ECE 320 - Solution to Homework #3

Ideal Diodes, Light Emitting Diodes. Due Monday, September 11th, 2017

LEDs: The specifications for the Piranah RGB LEDs in lab are

Color	Vf @ 20mA	mcd @ 20mA	Steel Blue
red	1.8V	8000 mcd	2080 mcd (26%)
green	3.0V	8000 mcd	2800 mcd (35%)
blue	3.0V	8000mcd	5920 mcd (74%)

1) Design a circuit with a +5V source which results in the LED outputting steel blue.

Red:

$$I_r = \left(\frac{2080mcd}{8000mcd}\right)20mA = 5.2mA$$

$$R_r = \left(\frac{5V-1.8V}{5.2mA}\right) = 615\Omega$$

Green:

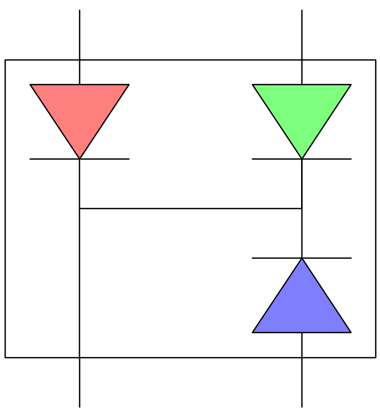
$$I_g = \left(\frac{2800mcd}{8000mcd}\right)20mA = 7mA$$

$$R_g = \left(\frac{5V-3.0V}{7mA}\right) = 285\Omega$$

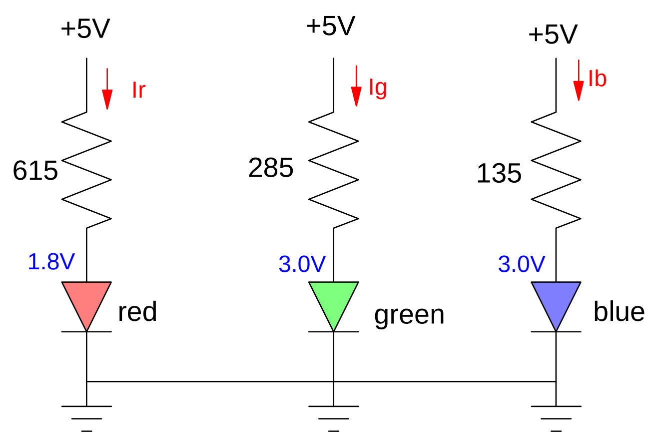
Blue

$$I_r = \left(\frac{5920mcd}{8000mcd}\right)20mA = 14.8mA$$

$$R_b = \left(\frac{5V-3.0V}{14.8mA}\right) = 135\Omega$$



Piranah Package



Assume ideal silicon diodes (Vf = 0.7V). Determine the currents and voltages for the following circuits.

2a) Assume Vin = 10V. Determine the currents I1 to I4

10V is should be large enough to turn on all diodes. Assume all three are on.

