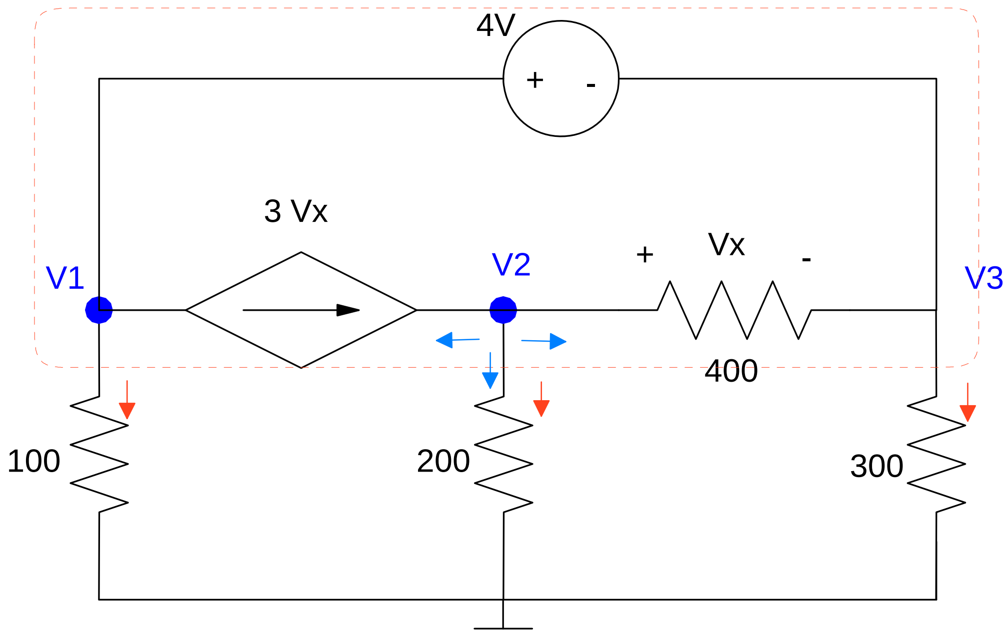
ECE 320 - Quiz #3 - Name ______________________

LEDs, ideal diodes. September 14, 2017

1) Write N voltae node equations which would allow you to solve for the N unknow voltages



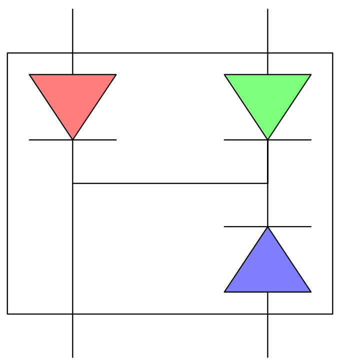
Votlage Source	$V_1 - V_3 = 4$
Node V2 (blue)	$-3(V_2 - V_3) + \left(\frac{V_2}{200}\right) + \left(\frac{V_2 - V_3}{400}\right) = 0$
Supernode (orange)	$\left(\frac{V_1}{100}\right) + \left(\frac{V_2}{200}\right) + \left(\frac{V_3}{300}\right) = 0$

2) A RGB has the following characteristics

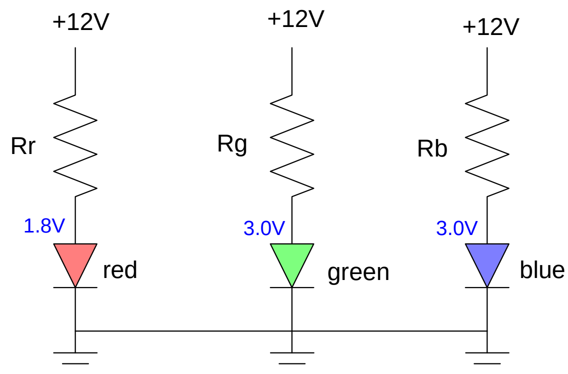
- Red: Vf = 1.8V @ 20mA 8000 mcd @ 20mA
- Green: Vf = 3.0V @ 20mA 8000 mcd @ 20mA
- Blue: Vf = 3.0V @ 20mA 8000 mcd @ 20mA

Find Rr, Rg, and Rb so that the LED outputs hot pink:

