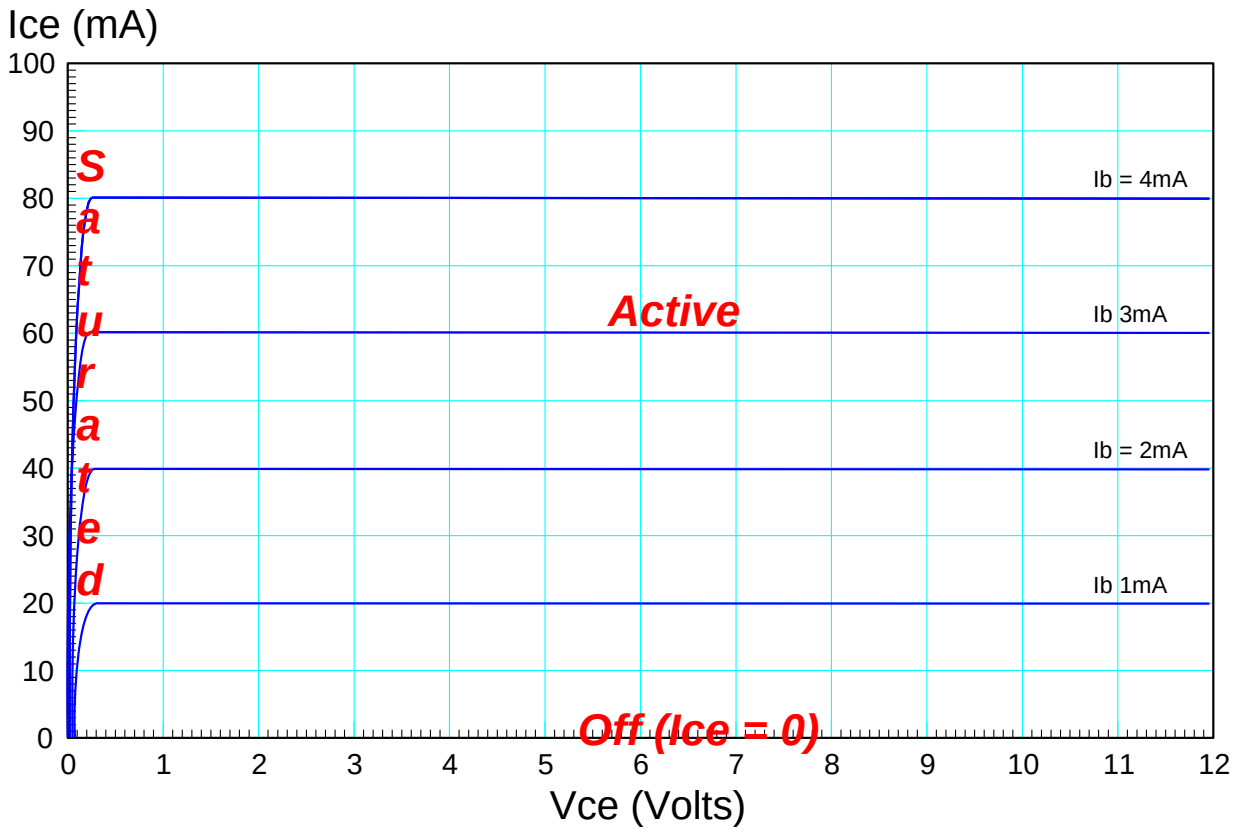
ECE 320: Quiz #6 Name _____ 9:00 / 11:00

Transistor Switch & H-Bridge - February 23, 2017

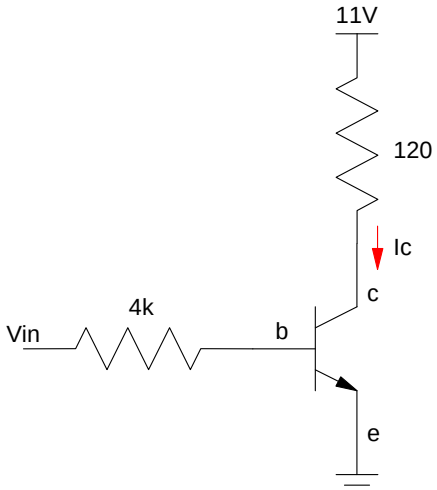
1) The VI characteristic for an NPN transistor is shown on the following plot. From this plot, determine the current gain, β and label the active / saturated / off regions.

