

# ECE 320 - Solution to Homework #5

H-Bridge - DC to AC Converters Due Monday, February 23rd

(no lab this week)

H-Bridge:

1) Design a circuit using NPN and PNP transistors which allows you to run a 12V DC motor forward (+12V) or in reverse (-12V).

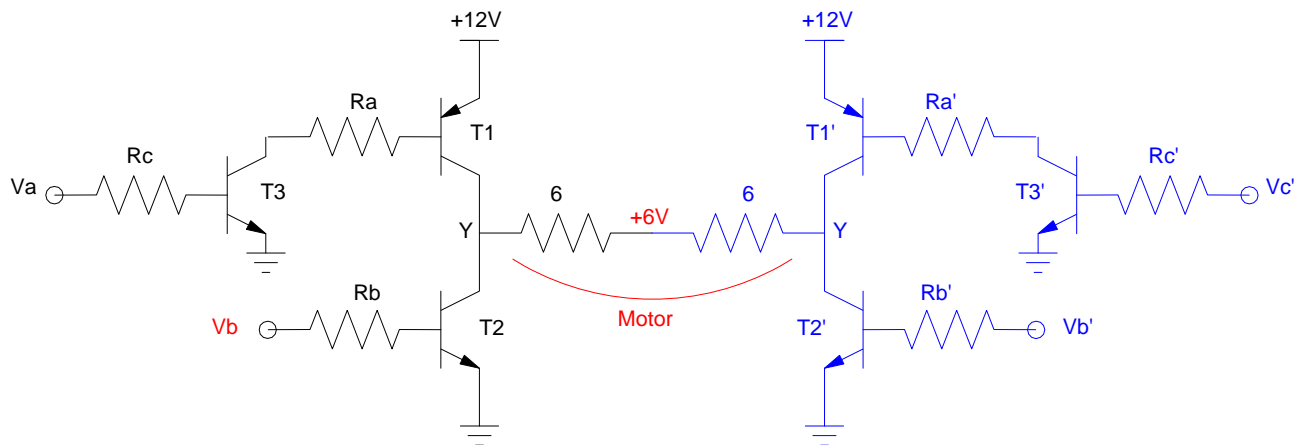
- Input:
  - 0V / 5V signals, <20mA
  - Single +12V DC power supply, capable of 3A
- Output:
  - 12V DC Motor
  - Draws < 1A
- Relationship:
  - You can make the motor run forward (+12V), reverse (-12V), or coast ( $I_m = 0$ )

First, model the motor as a 12 Ohm resistor

- Draws 1A @ 12V

Next, add an H-bridge. The two halves are symmetric so you only need to analyze the left side.

Assume transistors have a gain of 100:



To turn on T2 at 1A

$$V_b = 5V$$

$$I_{b2} > \frac{1A}{\beta} = 10mA$$

Let  $I_{b2} = 15\text{mA}$

$$R_b = \frac{5V - 0.7V}{15mA} = 287\Omega$$

To saturate T1:

$$I_b > \frac{I_c}{\beta} = 10mA$$

Let

$$I_b = 15mA$$

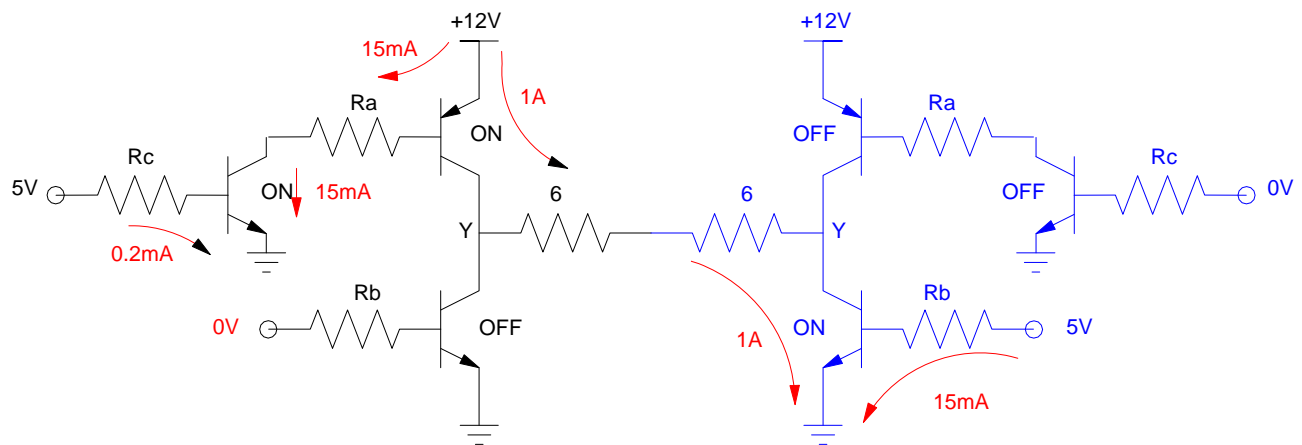
$$R_a = \frac{11.3V - 0.2V}{15mA} = 740\Omega$$

To saturate T3:

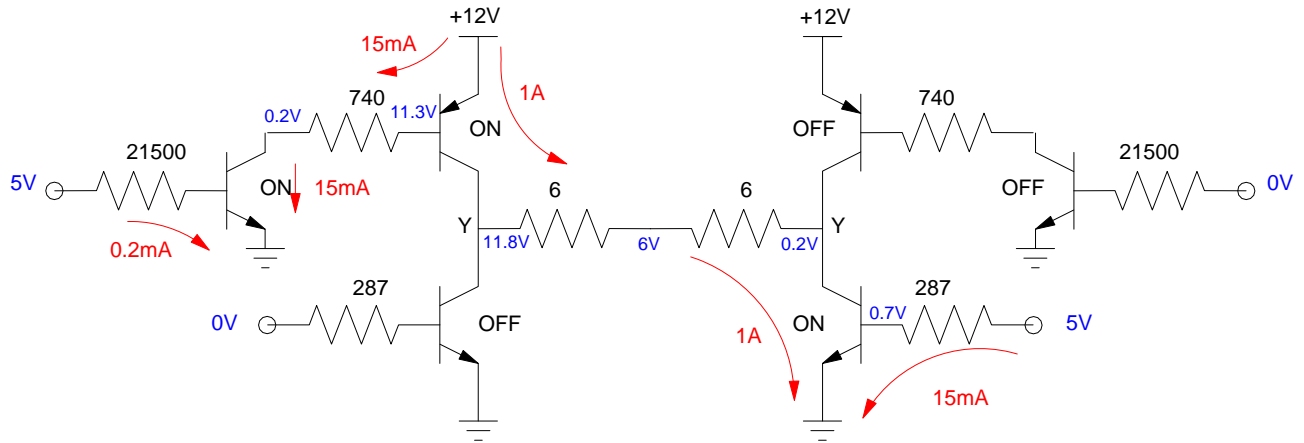
$$I_b > \frac{I_c}{\beta} = \frac{15mA}{100} = 0.15mA$$

Let  $I_b = 0.2\text{mA}$

$$R_c = \frac{5V - 0.7V}{0.2mA} = 21500$$



2) Specify the voltages and currents when the motor is running full forward



### 3) Check your calculations in simulation