R(red) 7500 mcd	R(green) 5781 mcd	R(blue) 7656 mcd
544	**622**	**470**



Piranah Package



Red:

$$I_r = \left(\frac{7500mcd}{8000mcd}\right)20mA = 18.75mA$$

$$R_r = \left(\frac{12V - 1.8V}{18.75mA}\right) = 544\Omega$$

Green

$$I_g = \left(\frac{5781mcd}{8000mcd}\right)20mA = 14.45mA$$

$$R_g = \left(\frac{12V - 3.0V}{14.45mA}\right) = 622\Omega$$

Blue

$$I_b = \left(\frac{7656mcd}{8000mcd}\right)20mA = 19.14mA$$

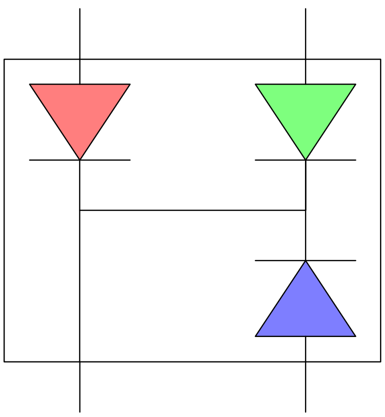
$$R_b = \left(\frac{12V - 3.0V}{19.14mA}\right) = 470\Omega$$

3) A RGB LED has the following specifications:

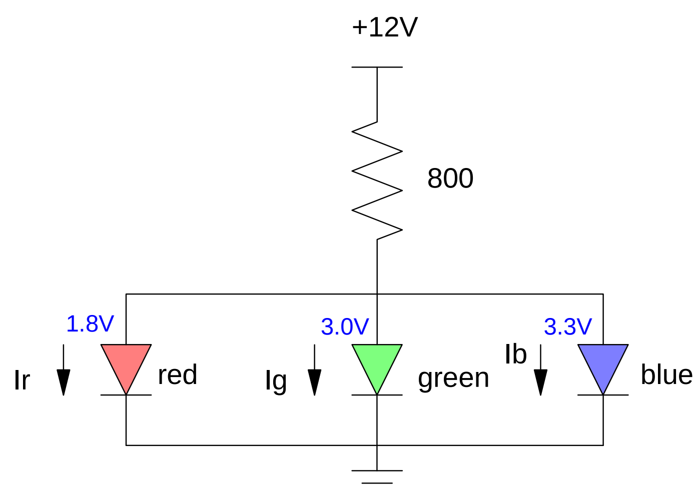
- Red: Vf = 1.8V @ 20mA 8000 mcd @ 20mA
- Green: Vf = 3.0V @ 20mA 8000 mcd @ 20mA
- Blue: Vf = 3.0V @ 20mA 8000 mcd @ 20mA

Determine the current through each LED and the number of mcd produced for the following circuit:

	Red	Green	Blue
Current	**12.8mA**	**0**	**0**
mcd	**5100 mcd**	**0**	**0**



Piranah Package



Only the red LED turns on. It limits the voltage to 1.8V, which isn't enough to turn on the green or blue LEDs.

