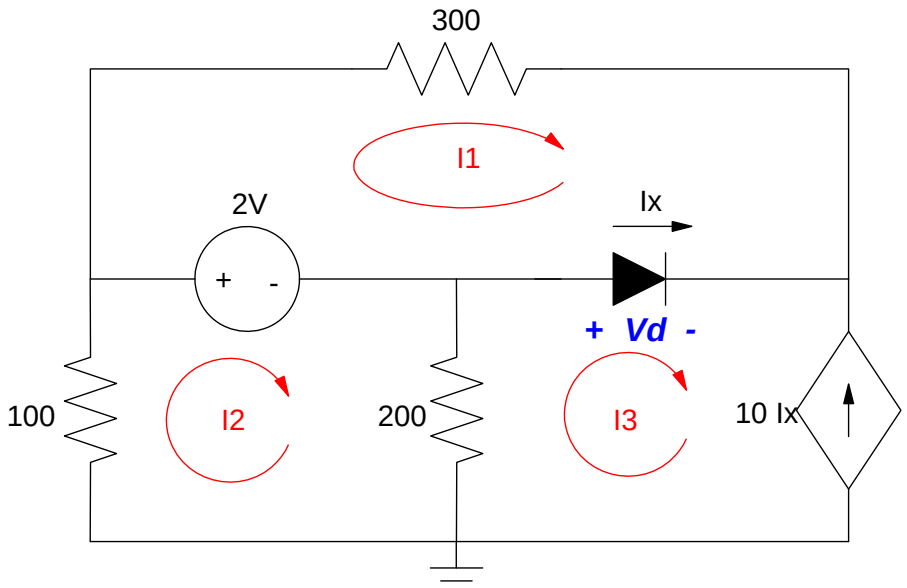


$I_x = 10^{-8}\left(\exp\left(\frac{V_2 - V_3}{0.052}\right) - 1\right)$
$V_1 - V_2 = 2$
$\left(\frac{V_1}{100}\right) + \left(\frac{V_1 - V_3}{300}\right) + \left(\frac{V_2}{200}\right) + I_x = 0$
$-I_x - 10I_x + \left(\frac{V_3 - V_1}{300}\right) = 0$

3) Assume the VI characteristics for a diode are:

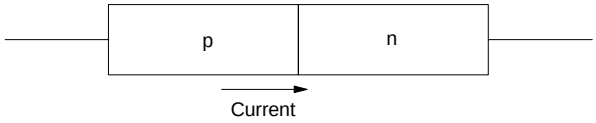
$$V_d = 0.052 \cdot \ln(10^8 I_d + 1) \qquad I_d = 10^{-8}\left(\exp\left(\frac{V_d}{0.052}\right) - 1\right)$$

Give N current loop equations which allow you to solve for the N unknown currents in this circuit.



$V_d = 0.052 \cdot \ln(10(^8 I_3 - I_1) + 1)$
$300I_1 - V_d - 2 = 0$
$100I_2 + 2 + 200(I_2 - I_1) = 0$
$I_3 = -10(I_3 - I_1)$

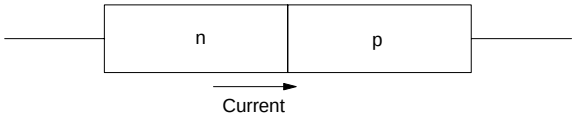
4a) Can a +5V source force current to flow from p to n through a pn junction? Why or why not?



Yes

- You are using majority carriers so the resistance is small
- +5V is enough to overcome the potential energy barrier, allowing current to flow.
- +5V is enough to squeeze the depletion zone down to zero, allowing current to flow.

4b) Can a +5V source force current to flow from n to p through a pn junction? Why or why not?

