ELEC 3300

LAB 1: USE OF EQUIPMENTS

A. OBJECTIVE:

1. To familiarize yourself with the basic equipments and components, power supply, multi-meter, transistors.
2. To understand the power limitation of an IC.
3. To understand the use of transistor as a electronic switch
4. To correlate the knowledge that you learn from previous courses to the real world environment.

B. PRE-LAB ASSIGNMENT:

1. Study the Power Supply IPS-3303 information (available from the course webpage).
2. Study the 74LS04 datasheet (available from the course webpage).
3. Study the PN2222 datasheet; note the orientation of Base, Emitter and Collector.
4. Study the tutorial information related to LAB1.
5. Finish the PRE-LAB part of the activity sheet.

C. INTRODUCTION:

In this lab, you need to familiar yourself with the basic tools of electronics.

- Power Supply – A power supply is to provide power to your circuits, you need to be able to understand the operation modes of the power supply. How does it related to Voltage and Current.
- Multi-meter – A meter to measure the voltage and current of your circuit.
- Transistor – A device normally to amplify the current from the digital logic system.

D. POWER SUPPLY INFORMATION:

The following are the photos for the power supply that is actually used in the lab Model IPS-3303.

Please refer to the Canvas for more information about the Power Supply

ELEC 3300

LAB 1 : USE OF EQUIPMENTS

ACTIVITY SHEET

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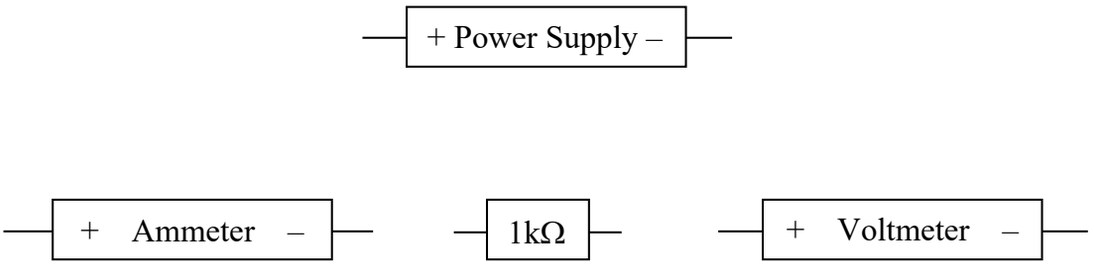
PRE-LAB

Consider the circuit below that consist of a 1kΩ resistor, a power supply, an ammeter and a voltmeter. If you want to measure the voltage and current across the resistor. How do you connect the ammeter and voltmeter? **WARNING ** If you connect WRONGLY, you will DAMAGE the EQUIPMENT, so, if you are not sure, please ASK your best friend, Google!!**



Please check the following components before you start each Part of the LAB

Check List

	Components / Equipment	Tested Result	
Part A	Power Supply	☑ OK	□ NOT OK
	100Ω resistor	☑ OK	□ NOT OK
	10Ω resistor	☑ OK	□ NOT OK
	470Ω resistor	☑ OK	□ NOT OK
Part B	LED	□ OK	□ NOT OK
	10Ω resistor	□ OK	□ NOT OK
	74LS04 IC	□ OK	□ NOT OK
	Digital Multimeter	□ OK	□ NOT OK
Part C	Motor	□ OK	□ NOT OK
	74LS04 IC	□ OK	□ NOT OK
	NPN Transistor	□ OK	□ NOT OK

A. Power Supply:

WARNING ** Part A requires you to set the Voltage and Current according to your student ID. Please double check your voltage and current before you connect the resistor and do the measurement.

2 0 6 5 4 0 9 1

Assume your student ID is	**2**	**0**	**1**	**2**	**3**	**4**	**5**	**6**
	a	**b**	**c**	**d**	**e**	**f**	**g**	**h**

Please set the maximum voltage to Y volt, where Y = (gh) mod 5 + 4
Please set the maximum current to 0.Z A, where Z = (ef) mod 2 + 2

56 % 5 + 4 = 5V

34 % 2 + 2 = 0.2A

Example:
For above student ID, the maximum voltage will be = (56) mod 5 + 4 = 5V
For above student ID, the maximum current will be = (34) mod 2 + 2 = 2 → 0.2A

1. Consider the independent mode and the master supply only. In order to set the maximum power of the supply, you need to do the two steps below **separately**.

