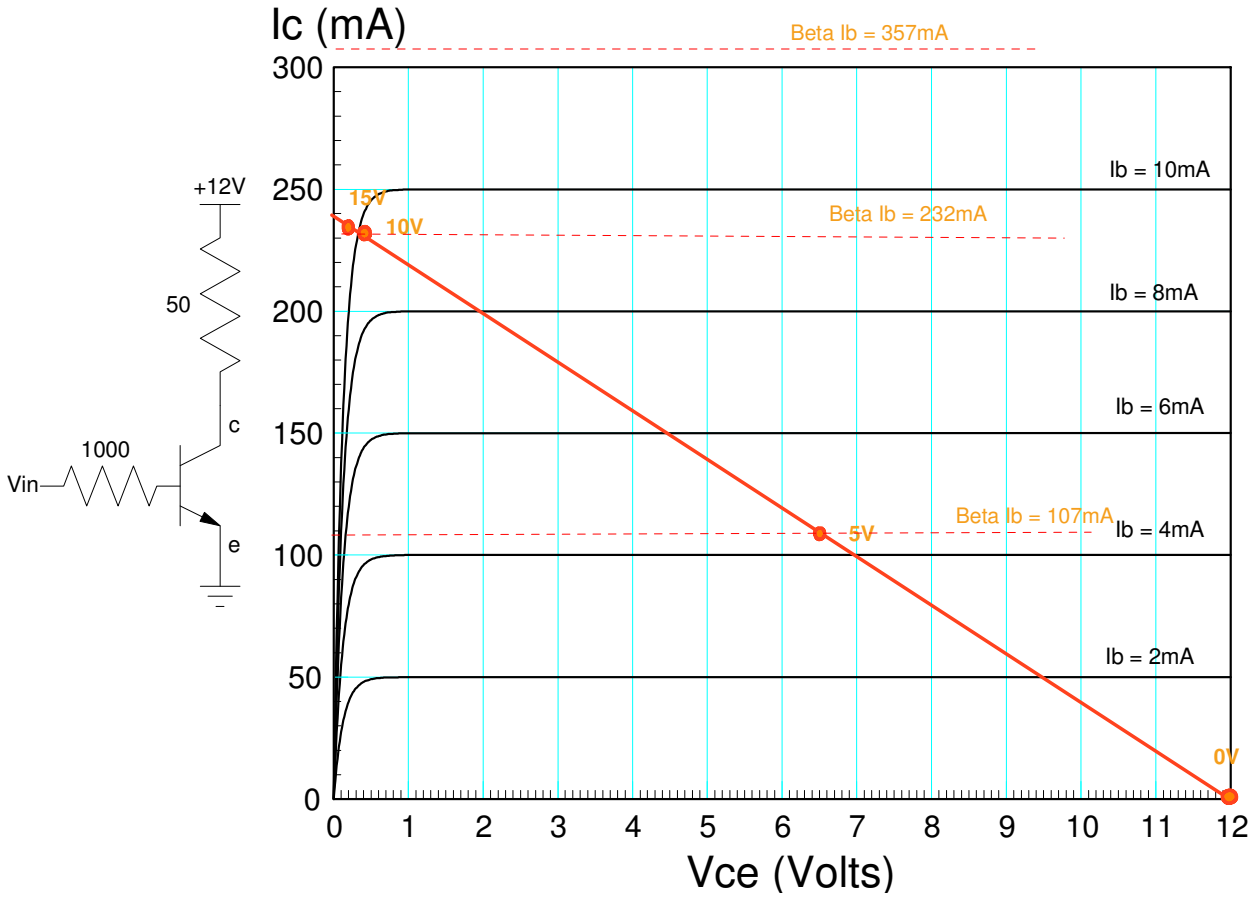
ECE 320 - Solution #5

Transistors, Transistos Used as a Switch. Due Monday, Feb 11th, 2019

Transistors

1) For the following transistor circuit and VI characteristics for the transistor, determine

- The current gain, β $\beta = 25$
- The load line
- The operating point for Vin = {0V, 5V, 10V, 15V}



Vin	0V	5V	10V	15V
Ib	0 mA	4.3 mA	9.3 mA	14.3 mA
beta * Ib	0 mA	107mA	232.5 mA	357.5 mA
Ic	0 mA	107 mA	232.5 mA	236 mA
Vce	12 V	6.65 V	0.375 V	0.2V
	off	active	active	saturated

