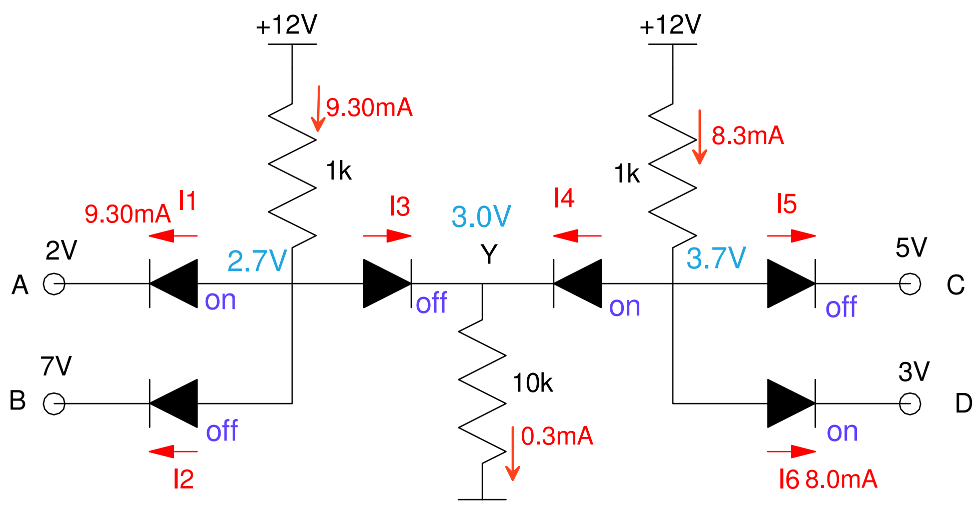
ECE 320 - Homework #4

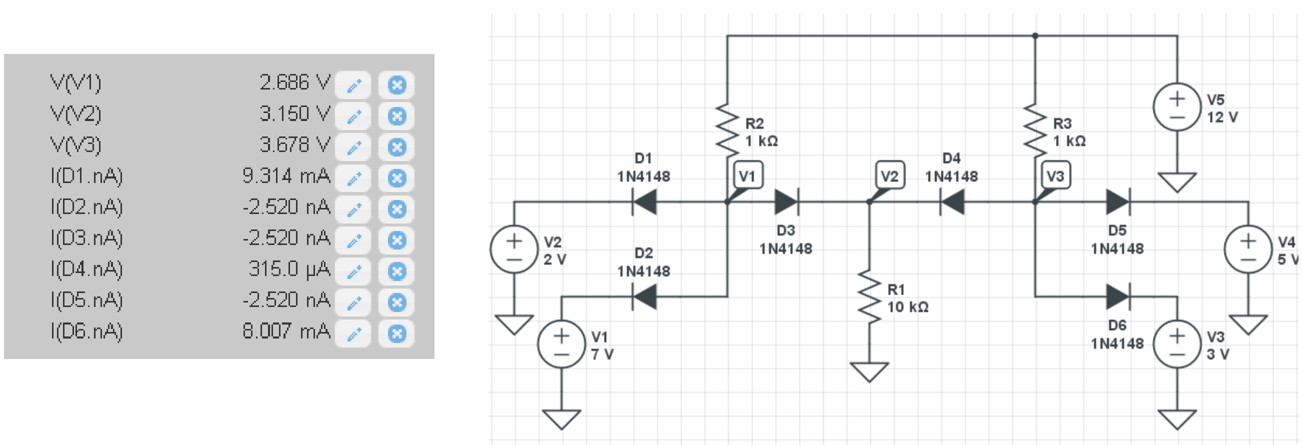
Max/Min Circuits, Clipper Circuits, Transistor Theory. Due Monday, February 8th

Max/Min:

1) Determine the voltages and currents for the following max/min circuit. What function does this circuit implement?   Y = f(A, B, C, D)



2) Check your results in CircuitLab (or similar program)