   I. Set the maximum voltage to Y Volt by the voltage knob **under an open circuit condition.**
   II. **Shorting the output and set the maximum current to 0.Z A by the current knob.**

   What is the maximum Power that delivered by the power supply using above configuration using the setting from your student ID? Show your calculation.

   Ans: 1W (5 x 0.2 = 1W)

   1. **Connect a 100Ω resistor across the +ve and –ve terminal** — Step 3
   2. **Turn on the Power supply**
   3. **Enable the output**
   4. **Answer the following questions**

$R = \frac{V}{I}$

   Which mode (CC or CV) is the power supply operates in? — Step 2

   Ans: CV

0.2

   What is the current drawn from the power supply? How can you know that?

   Ans: 0.05A, By observing the LCD of power supply.

   Calculate the power dissipated by the 100Ω resistor.

   Ans: 0.25W (0.05 x 5) = 0.25W

   Check the power delivered by supply by values shown on LCD. Does power dissipated by the resistor equals to the power delivered by the power supply? Please comment.

   Ans: Yes. Resistor will dissipate energy supplied by power supply.

   5. **Disable the output by pressing the button.** — Step 5
   6. **Turn off the Power supply** — Step 6

Repeat the previous steps with a 10Ω resistor.

Which mode (CC or CV) is the power supply operates in?

Ans: CC

What is the current drawn from the power supply? How can you know that?

Ans: 0.15A, from observing values on power supply LCD.

Calculate the power dissipated by the 10Ω resistor.

Ans: 0.225W (1.5 X 0.15) = 0.225W.

2. Keep the same setting but change the 10Ω resistor to a copper wire to connect the 2 output terminals, this time, which mode, CC or CV mode is the power supply operates in?

Ans: CC

What is the Voltage and Current across the 2 output terminals?

Ans: Voltage = 0.2V current = 0.15A

Change the 10Ω resistor to a 470Ω resistor, follow the steps, and answer the following question

3. **<u>Configure the Power Supply to series mode and output −YV to +YV</u>**, connect a **<u>470Ω</u>** resistor to the output terminals, **<u>set appropriate current so that the Power Supply operates in CV mode</u>**. Measure the voltage, current and hence calculate the power delivered to the 470Ω resistor.

Ans: voltage = 5V current = 0.02A power = 5 X 0.02 = 0.1A

Check point 1, TA Signature for finishing Part A: _____

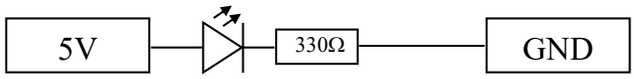
Check List

	Components / Equipment	Tested Result	
Part A	Power Supply	√ OK	□ NOT OK
	100Ω resistor	√ OK	□ NOT OK
	10Ω resistor	√ OK	□ NOT OK
	470Ω resistor	√ OK	□ NOT OK
Part B	LED	□ OK	□ NOT OK
	10Ω resistor	□ OK	□ NOT OK
	74LS04 IC	□ OK	□ NOT OK
	Digital Multimeter	□ OK	□ NOT OK
Part C	Motor	□ OK	□ NOT OK
	74LS04 IC	□ OK	□ NOT OK
	NPN Transistor	□ OK	□ NOT OK

B. Digital Circuit:

1. Consider the independent mode and the master supply only. Set the voltage to **<u>5V</u>** by open circuit, set current to **<u>0.3A</u>** by shorting the outputs.

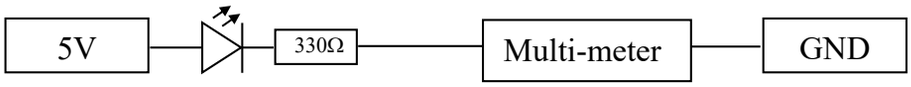
2. In your breadboard, build the following circuit.



From your knowledge in the other courses, assume the LED is an ideal diode with a 0.7V for forward bias, what should be the current flowing through the 330Ω resistor?

Ans: 0.013A $(5-0.7)/330 \approx 0.013A$

Now, measure the exact current through the 330Ω resistor using a desktop multi-meter, what is the reading?