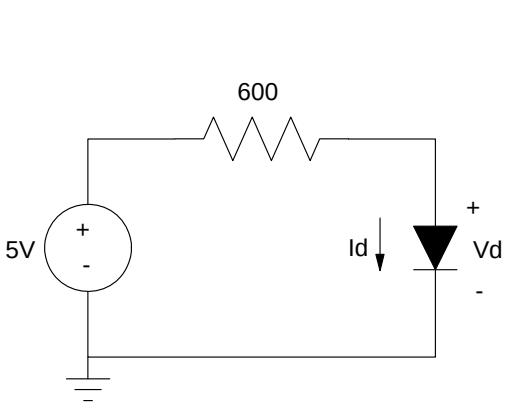


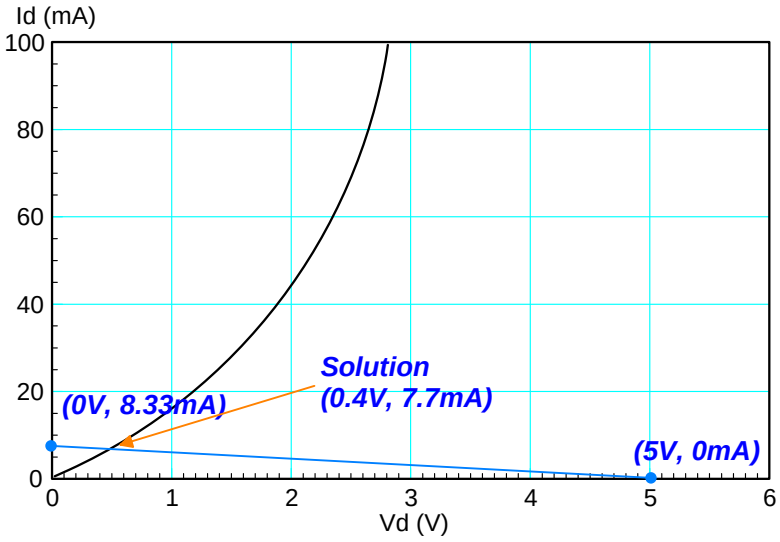
No

- You are using minority carriers so the resistance is very large
- +5V n to p makes the potential energy barrier even larger, preventing current flow.
- +5V n to p makes the depletion zone even larger, blocking current flow

5) The VI characteristic for a diode is shown below. Draw the load line for this circuit and determine the current and voltage through the diode.

Load Line	Vd	Id
show on graph	**0.4V**	**7.7mA**





Pick two points:

Assume Vd = 5V

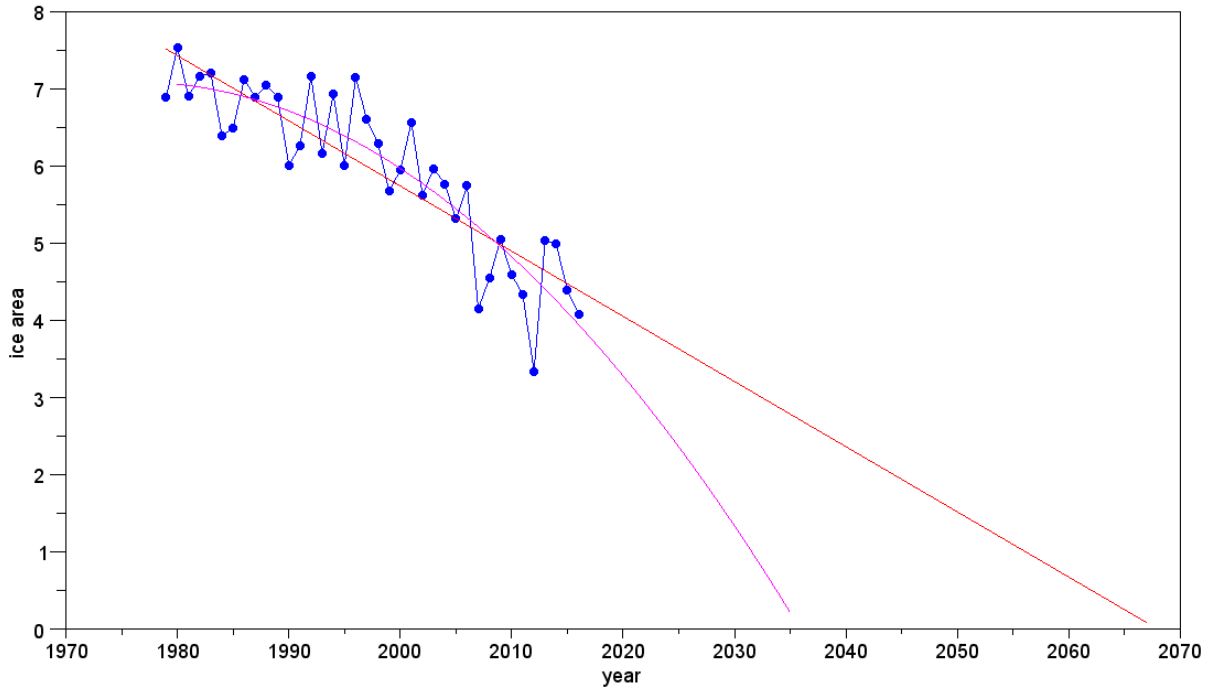
$$I_d = \left(\frac{5-5}{600}\right) = 0$$

Assume Vd = 0V

$$I_d = \left(\frac{5-0}{600}\right) = 8.33mA$$

Insurance Bonus (take 2): The amount of Arctic sea ice at its minimum each year is measured by the National Snow and Ice Data Center (shown below).

The Arctic has been covered by ice for somewhere between 5 and 15 million years. Based upon ice measurements show below, when will the arctic ocean be ice free again?



Minimum Arctic Sea Ice Area in million km^2. (National Snow and Ice Data Center)

If you use a linear curve fit (red), the zero crossing is in the year 2067 (52 years from now). A linear curve fit assumes that nothing changes: the melt doesn't increase or decrease with time.

If you use a parabolic curve fit (magenta), the zero crossing is in the year 2037 (22 years from now). A parabolic curve fit assumes the rate of melt increases over time. This could be due to

- Positive feedback: as more ice melts, more water is exposed to sunlight, absorbing more energy, causing even more melt.
- Human-caused global warming. More and more people put more and more CO2 into the atmosphere
- Natural Global Warming: As the poles melt, permafrost releases CO2, warming up the air, causing even more permafrost to melt.

Either way, it sure looks like we're going to witness something that hasn't happened in at least 5 million years.