Ig = 0

Ib = 0

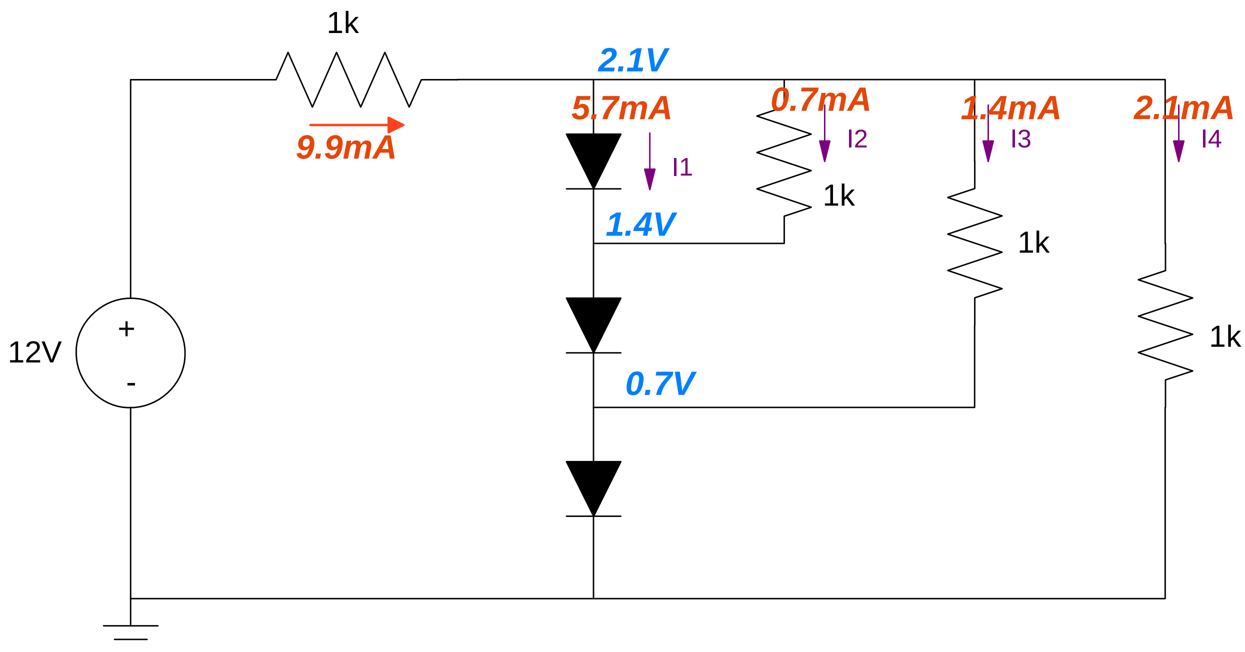
For the red LED

$$I = \left(\frac{12V - 1.8V}{800\Omega} \right) = 12.8mA$$

$$mcd = \left(\frac{12.8mA}{20mA} \right) 8000mcd = 5100mcd$$

4) Determine the currents I1 to I4. Assume ideal silicon diodes with Vf = 0.7V

I1	I2	I3	I4
5.7mA	**0.7mA**	**1.4mA**	**2.1mA**



Assume all diodes are on. The voltages are then {0.7V, 1.4V, 2.1V}

Once you know the voltages, you can compute the currents I2, I3, and I4 as well a the current in

