## ECE 320 - Homework \#5

Transistors used as a Switch, H-Bridges. Due Wednesday, February 10th

## Transistor Switch

Assume a TIP112 transistor (NPN) and TIP117 (PNP) (\$0.34 each)

$$
\beta=1000 \quad \min \left(\left|V_{c e}\right|\right)=0.9 \mathrm{~V} \quad \max \left(I_{c}\right)=4 A
$$

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

Input: $0 \mathrm{~V} / 5 \mathrm{~V}$ binary signal capable of 20 mA

- Output: DC Motor which draws 200mA @ 10V


## Relationship:

- When Vin $=0 \mathrm{~V}, 0 \mathrm{~V}$ is applied to the motor
- When Vin $=5 \mathrm{~V}, 10 \mathrm{~V}$ is applied to the motor $+/-1 \mathrm{~V}$

2) Check your design in PartSim

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

3) Check your design in lab.

- When Vin $=0 \mathrm{~V}$, are the voltages and currents what you calculated and simulated?
- When Vin $=5 \mathrm{~V}$, are the voltages and currents what you simullated?

| Vin = 0V (off) | Calculated <br> problem 1 | Simulated <br> problem 2 | Measured <br> problem 3 |
| :---: | :---: | :---: | :---: |
| Vin | 0.0 V |  |  |
| Vbe |  |  |  |
| Vce |  |  |  |
| Ic |  |  |  |


| Vin $=5$ V (on) | Calculated <br> problem 1 | Simulated <br> problem 2 | Measured <br> problem 3 |
| :---: | :---: | :---: | :---: |
| Vin | 5.0 V |  |  |
| Vbe |  |  |  |
| Vce |  |  |  |
| Ic |  |  |  |

## H-Bridges

4) Determine the voltages and currents for the following H-bridge. Assume TIP transistors

- $\quad|\mathrm{Vbe}|=1.4 \mathrm{~V}$
- $\beta=1000$
- $\mathrm{V}_{\mathrm{ce}(\mathrm{sat})}=0.9 \mathrm{~V}$


5) Design an H-Bridge cable of running a DC servo motor forward ( +10 V ), reverse ( -10 V ) and stop ( 0 V ). Assume the DC servo motor draws 200 mA @ 10 V .
6) Check your design for problem \#2 in PartSim (or similar program)
7) Lab: Build your circuit in lab and verify it works for all three states (forward, reverse, stop).

- note: Check Vce. If it's 0.9 V , the transistor is saturated (on)

