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 and PNP), H-Bridge Driver L293

C) Experiment Procedures:

Reminder: Find "Breadboard Small" in Tinkercad to build each simulation circuit on it.

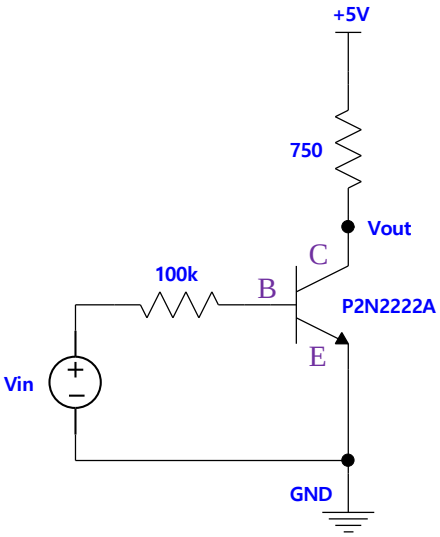
Simulation 1: Transistor Analysis [Lab#04_S1]

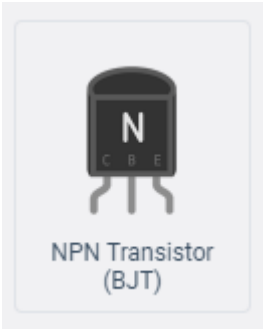
Follow the steps below to study the characteristics of an NPN transistor.

Step 1: Create a new circuit in **Tinkercad** and change the circuit name.

Step 2: Find "NPN Transistor" in the instrument list and construct the circuit shown in Figure 1 below.

Figure 1





Step 3: In this experiment, you need two "Power supply". Use Power Supply 1 to generate 5V. Use Power Supply 2 to generate V_{in}.

Step 4: Set V_{in} to be $(1 + \frac{x}{10})$ V. Use Multimeter to 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.**

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.

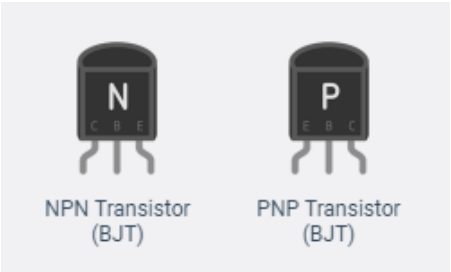
Q2: Complete the table in the summary sheet.

Simulation 2: Transistor as H-Bridge Motor Driver [Lab#04_S2]

Follow the steps below to construct the H-bridge using four transistors.

Step 1: Create a new circuit in **Tinkercad** and change the circuit name.

Step 2: Find **NPN** and **PNP** transistors in the instrument list and construct the circuit shown in Figure 2 below. Note the pin assignment of the PNP transistor (You may refer to Tutorial notes for the breadboard arrangement).



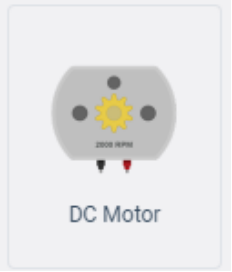
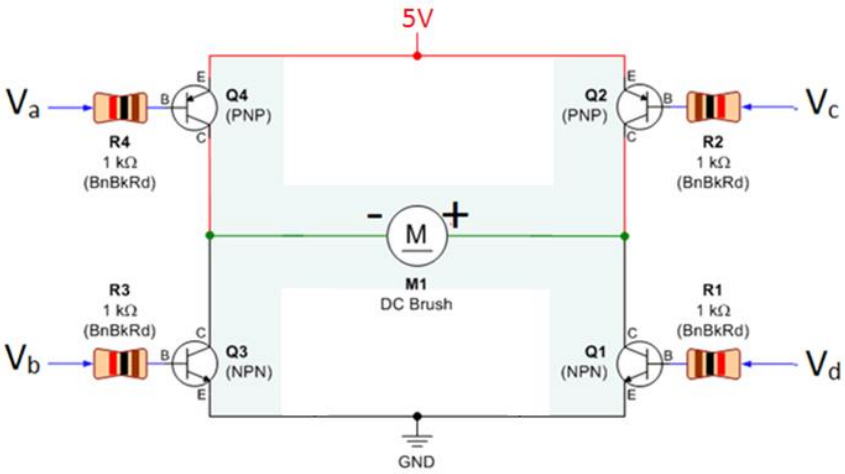


Figure 2



Step 3: Use "Power Supply" to 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.