$$I_2 = \left(\frac{2.1V - 1.4V}{1k}\right) = 0.7mA$$

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

$$I_4 = \left(\frac{2.1V - 0V}{1k}\right) = 2.1mA$$

$$I_{in} = \left(\frac{12V - 2.1V}{1k}\right) = 9.9mA$$

Current in equals current out

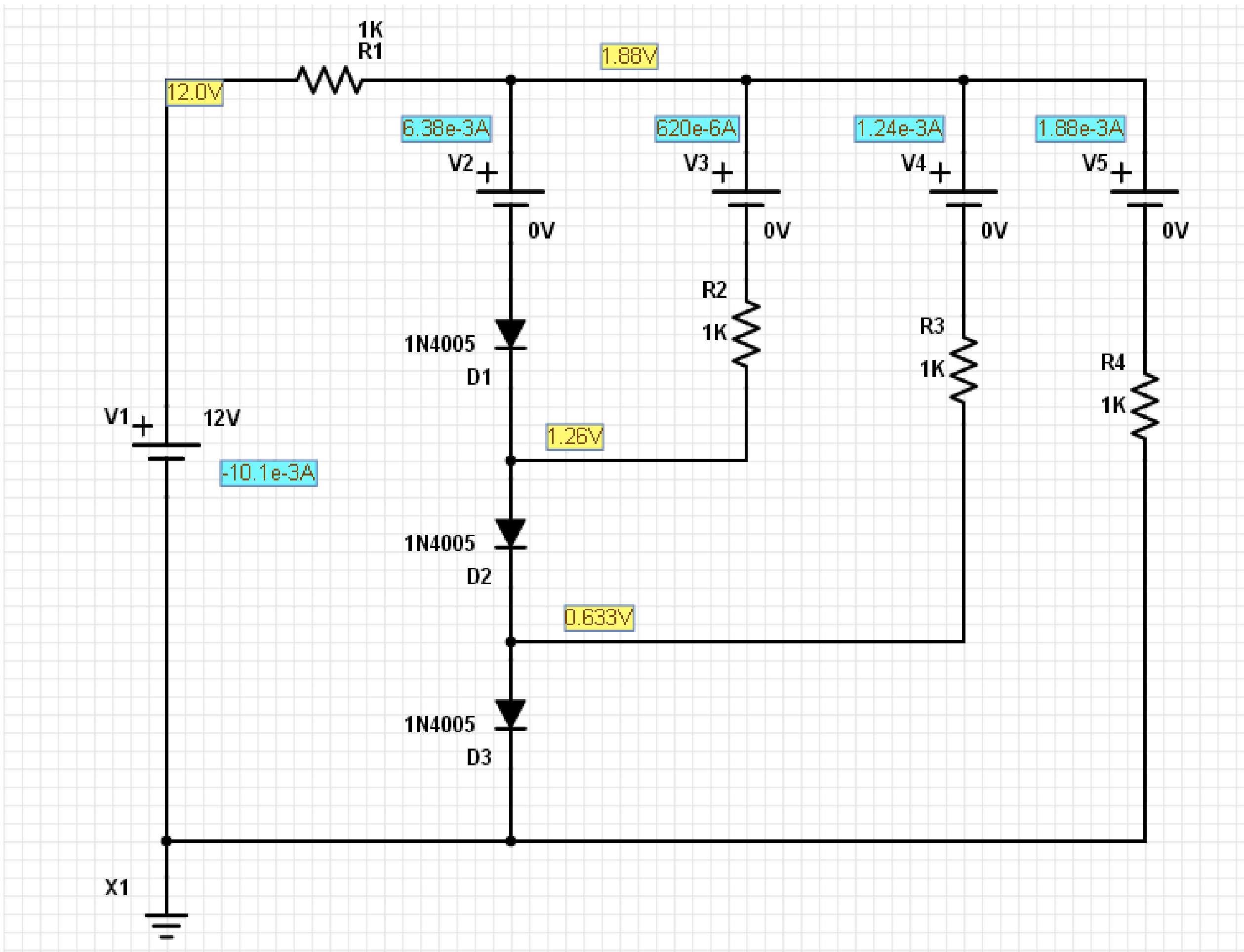
$$I_{in} = I_1 + I_2 + I_3 + I_4$$

$$9.9mA = I_1 + 0.7mA + 1.4mA + 2.1mA$$

$$I_1 = 5.7mA$$

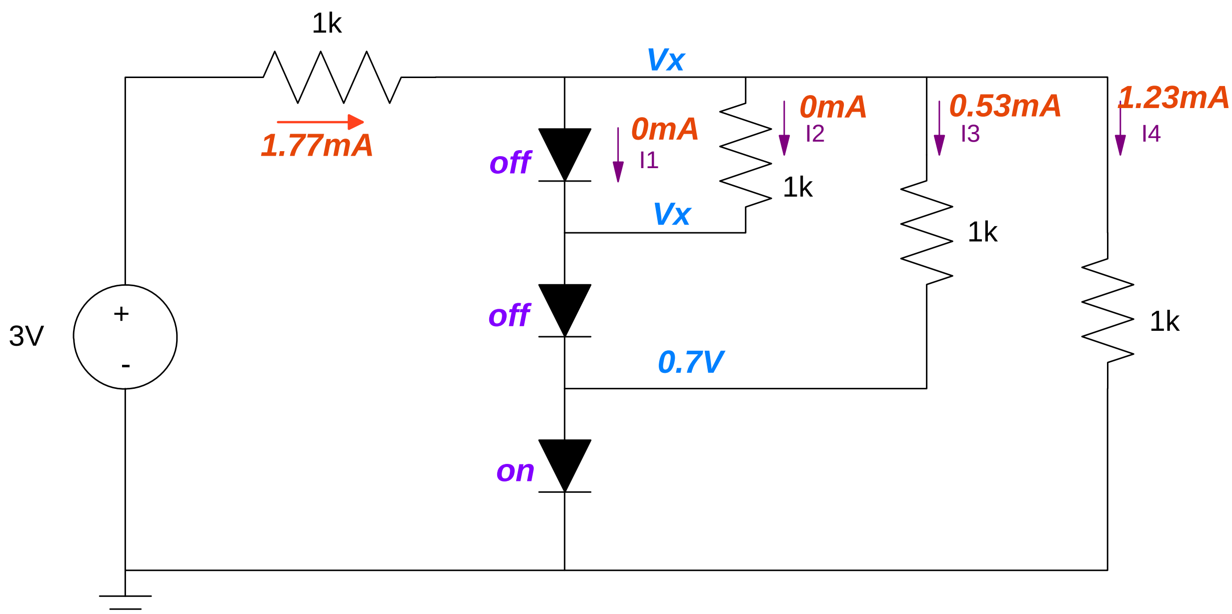
Problem 4) Checking in PartSim

	Iin	I1	I2	I3	I4
Calculate	9.9mA	5.7mA	0.7mA	1.4mA	2.1mA
Simulate	10.1mA	6.38mA	0.62mA	1.24mA	1.88mA