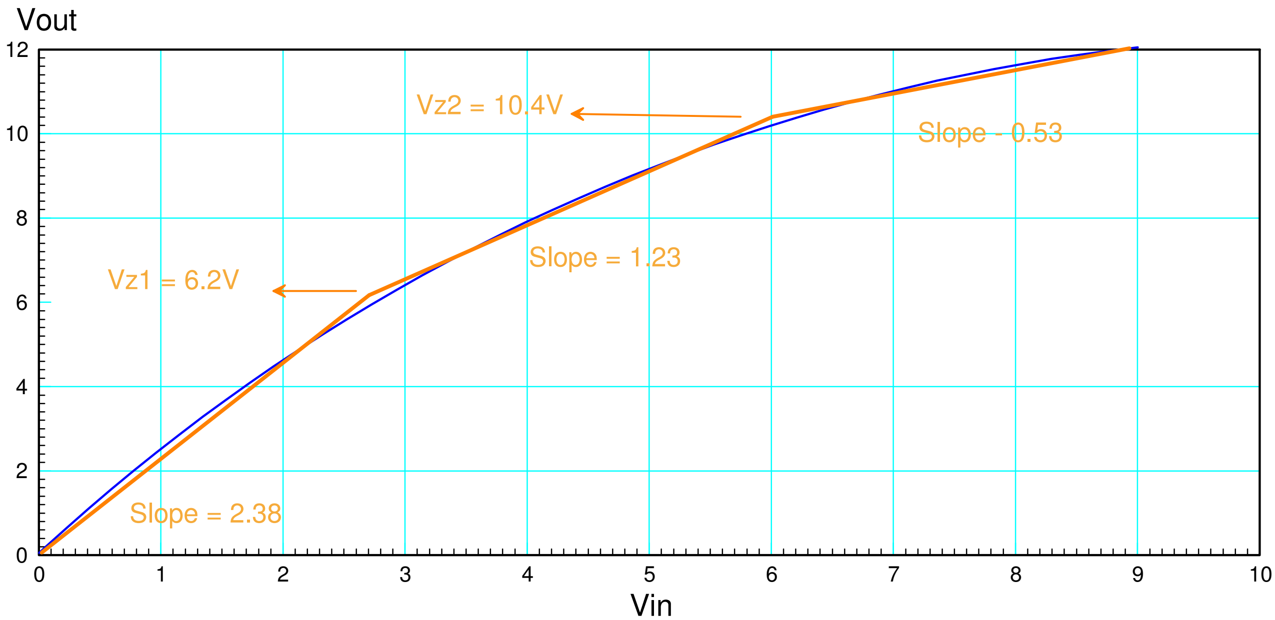
	I1	I2	I3	I4	I5	I6
Calculated (ideal diode)	9.30 mA	0	0	0.3 mA	0	8.0 mA
Simulated (nonlinear model)	9.314 mA	-0.00000025mA	-0.00000025mA	0.315mA	-0.0000025mA	8.007mA

The ideal diode model is fairly accurate

Clipper Circuits:

3) Design a circuit to approximate the following function subject to the following requirements:

- Input: 0 .. 10V, capable of 100mA
- Output: 100k resistor
- Relationship: Graph below, +/- 200mV



The zener voltages are the voltage (y-axis) where the slope changes

R0:

$$\text{Slope} = 2.38 = 1 + \frac{R_0}{1k}$$

$$R_0 = 1.38k$$

R1:

$$\text{Slope} = 1.23 = \left(\frac{R_1}{R_1+1000}\right)2.38$$

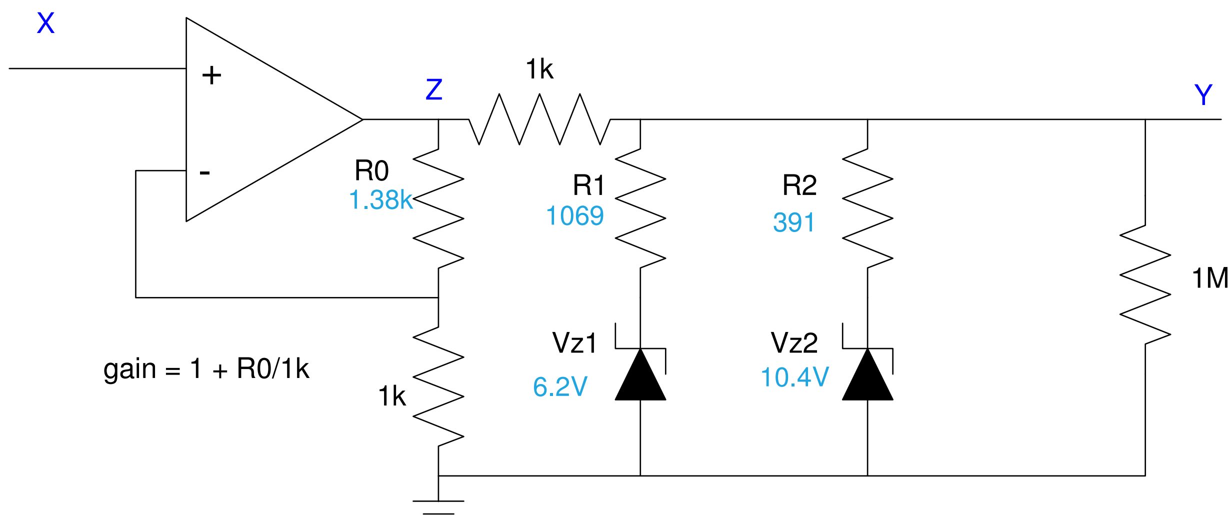
$$R_1 = \left(\frac{1.23}{2.38-1.23}\right)1000 = 1069\Omega$$

