THE HONG KONG UNIVERSITY OF SCIENCE AND TECHNOLOGY
Department of Electronic and Computer Engineering
ELEC 1100

Laboratory 4: Transistor and Motor Interface (5%)

A) Objectives:

- To study transistor characteristics.
- To control the DC motor with ICs.

B) Equipment:

- Bipolar junction transistor (NPN: P2N2222A, PNP: PN2907A), H-Bridge Driver L293

C) Experiment Procedures:

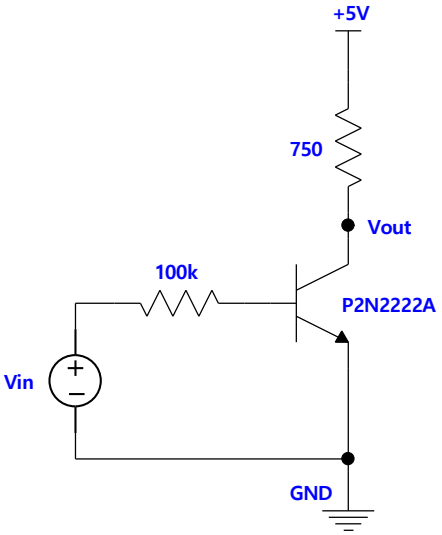
Experiment 1: Transistor Analysis (~30 mins)

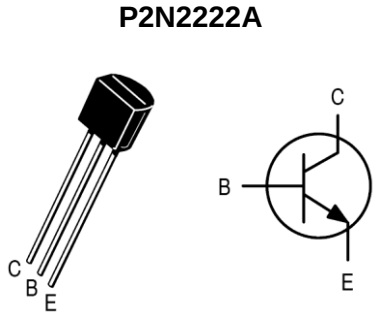
Follow the steps below to study the characteristics of an NPN transistor (P2N2222A).

Step 1: Switch off the power supply and turn all the knobs fully anticlockwise.

Step 2: Construct the circuit shown in Figure 1. Connect the Master Channel of the power supply to +5V of the circuit, and the Slave Channel to V_{in}. Remember that both –ve terminals must connect to the Emitter (E) of transistor as GND as shown in the Figure.

Figure 1





Step 3: Switch on the power supply. Set the current limits for both channels as in Lab#1.

Step 4: Set Master Channel to 5V. Set V_{in} (Slave Channel) to $(1 + \frac{x}{10})$ V. Measure V_{out}.

Note: let x be the number represented by the last digit of your own student ID. For example, if your student ID is 12345678, then x = 8.

****** TA Check 1: Show your measured value of V_{out} to your TA. Each member of a group should demo once, using your own student ID for x.**

Q1: Write down the measured voltage V_{out}.

Step 5: Set V_{in} = 0V. Slowly increase V_{in} from 0V to 5V, 0.2V at a time. Measure V_{out} and fill in the table in the summary sheet.

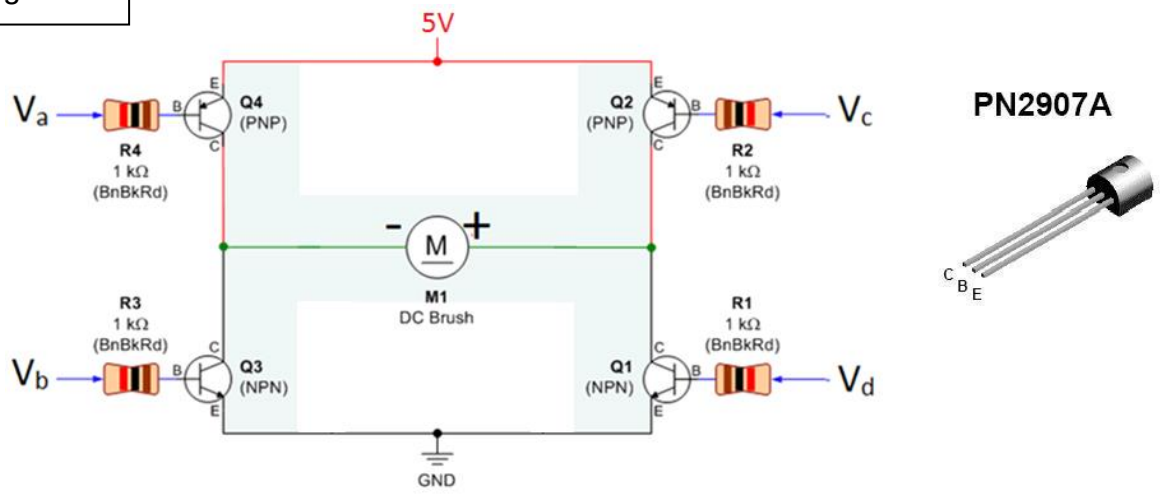
Q2: Complete the table in the summary sheet.