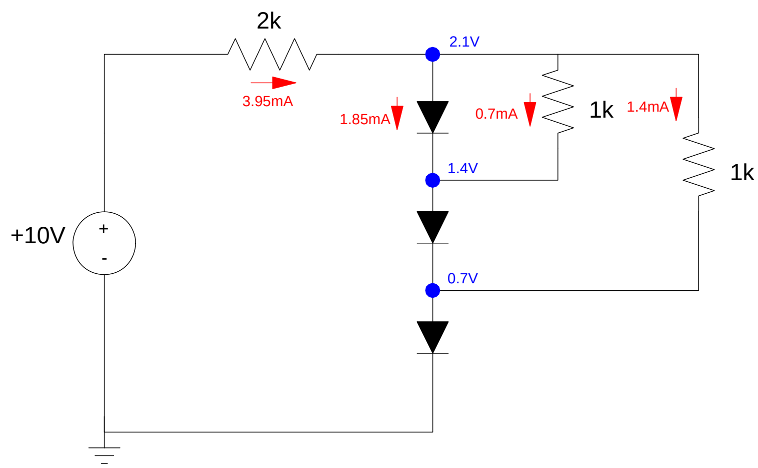
- V3 = 0.7V
- V2 = 1.4V
- V1 = 2.1V

Then

$$I_1 = \left(\frac{10V - 2.1V}{2k}\right) = 3.95mA$$

$$I_3 = \left(\frac{2.1V - 1.4V}{1k}\right) = 0.7mA$$

$$I_4 = \left(\frac{2.1V - 0.7V}{1k}\right) = 1.4mA$$



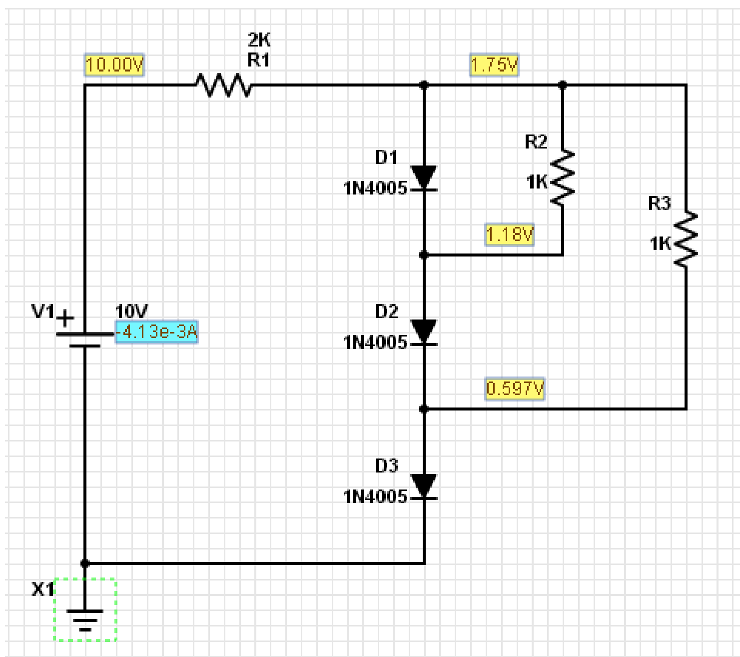
The currents have to balance, so

$$I_1 = I_2 + I_3 + I_4$$

$$I_2 = 1.85mA$$

2b) Check your answers in PartSim.

The voltages match up. If the voltages match, the currents match.



3a) Assume Vin = 2V. Determine the currents I1 to I4

2V isn't enough to turn on all three diodes (this requires 2.1V).

It is enough to turn on one diode (this requires 0.7V).

Guess that only one diode is on. then

- V3 = 0.7V (diode3 is on)
- I2 = 0
- I3 = 0

To find V3

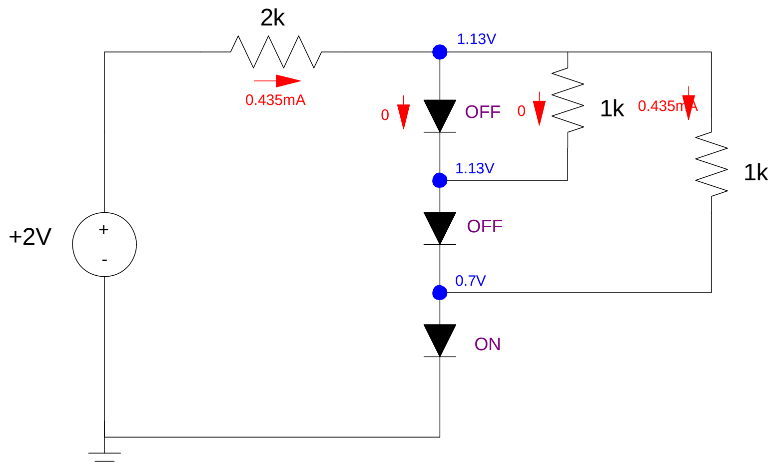
$$\left(\frac{V_3-2}{2k}\right)+0+0+\left(\frac{V_3-0.7}{1k}\right)=0$$