R2:

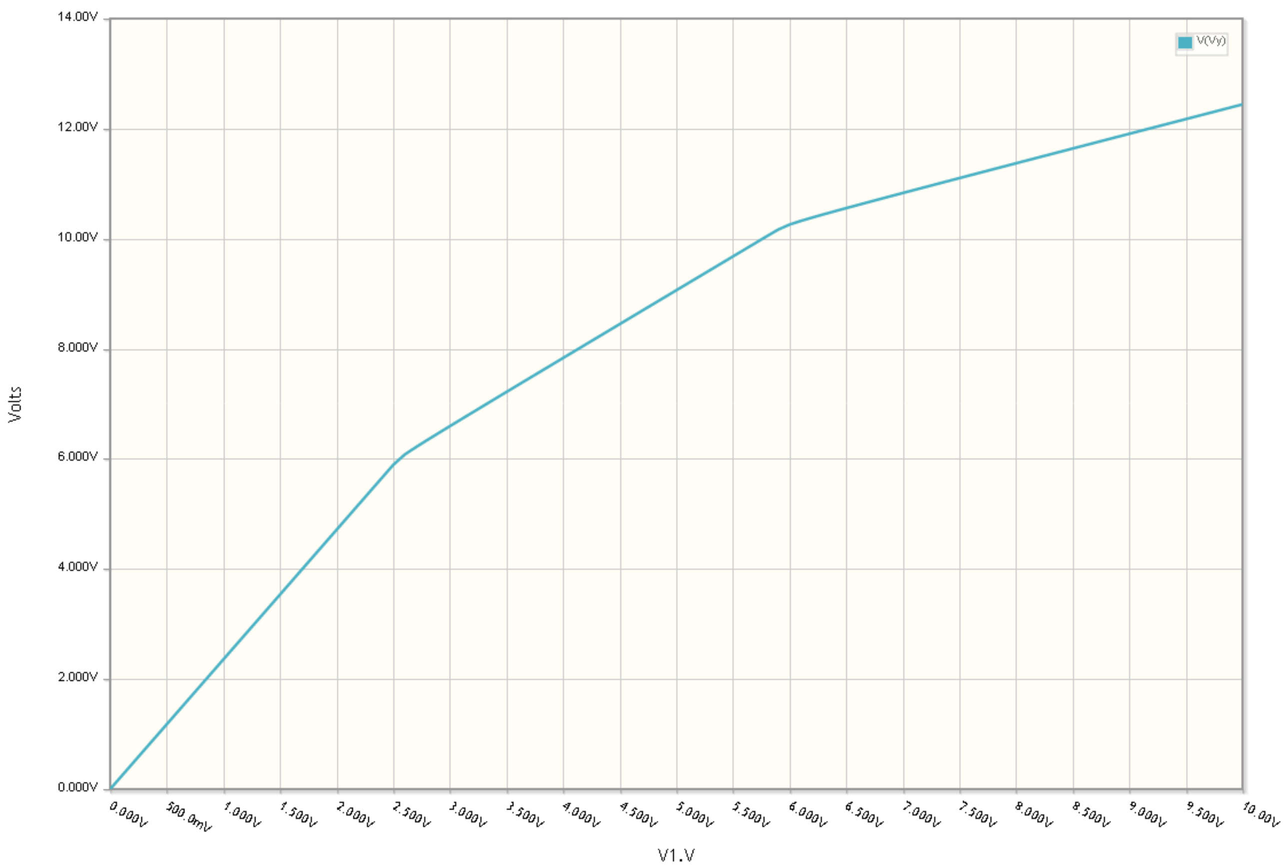
$$\text{Slope} = 0.53 = \left(\frac{R_{12}}{R_{12}+1000}\right)2.38$$