5) Determine the currents I1 to I4. Assume ideal silicon diodes with Vf = 0.7V

I1	I2	I3	I4
0	**0**	**0.53mA**	**1.23mA**



Guess the top diodes are off. Solve for the voltage at Vx

$$\left(\frac{V_x - 3}{1k}\right) + 0 + 0 + \left(\frac{V_x - 0.7}{1k}\right) + \left(\frac{V_x}{1k}\right) = 0$$

$$V_x = 1.23V$$

Check:

- The voltage across the top diode is 0V (< 0.7V   off)
- The voltage across the middle diode is 0.53V (< 0.7V   off)

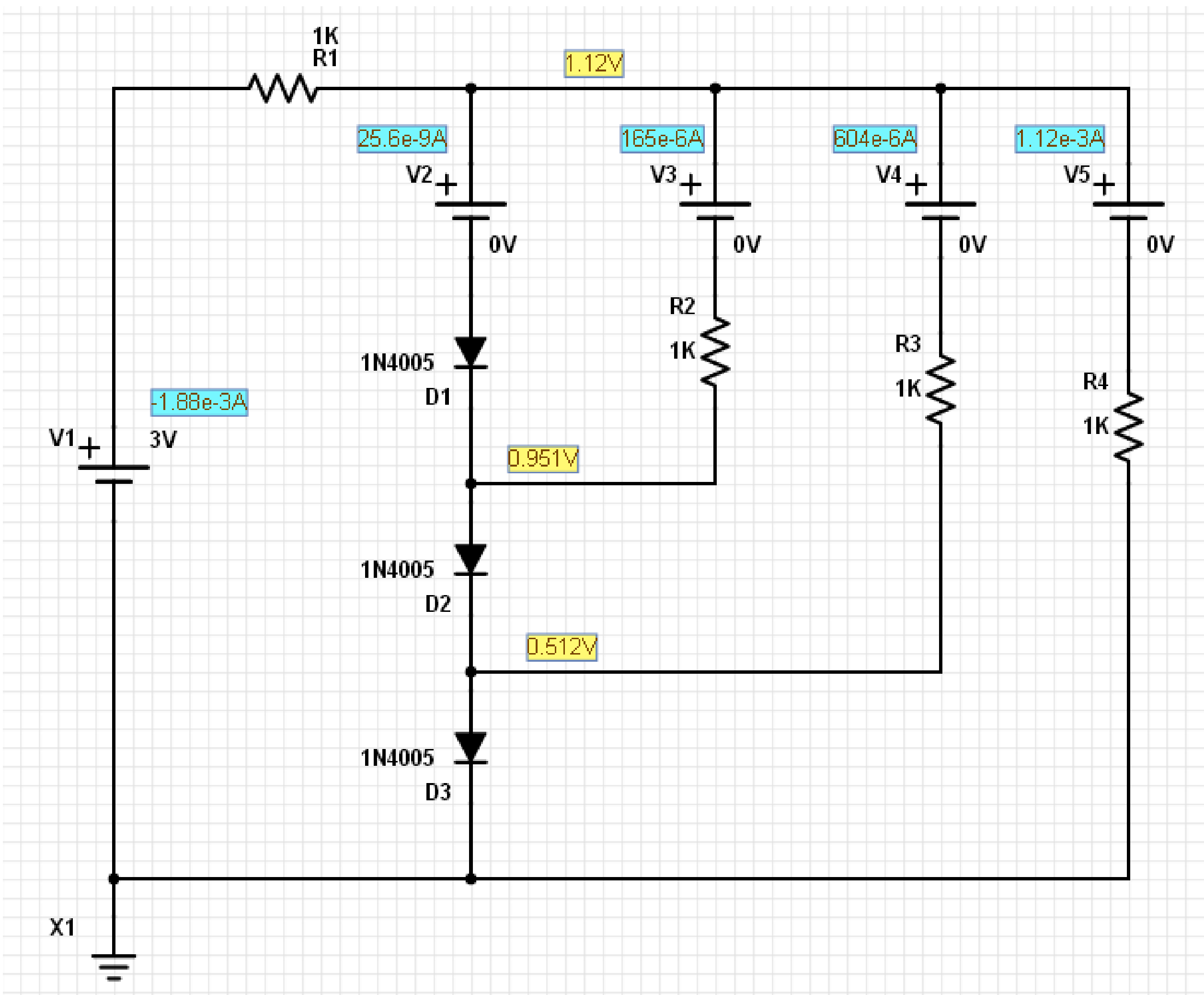
The currents are then

$$I_3 = \left(\frac{1.23V - 0.7V}{1k}\right) = 0.53mA$$

$$I_4 = \left(\frac{1.23V - 0V}{1k}\right) = 1.23mA$$

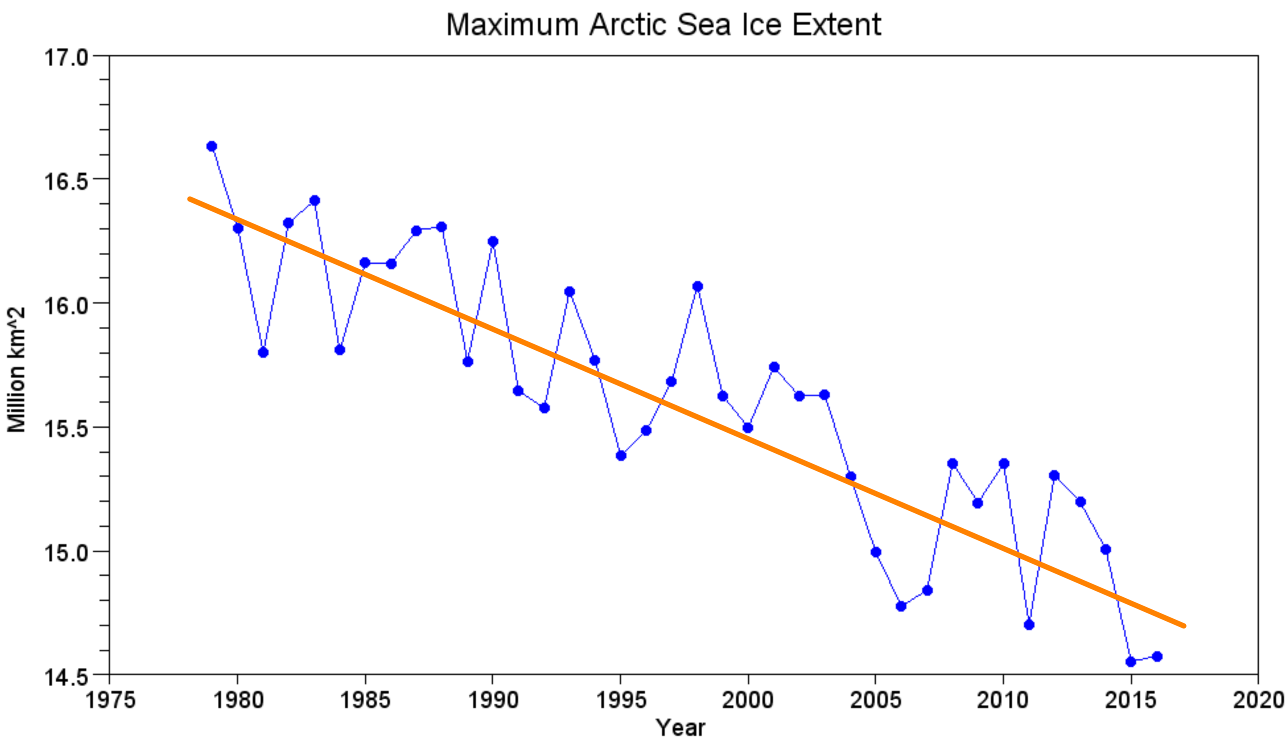
Problem 5) Checking in PartSim

	Iin	I1	I2	I3	I4
Calculate	1.77mA	0	0	0.53 mA	1.23 mA
Simulate	1.88 mA	0.000025 mA	0.000165 mA	0.604 mA	1.12 mA



The maximum extent of Arctic sea ice from 1979 to 2016 is plotted below (source: National Sea and Ice Data Center).

Based upon this data, when will the Arcitc be ice free all year long?



Draw a line through the data. The slope of this line is

$$slope = \left(\frac{16.5-14.5}{1975-2020}\right) = -0.0444\frac{\text{million km^2}}{\text{year}}$$

Projecting into the future from 2020, you'll hit zero at

$$years = \left(\frac{\text{14.5 million km^2}}{\text{0.0444 million km^2/year}}\right) = 326 \text{ years.}$$

Since this was from the year 2020

year = 2020 + 326 = 2346

The Arctic should be ice free all year round in the year 2346. (approximately)