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

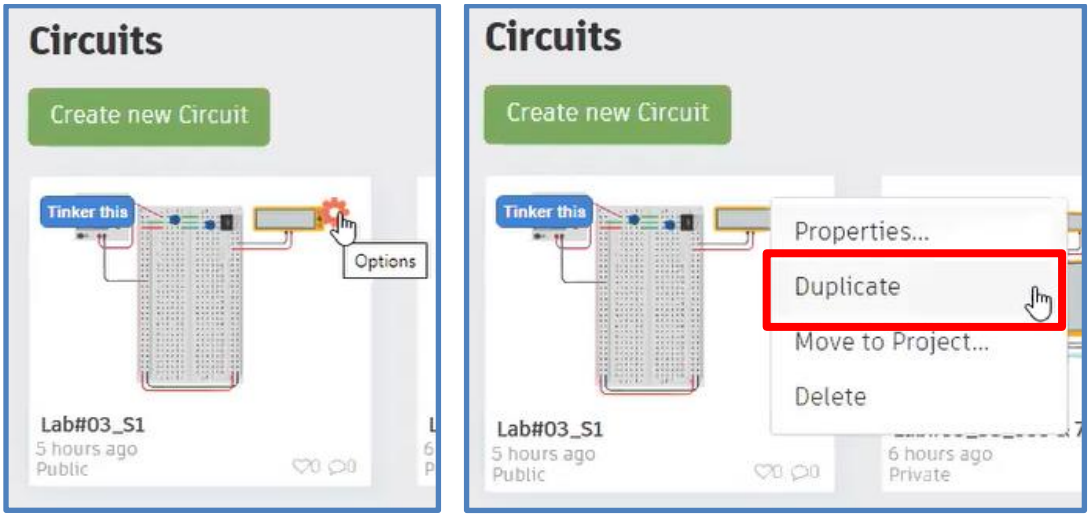
Step 4: Use “Power Supply” to provide suitable DC voltage inputs to V_a, V_b, V_c, V_d (either 5V or 0V for each of them) such that the motor turns in the opposite direction.

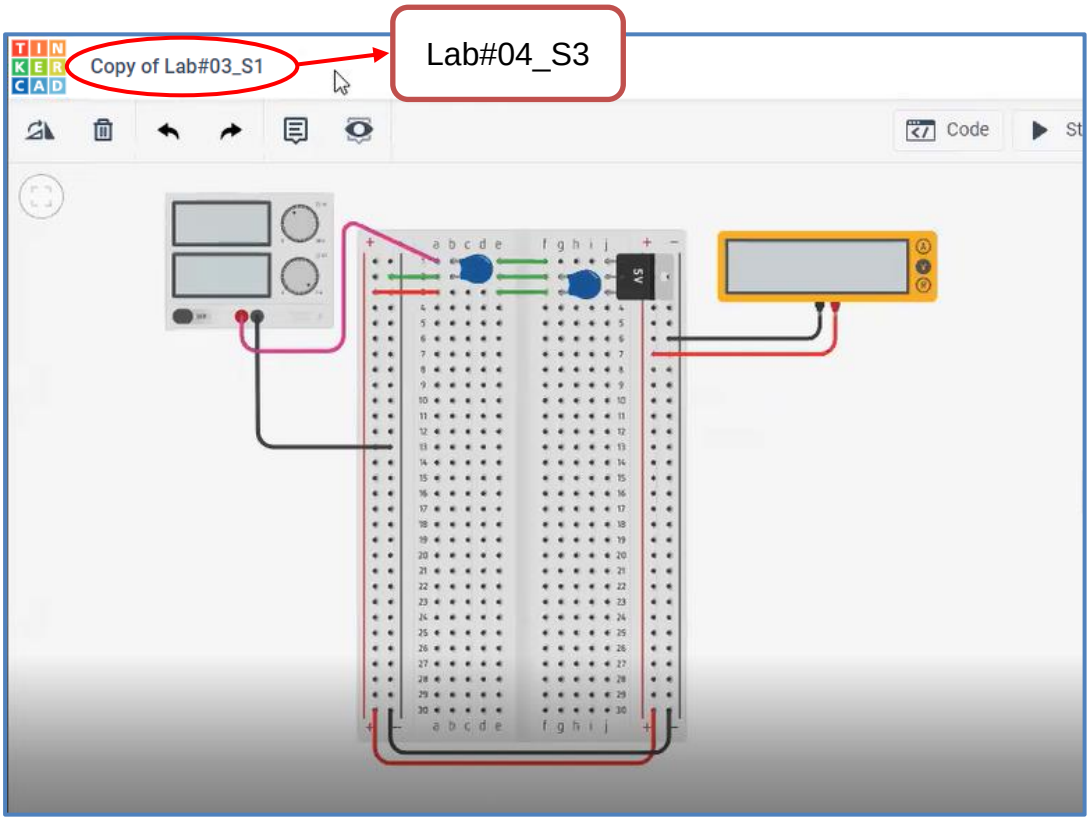
Q4: What are the voltage values of V_a, V_b, V_c, V_d?