Current Gain (beta)	Active / Saturated / Off Regions
20	show on graph



2) Draw the load-line for the following circuit and mark the Q-point (Vce, Ice) for each Vin. Assume a transistor with

- $V_{be} = 0.7V$
- $\beta = 100$
- $V_{ce(sat)} = 0.2V$



a) Vin = 0V

Ib = 0 (not enough voltage to turn on the diode)

b) Vin = 2V

$$I_b = \left(\frac{2V - 0.7V}{4k}\right) = 325\mu A$$

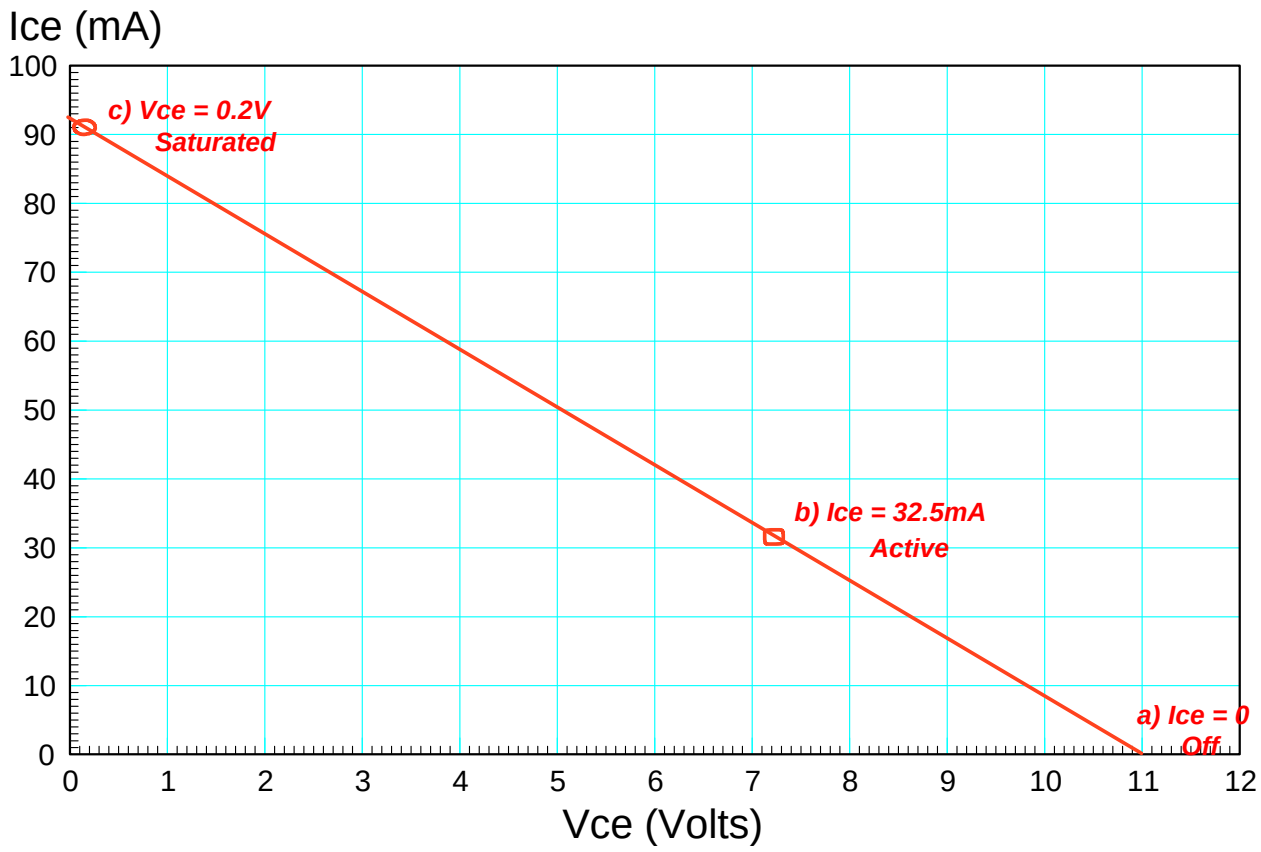
$$I_c = \beta I_b = 32.5mA$$

c) Vin = 5V

$$I_b = \left(\frac{5V - 0.7V}{4k}\right) = 1.07mA$$

$$\beta I_b = 107mA > 91.5mA$$

Saturated: Vce = 0.2V

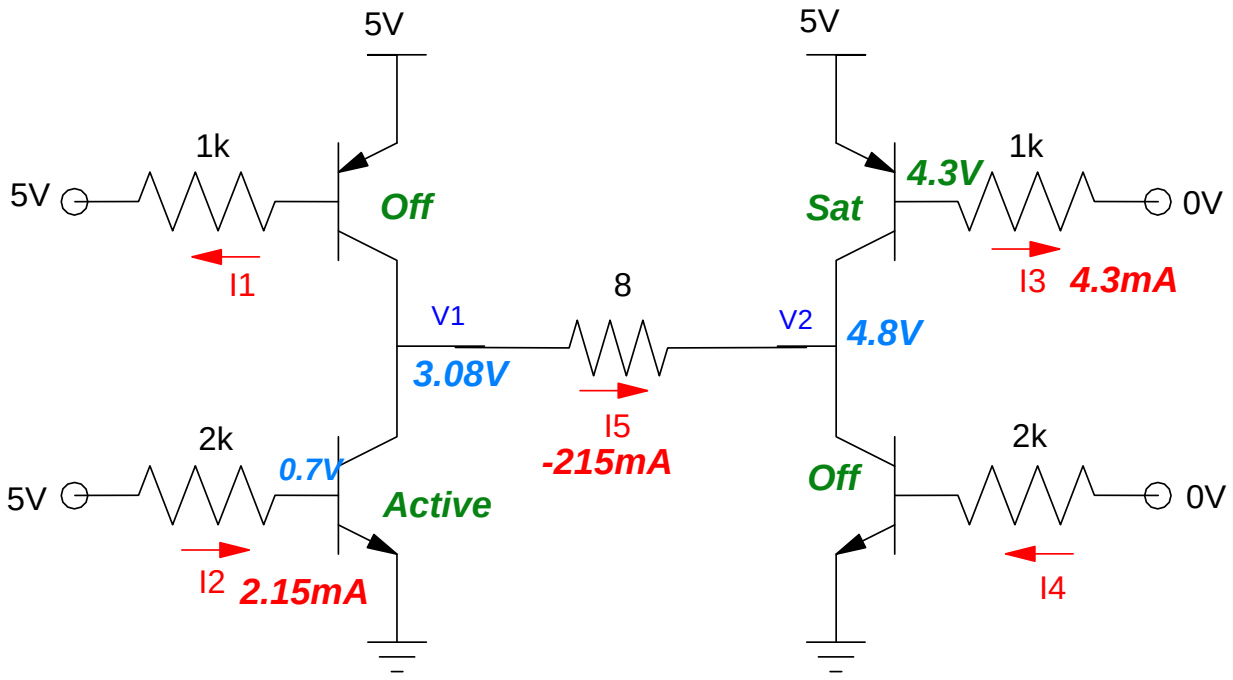


3) Assume each transistor has the following specificaitons:

- β = 100
- Vbe = 0.7V
- Vce(sat) = 0.2V
- Ic(max) = 2A

Determine the currents I1 .. I5

I1	I2	I3	I4	I5
0	**2.15mA**	**4.30mA**	**0**	**-215mA**



$$I_2 = \left(\frac{5V-0.7V}{2k}\right) = 2.15mA$$

$$\beta I_b = 215mA$$

This transistor allows up to 215mA to flow

$$I_3 = \left(\frac{5V-0.7V}{1k}\right) = 4.3mA$$

$$\beta I_b = 430mA$$

This transistor allows up to 430mA to flow

The 8 Ohm resistor limits the total current to

$$\left(\frac{5V-0.2V-0.2V}{8\Omega}\right) = 575mA$$

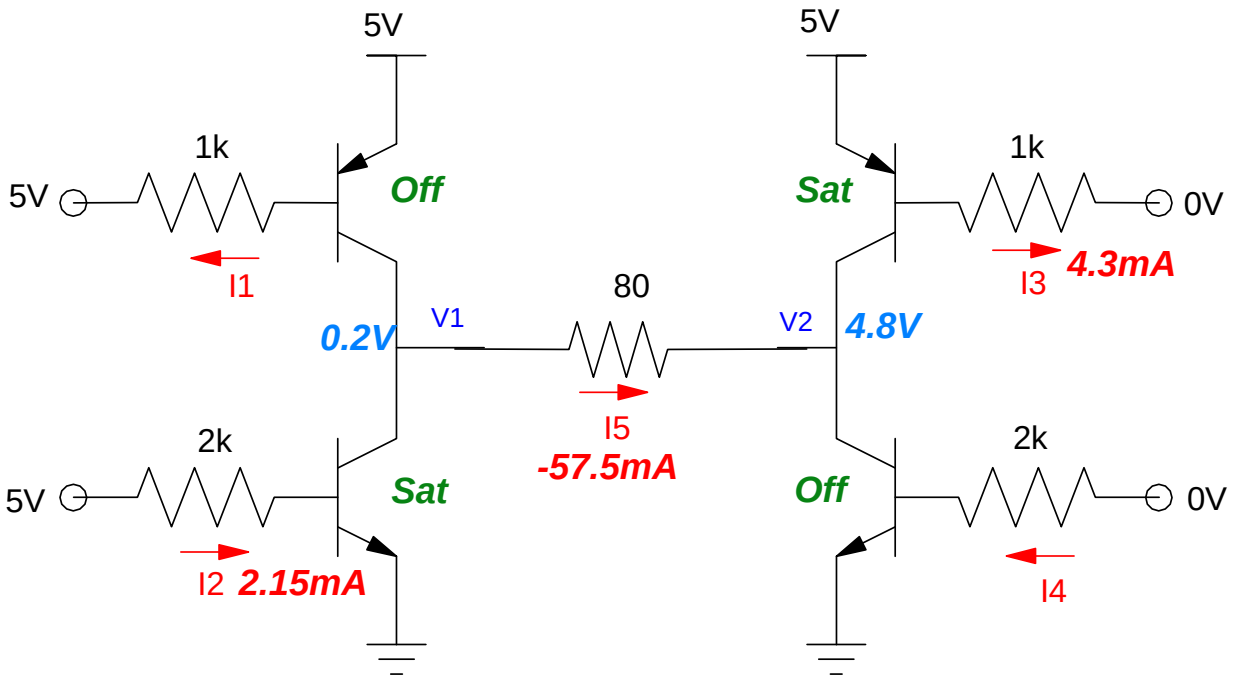
The actual current is the smallest of these three: min(**215mA,** 430mA, 575mA)

4) Assume each transistor has the following specificaitons:

- β = 100
- Vbe = 0.7V
- Vce(sat) = 0.2V
- Ic(max) = 2A

Determine the currents I1 .. I5

I1	I2	I3	I4	I5
0	**2.15mA**	**4.30mA**	**0**	**-57.5mA**



Same as problem #3 but the 80 ohm resistor limits the current to

$$\left(\frac{5V-0.2V-0.2V}{80\Omega}\right) = 57.5mA$$

so I is the minimum of

I = min(215mA, 430mA, **57.5mA**)

5) Determine the voltages and currents for the following transistor circuit. Assume

- $\beta = 100$
- Vbe = 0.7V
- Vce(sat) = 0.2V
- Ic(max) = 2A

Ib	Ic	Ie	Ve
524uA	**52.4mA**	**53mA**	**5.3V**

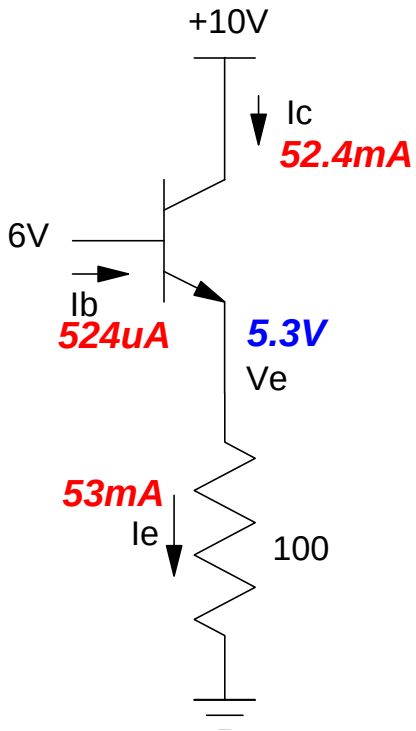
The voltage drop across the diode is 0.7V, so Ve = 5.3V

5.3V across 100 Ohms is 53mA

$$I_e = I_b + I_c$$

$$I_e = I_b + \beta I_b$$

$$I_b = \left(\frac{I_e}{1+\beta}\right) = 524\mu A$$



Bonus! According to the National Renewable Energy Lab, how many kWh could North Dakota produce in wind energy in a given year? (hint: the entire U.S. consumption of electricity in 2015 was 4 trillion kWh).

ans: 1.1 trillion kWh

This is enough to provide 25% of all the electricity used in the United States. At 10 cents / kWh, that would bring in $110 billion to the North Dakota ecomony each year. To put that in perspective, that's more than double the entire state's GDP in 2015.

http://apps2.eere.energy.gov/wind/windexchange/wind_resource_maps.asp?stateab=nd

http://www.nrel.gov/docs/fy00osti/28054.pdf