Problem 2 - 3: Assume a TIP112 transistor (NPN) and TIP117 (PNP) ($0.34 each)

- $\beta = 1000$
- $\min(|V_{ce}|) = 0.9V$
- $\max(I_c) = 4A$
- $V_{be} = 1.4V$

2) Design a circuit to meet the following requirements (i.e. a transistor used as a switch)

- Input: 0V / 5V binary signal capable of 20mA
- Output: DC Motor which draws 200mA @ 10V
- Relationship:
- When Vin = 0V, 0V is applied to the motor
- When Vin = 5V, 10V is applied to the motor +/- 1V

What matters is the current. When the motor is on, it draws 200mA. Design a circuit to turn on and off 200mA

On the collector side, you don't have to do anything: just connect the motor to power and ground (with a transistor in series to act as a switch)

On the base side, the base current you need to saturate the transistor is

$$\beta I_b > I_c$$

$$1000 I_b > 200mA$$

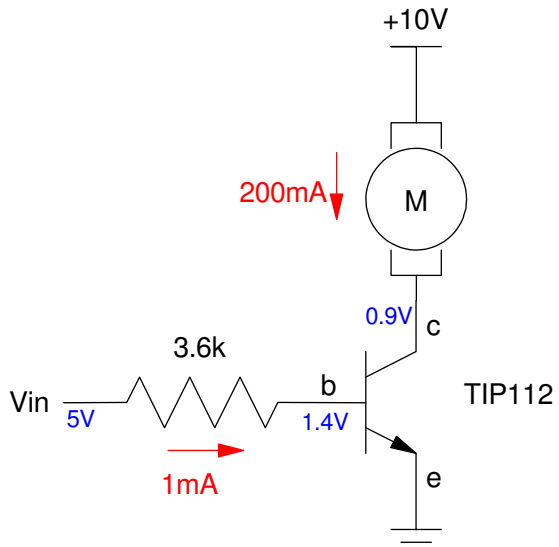
$$I_b > 200\mu A$$

Pick someting larger than 200uA but less than 20mA (the most the function generators can output). Let