Experiment 2: Transistor as H-Bridge Motor Driver (~30 mins)

Warning: In this experiment, do NOT use the "fixed 5V" as the 5V power supply. Use the two controllable power supplies instead. Also, limit the current to around 0.5A.

Step 1: Use **NPN (P2N2222A)** and **PNP(PN2907A)** transistors. Build the circuit shown in Figure 2 below. Note the pin assignment of the PNP transistor.

Figure 2



Step 2: Provide suitable DC voltage inputs to V_a, V_b, V_c, V_d (either 5V or 0V for each of them) such that the motor turns, with current flowing from its positive to negative end.

Q3: What are the voltage values of V_a, V_b, V_c, V_d?

Step 3: Provide suitable DC voltage inputs to V_a, V_b, V_c, V_d (either 5V or 0V for each of them) such that the motor turns in the opposite direction (with current flowing from its negative to positive end).

Q4: What are the voltage values of V_a, V_b, V_c, V_d?

****** TA Check 2: Show your TA that your motor turns and turns in opposite direction.**

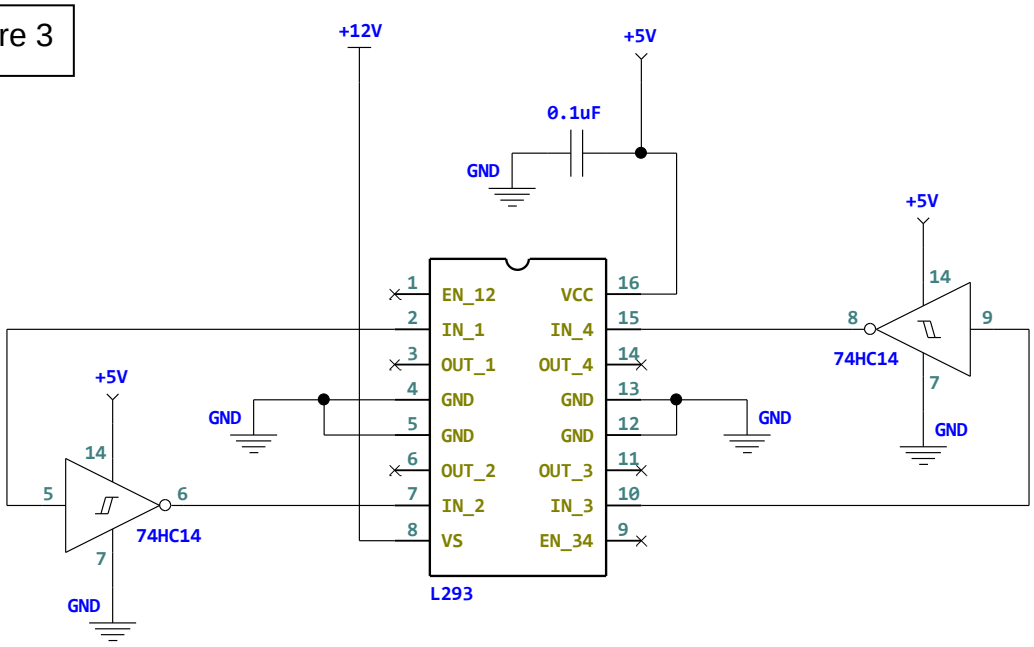
Experiment 3: H-Bridge Driver (~30 mins)

Step 1: As in previous labs, connect the power supply to your breadboard and set it to **12V**. Measure the input and output voltages of your LM7805 regulator. You should have a regulated 5V from 12V.