$$V_3=1.13V$$

The currents are then

$$I_1=\left(\frac{2-1.13}{2k}\right)=0.435mA$$

$$I_4=\left(\frac{1.13V-0.7V}{1k}\right)=0.435mA$$

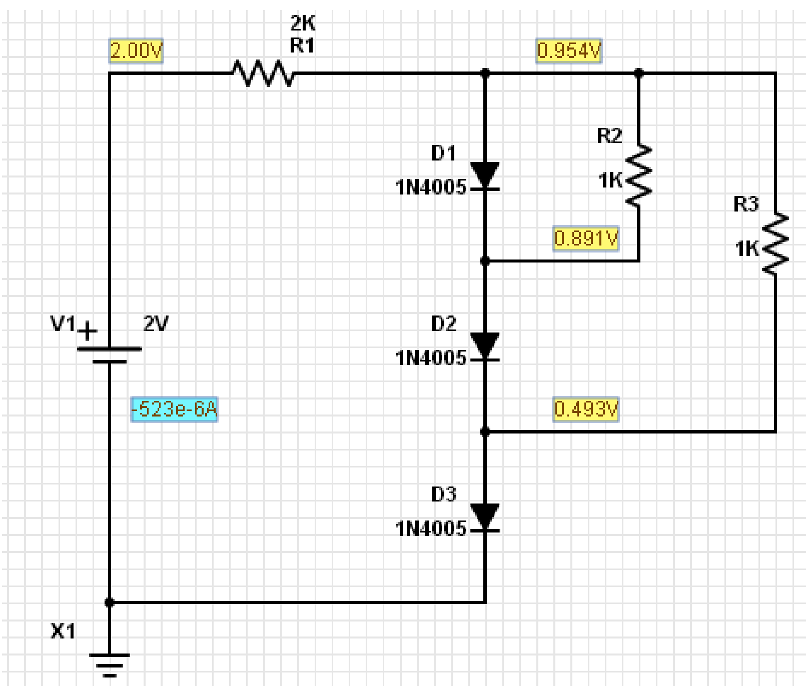


Currents balance. Checking if the diodes are really off:

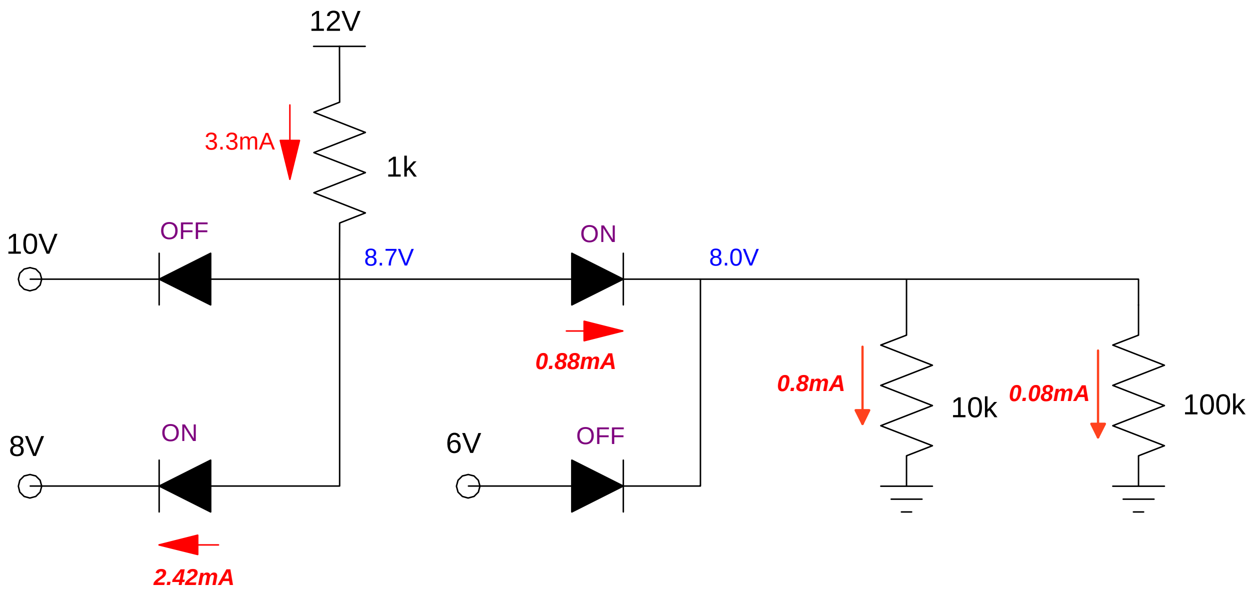
D1: V1 - V2 = 0 < 0.7V check

D2: V2 - V3 = 0.43V < 0.7V check

3b) Check your answers in PartSim. The votlages are similar to what was calculated.