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

Simulation 3: H-Bridge Driver **[Lab#04_S3]**

Step 1: As in previous lab, “Duplicate” your LM7805 regulator circuit (“Lab#03_S1”) and change the circuit name to “Lab#04_S3”.





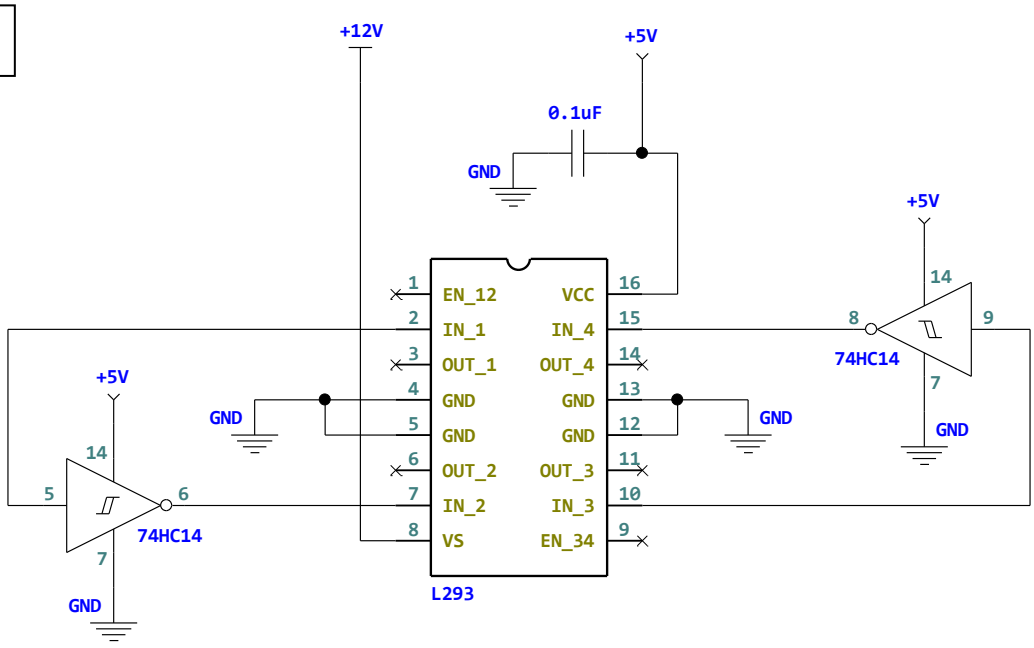
Step 2: Use Multimeter to measure the output voltage of your LM7805 regulator. Make sure you still have a regulated 5V from 12V.

Note: For this circuit simulation, you need to put your motor driver circuit below the LM7805 regulator circuit on the breadboard (You may refer to Tutorial notes for the breadboard arrangement).

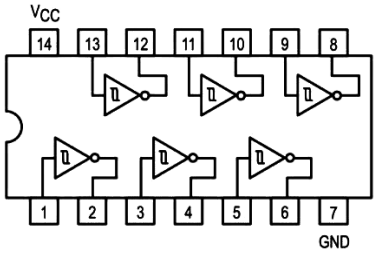
Step 3: Connect a driver circuit using L293 and 74HC14 as shown in Figure 3 below.

Note: Be clear about where the 12V and 5V are from your breadboard (both are from your LM7805 regulator circuit).

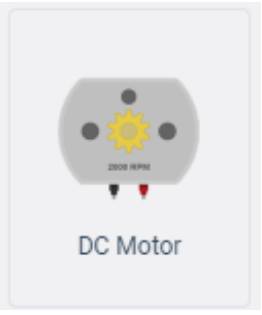
Figure 3



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 to connect to L293.



Step 4: You need to use two of "DC Motor". Connect DC Motor 1 to the left side of L293 (to **pin 3 & 6**), connect DC Motor 2 to the right side of L293 (to **pin 11 & 14**).



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

Step 6: 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.

****

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 change the circuit names and copy share links of your **Simulations 1-3** to the table in your summary sheet.