$$R_{12} = R_1 || R_2 = \left(\frac{0.53}{2.38-0.53}\right)1000 = 286.5\Omega$$

$$R_2 = 391.4\Omega$$



4) Check your design in CircuitLab

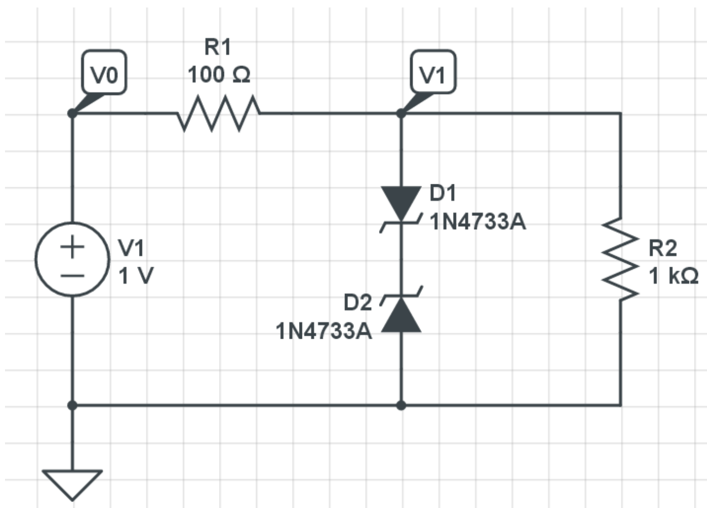


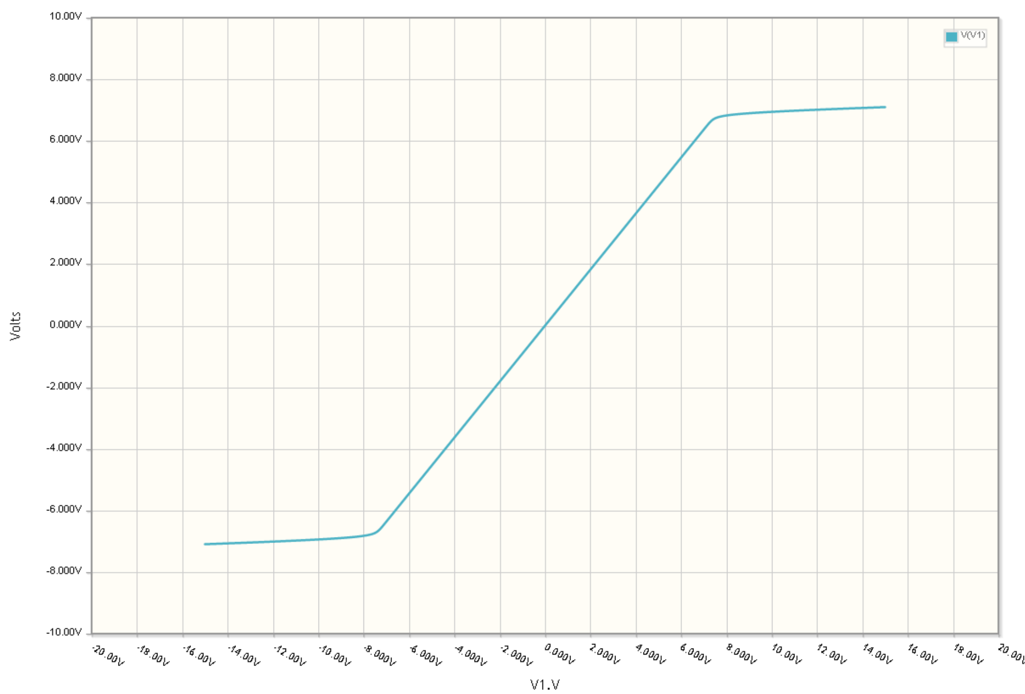
5) Design a circuit which meets the following requirements:

- Input: -10 .. +10V, capable of 100mA
- Output: 1k resistor
- Relationship:

$$V_{out} = \begin{cases} +7V & V_{in} > +7V \\ V_{in} & -7V < V_{in} < +7V \\ -7V & V_{in} < -7V \end{cases}$$