$$I_b = 1mA$$

Then

$$R_b = \left(\frac{5V - 1.4V}{1mA}\right) = 3.6k\Omega$$

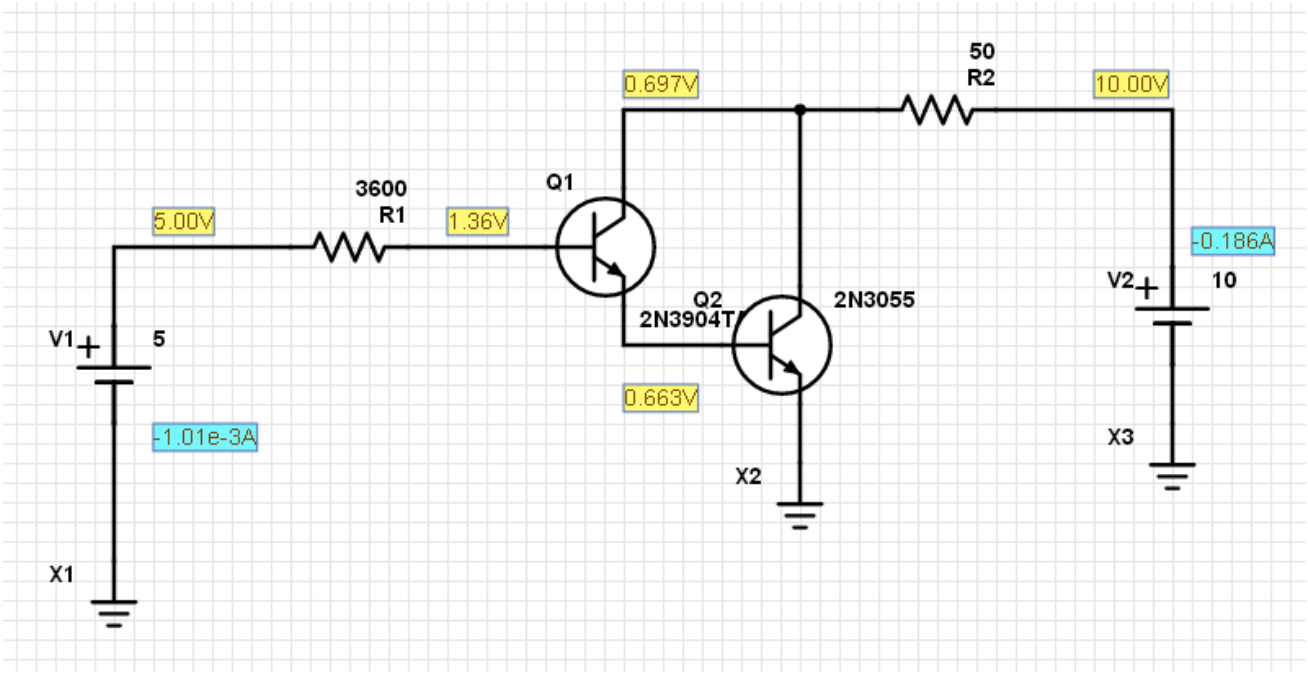


3) Check your design in PartSim

4) Check your design in lab.

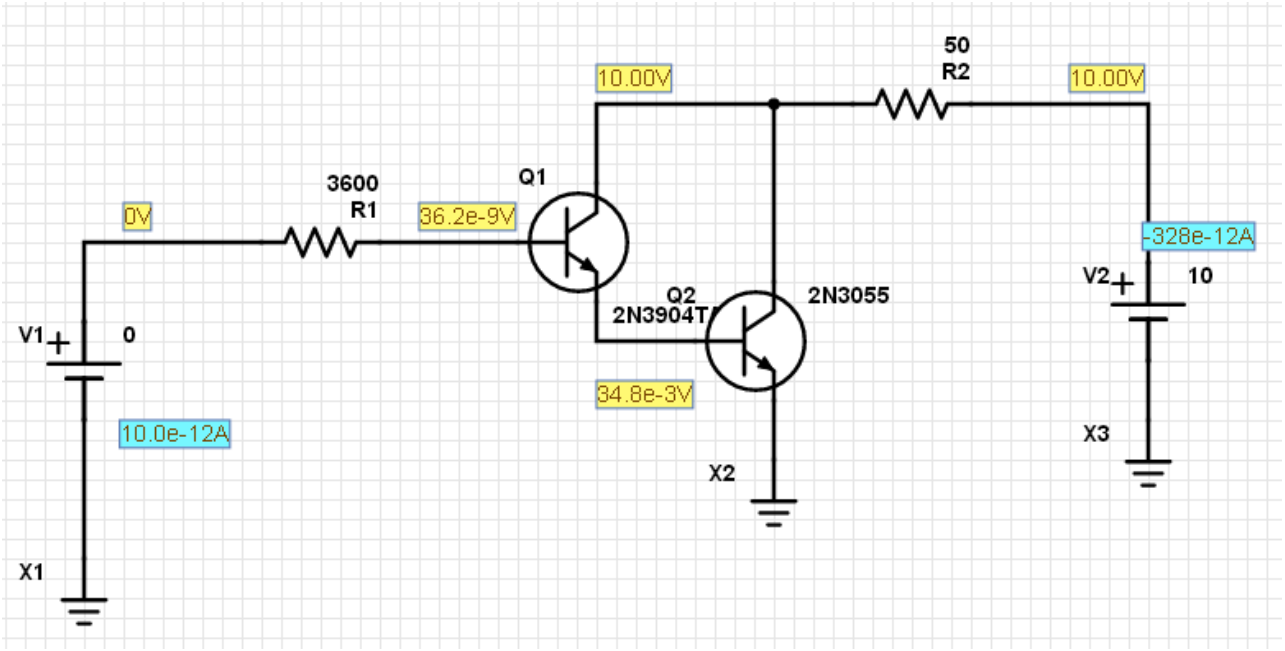
- Model th emotor as a 50 Ohm resistor (200mA @ 10V)
- When Vin = 0V, is 0A flowing ni the motor?
- When Vin = 5V, is 200mA flowing through the motor (i.e. the 20 Ohm resistor)?

Motor On: Vin = 5V, Imotor = 186mA



Vin = 5V (on)	Calculated porblem 2	Simulated problem 3	measured problem 4
Vin	5.0V	5.00 V	5.00 V
Vbe	1.4V	1.36 V	1.404 V
Vce	0.9V	0.697 V	0.87 V
Ic	182mA	186 mA	0.2 A

Motor Off: Vin = 0V, Imotor = 0mA



Vin = 0V (off)	Calculated porblem 2	Simulated problem 3	Measured problem 4
Vin	0.0V	0 V	0 V
Vbe	0 V	36.2 nV	0 V
Vce	10 V	10.00 V	10.0 V
Ic	0 mA	328 pA	0 A