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

Laboratory 4: Transistor and Motor Interface (4%)

A) Objectives:

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

B) Equipment:

- Bipolar junction transistor (NPN: P2N2222A), Motor driver L293

C) Prelab (solution included)

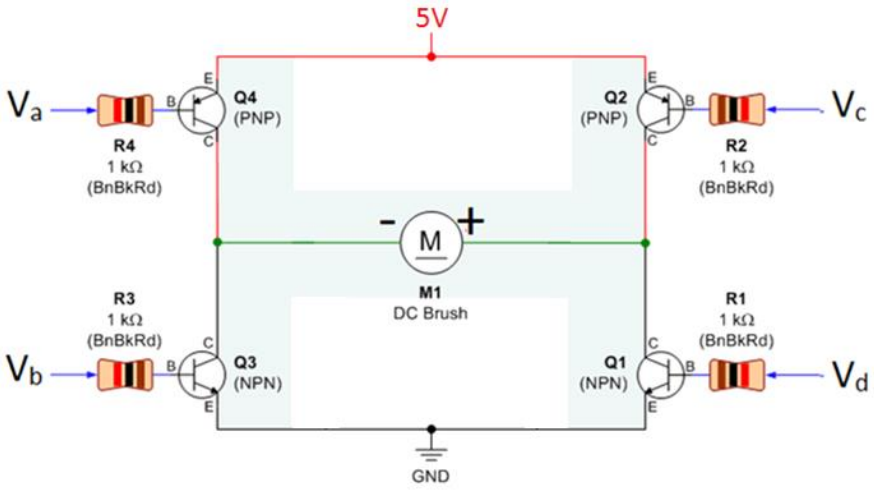
- Q1 In the circuit of Experiment 1, if V_{in} = 2V and β of the transistor is 200, what should be the voltage at V_{out}?

  $V_{out} = 5 – [(2 – 0.7) / 100k] * 200 * 750 = 3.05V$

- Q2 In the circuit shown below.

  What are the voltage values of V_a, V_b, V_c, V_d (either 5V or 0V for each of them) when the motor turns with current flowing from its positive to negative end? **5V, 5V, 0V, 0V**

  What are the voltage values of V_a, V_b, V_c, V_d (either 5V or 0V for each of them) when the motor turns in the opposite direction? **0V, 0V, 5V, 5V**



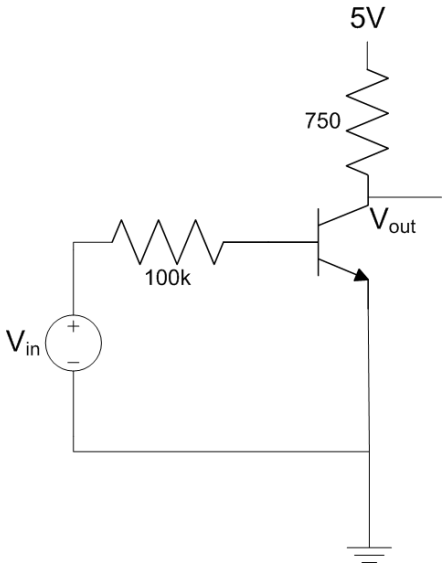
- Q3 Draw the breadboard connection of Experiment 2.

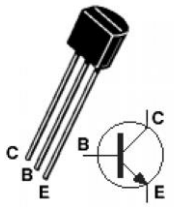
  (Check with your partner or refer to Tutorial slides)

D) Experiment Procedures:

Experiment 1: Transistor Analysis (~50 mins)

Step 1: Use **NPN (P2N2222A)** transistor. Connect the circuit shown in the figure below.





NPN: P2N2222A

Q1: Suggest a reason why the 100kΩ resistor has to be added.

Step 2: Set V_{in} = (2 + $\frac{x}{10}$) V. Measure V_{out}.

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

Q2: Write down the voltage V_{out}.

Step 3: 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.

Q3: Complete the table in the summary sheet.

Q4: Plot V_{out} against V_{in}. This is called the "Voltage Transfer Curve".

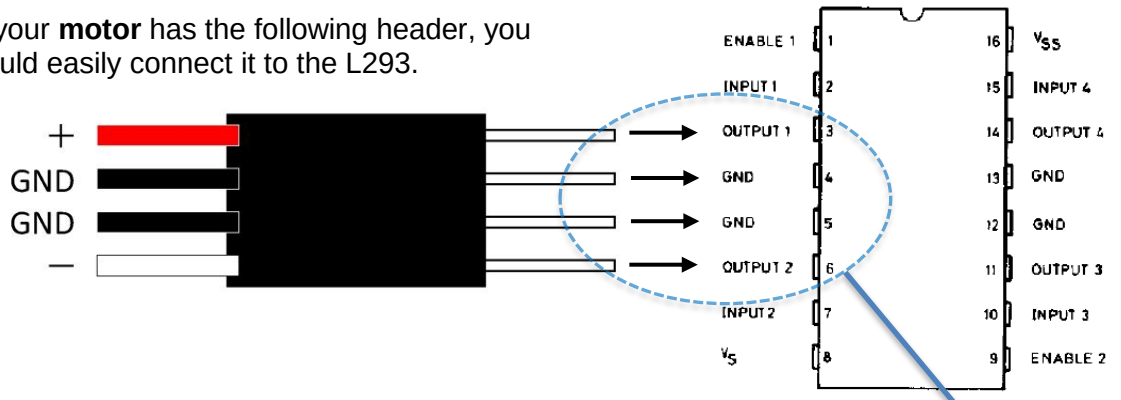
Experiment 2: H-Bridge DC Motor Driver (~50 mins)

Step 1: Connect the motor driver (L293) circuit shown at next page on your breadboard. (74LS14 is the Schmitt Trigger you used at lab02).