Use a pair of zener diodes with Vz = 6.3V





Transistors

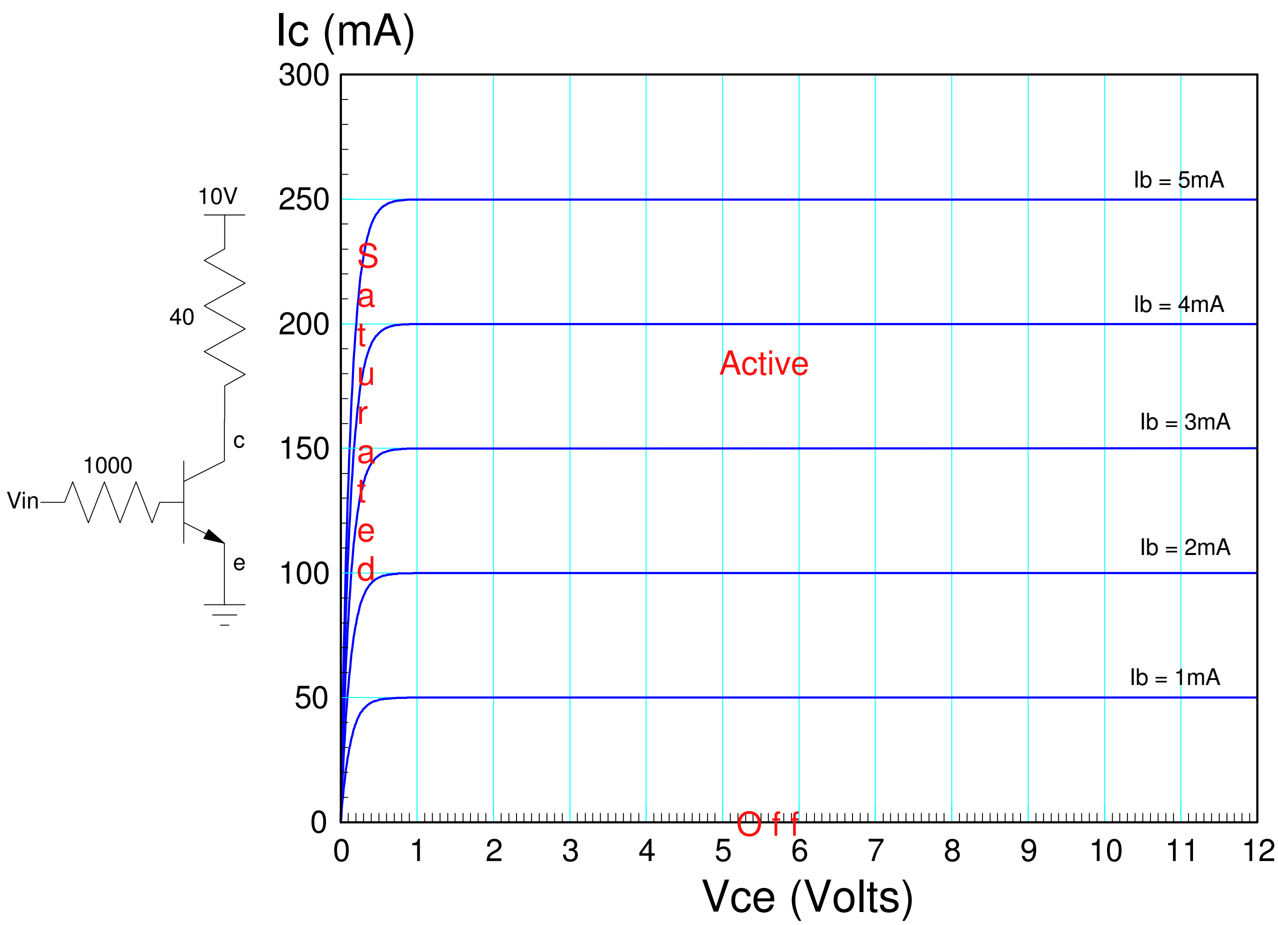
6) Determine the current gain, β, for the transistor show below. Also label the off, active, and saturated regions.