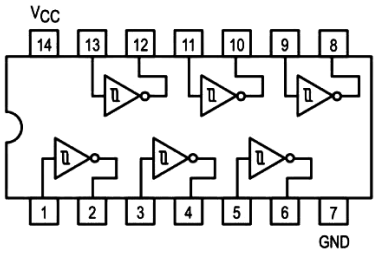
Step 2: Connect a driver circuit using L293 and 74HC14 as shown in Figure 3 below.

Note: Be clear about where the 12V and 5V are from your breadboard and be careful with the process so that you do not burn any IC. If you notice anything wrong, **TURN OFF** the **power supply** and check again, or ask your TAs for help.

Figure 3

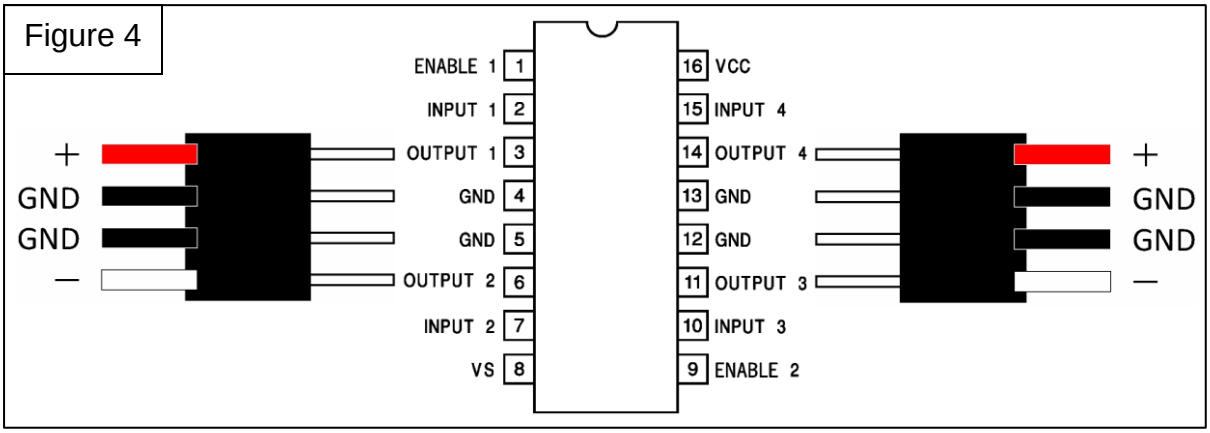


74HC14 is the Schmitt-Trigger Inverter you used in Lab3. As shown in the illustration, there are six inverters inside the package and they are independent to each other. You may choose whichever is available and convenient according to your breadboard layout.



Step 3: As shown in Figure 4 below, connect motor headers to both sides of L293.

Figure 4



Step 4: Apply voltage at Pin 1 and Pin 9 to 5V both.

Step 5: Connect **Pin 2** and **Pin 10** to 0V (ground) for now.

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TA Check 3: Demo to your TA that

(1) the two motors turn;

(2) the two motors can turn in opposite direction by changing Pin 2 & 10 voltages from 0V to 5V.

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This Experiment demonstrates how to use L293 to control the rotation of a DC motor.

- *Pin 2* changes the polarity (**rotating direction**) between pins 3 and 6.
- *Pin 10* changes the polarity (**rotating direction**) between pins 11 and 14.

This also reveals L293 can control two independent motors at the same time.

Remember to clean up your bench! A messy table will cost 3 points.