Notice that you need **two different power supplies** in this part and be careful with the process so that you do not burn any IC.

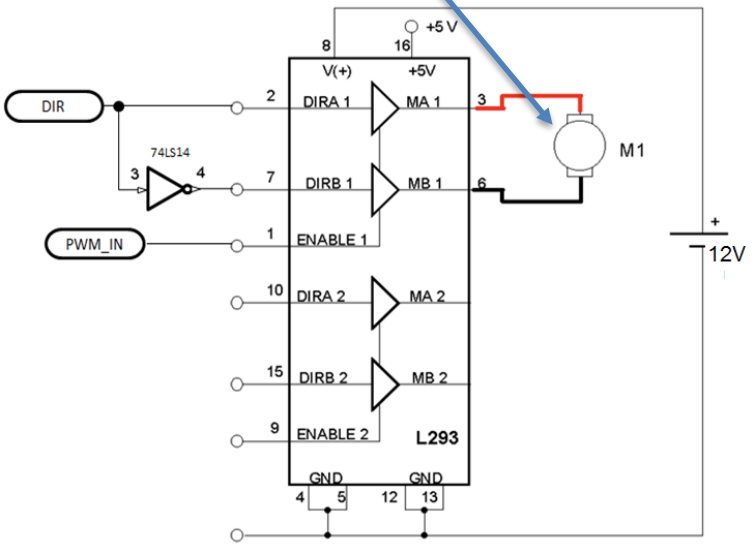
If you notice anything wrong, **TURN OFF** the **power supply** and check again, or ask your TAs for help.

If your **motor** has the following header, you could easily connect it to the L293.



In the figure, **DIR** and **PWM_IN** are diagram labels indicating particular input functions.

- **DIR** is for controlling the rotate **direction** of **motor**.
- **PWM_IN** is for controlling the rotational **speed** of **motor**.



L293: Push-pull four channel driver

Step 2: Confirm the PWM signal at Pin 7 of your comparator 74HC85 (from lab03) with $Q_3Q_2Q_1Q_0$=1000 set on DIP switch (duty cycle = 50%).

Demo to your TA and get his/her signature.

Step 3: Use the PWM output confirmed at step 2 to be **PWM_IN** to pin 1 of L293 shown above.

Step 4: Set **DIR** to ground (0V), your motor should be turning in one direction. Change the **DIR** to 5V. Demo to your TA that the motor is turning in the opposite direction.

Step 5: Change the manual input Q by modifying the DIP-switches.

Q5: Which setting of Q gives you the fastest rotation to your motor?

Q6: Which setting of Q gives you the non-stop slowest rotation to your motor?

Q7: Which setting of Q stops the motor (without vibration or noise from motor)?

Important: The motor driver circuit is part of your project.

Arrange it nicely and keep it on your breadboard.

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

ELEC 1100 Laboratory 4: Summary Sheet

Group Number: _____

Name: _____ Lab Partner: _____

Student ID: | | | | | | | | | Student ID: | | | | | | | | |

Experimental Part

Experiment 1: Transistor Analysis

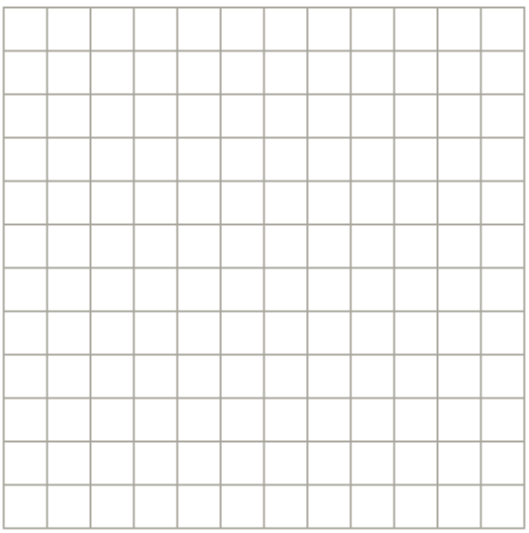
Q1: Suggest a reason why the 100kΩ resistor has to be added. _____

Q2: Write down the voltage V_{out}. _____ (Use your own student ID to give V_{in})

Q3: Complete the table in the summary sheet.

V_{in} (V)	0	0.2	0.4	0.6	0.8	1	1.2	1.4	1.6
V_{out} (V)									
V_{in} (V)	1.8	2	2.2	2.4	2.6	2.8	3	3.2	3.4
V_{out} (V)									
V_{in} (V)	3.6	3.8	4	4.2	4.4	4.6	4.8	5	
V_{out} (V)									

Q4: Plot V_{out} against V_{in}. This is called the “Voltage Transfer Curve”.



Experiment 2: H-Bridge DC Motor Driver

Demo: Confirm the PWM signal at Pin 7 of comparator 74HC85.

TA's Signature: _____

Demo: The motor is turning in the opposite direction (by changing DIR from 0V to 5V).

TA's Signature: _____

Q5: Which setting of Q gives you the fastest rotation to your motor?

Q: (Q3) _____ (Q2) _____ (Q1) _____ (Q0) _____

Q6: Which setting of Q gives you the non-stop slowest rotation to your motor?

Q: (Q3) _____ (Q2) _____ (Q1) _____ (Q0) _____

Q7: Which setting of Q stops the motor (without vibration or noise from motor)?

Q: (Q3) _____ (Q2) _____ (Q1) _____ (Q0) _____