Pick a point in the active region:

When Ib = 5mA, Ic = 250mA

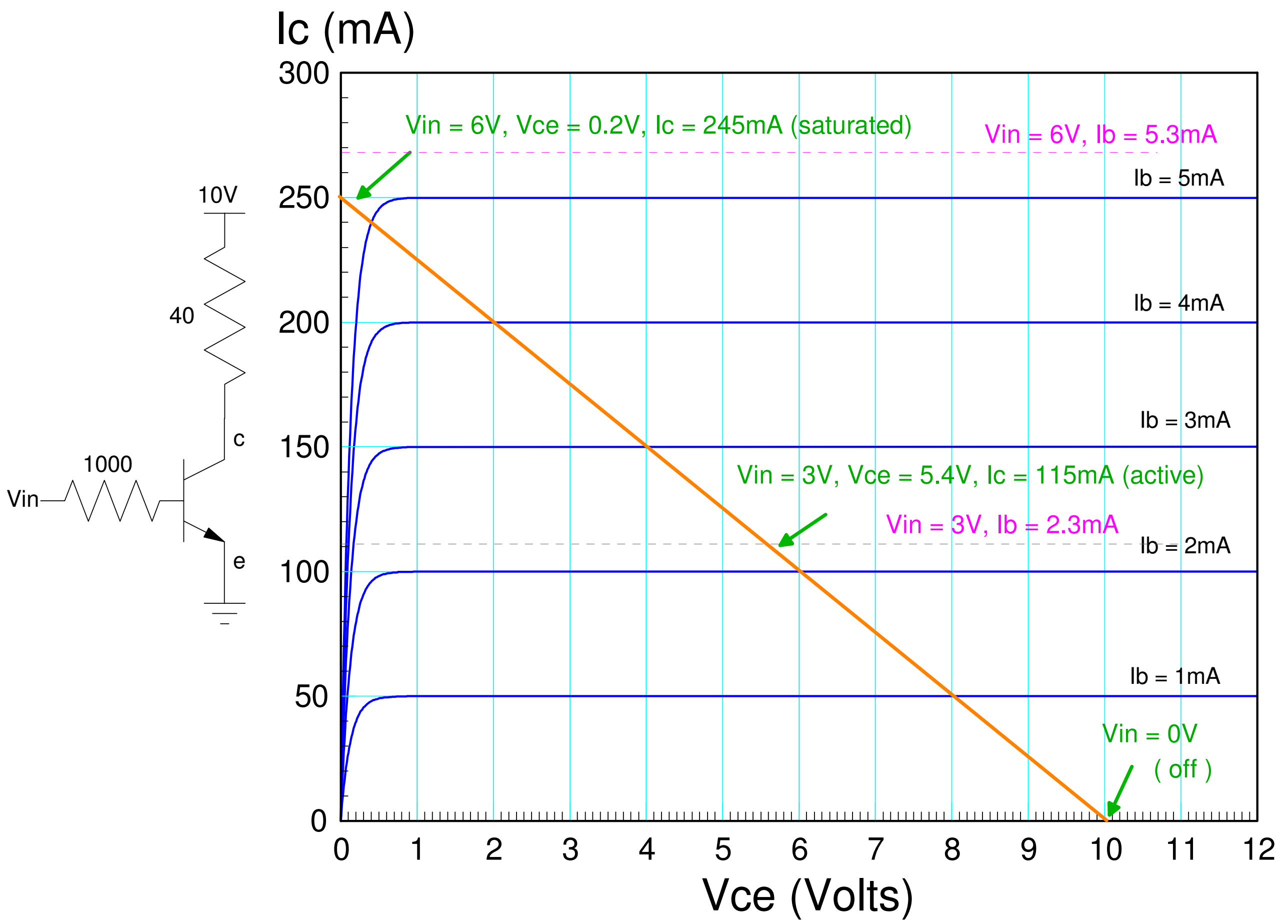
$$\beta I_b = I_c$$

$$\beta = \frac{250mA}{5mA} = 50$$



7) Draw the load-line and determine the Q-point for

- Vin = 0V
- Vin = 3V
- Vin = 6V



Lab (over)

Lab: Please include a photo of your circuit to receive credit for problems 8-10

8-10) Build the following circuit with your electronics kit.

- Measure Vce and Ic for 1k < Rb < infinity.
- Determine the operating point for each conidition and the current gain for your 3904 transistor
- Draw the load line on the graph below and mark each point you measured

Rb	Ib	Vce	Ic	Current Gain (Ic/Ib)	Operating Region (off / active / saturated)
1k br - bl - re	4.25mA	0.01V	4.99 mA	1.174	saturated
10k br - bl - or	428uA	0.06 V	4.94 mA	11.54	saturated
100k br - bl - ye	43.30 uA	3.11 V	1.89 mA	**43.65**	active
1M br - bl - gr	4.410 uA	4.79 V	0.21 mA	**47.62**	active
infinity	0 uA	4.98 V	0 mA	n/a	off