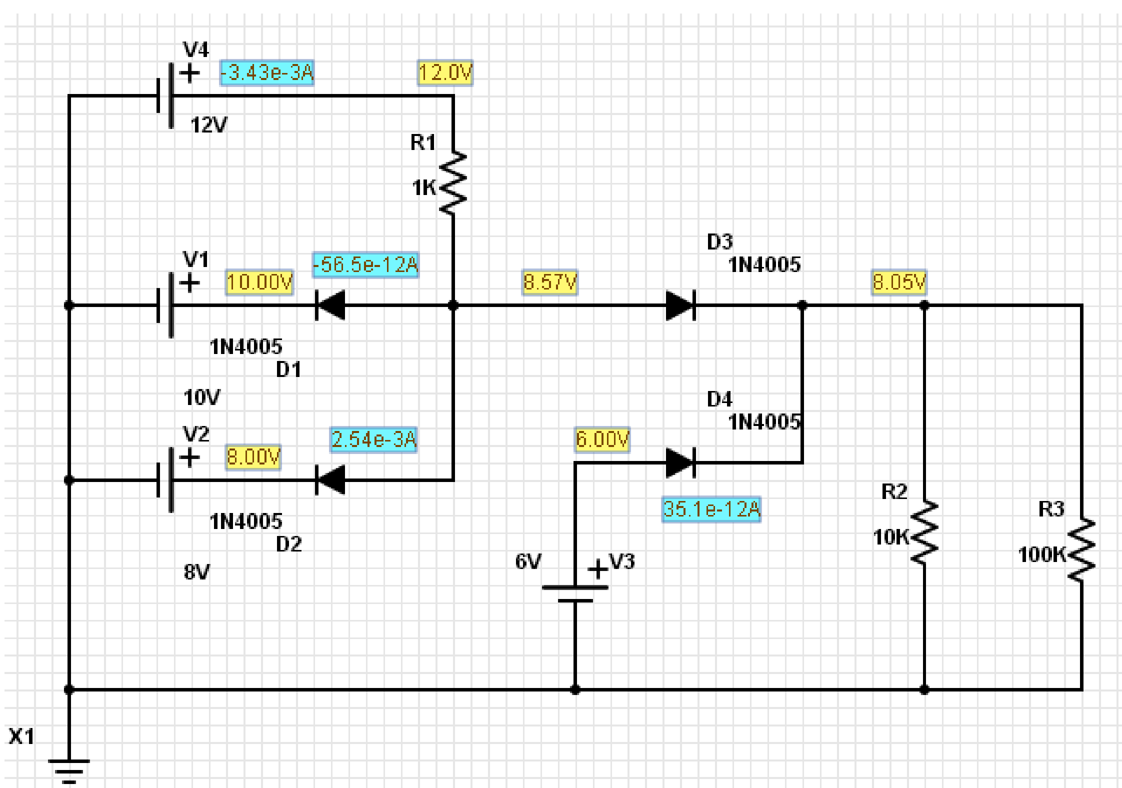


4a) Determine the currents I1 to I4



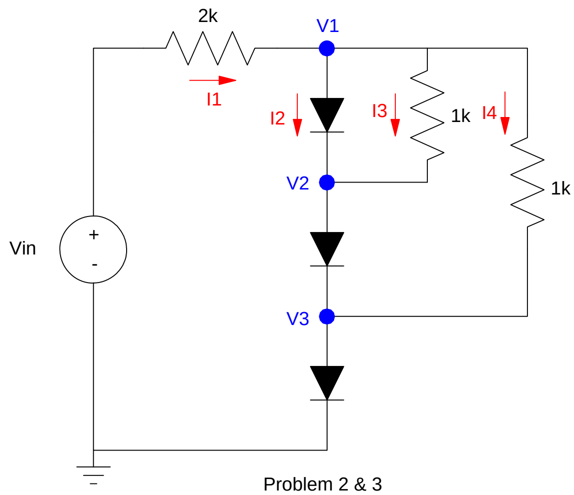
4b) Check your answer in PartSim.

The voltages match up. The current through D1 and D4 should be zero. PartSim reports them as being 56pA and 35pA. This is very small (0.000056mA and 0.000035mA respectively) and essentially zero for this circuit.

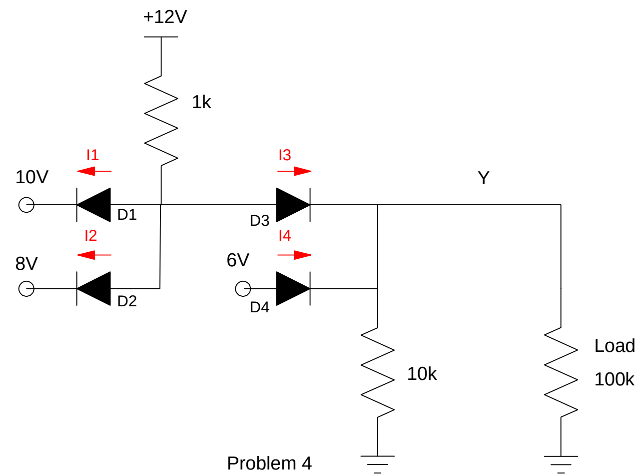


Lab:

5) Build one of these circuits in lab and verify your previous answers.



Problem 2 & 3



Problem 4