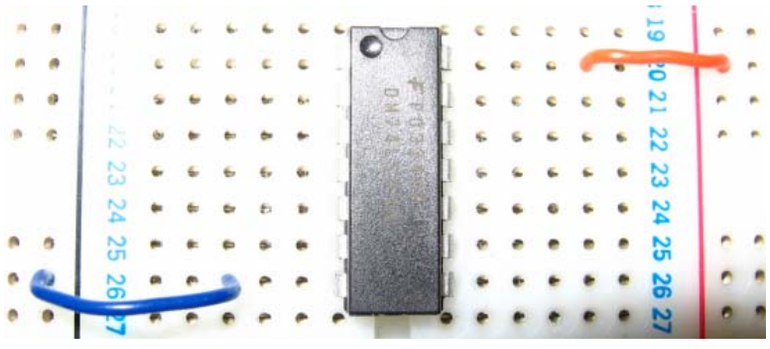


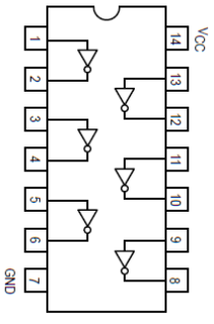
Ans: 100 μA

With the knowledge that you learnt from the other courses, comments on the two measurements above if the assumption on 0.7V bias is valid or not.

Ans: Not valid. The current measured is very small as such, the bias value should be higher.

Now, consider a 74LS04 IC.





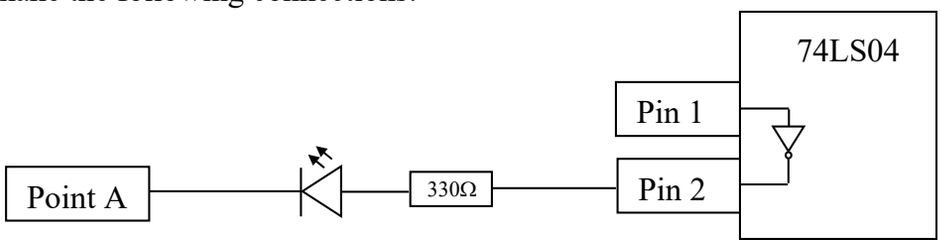
3. Connect Pin 1 to GND, measure the voltage at Pin 2. What is the voltage at Pin 2?

Ans: 4.46V

4. Connect Pin 1 to 5V, measure the voltage at Pin 2. What is the voltage at Pin 2?

Ans: 140 mV

5. Now, make the following connections:



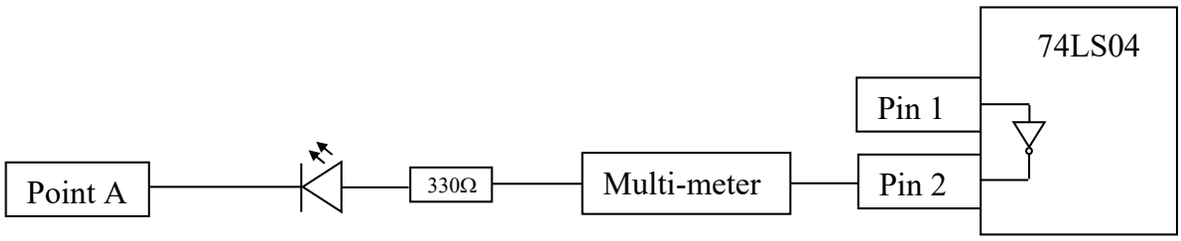
In order to light up the LED, what should Pin 1 and Point A connected to?

Ans: Pin 1 connected to (5V / GND), Point A connected to (5V / GND)

In this example, the power that lights up the LED comes from where?

Ans: Power comes from Pin 2

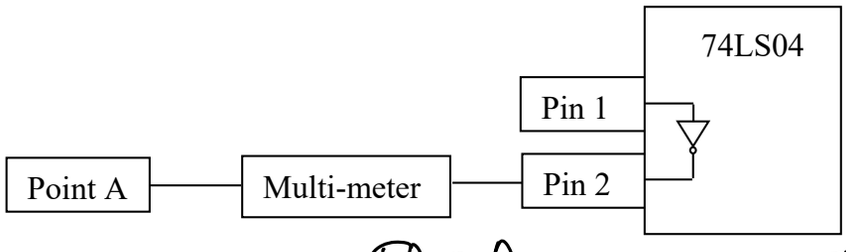
Now, use a multi-meter to measure the current. Please note the +ve and –ve terminals of the multi-meter.



What is the current shown on the multi-meter? Is the current flowing out from Pin 2 or flowing into the Pin 2?

Ans: Current shown on multi-meter: 5 μA. Direction: (out from / into) Pin 2

Now, try to directly connect pin 2 through the multi-meter to Point A, measure the current again. Is the current flowing out from Pin 2 or flowing into the Pin 2?

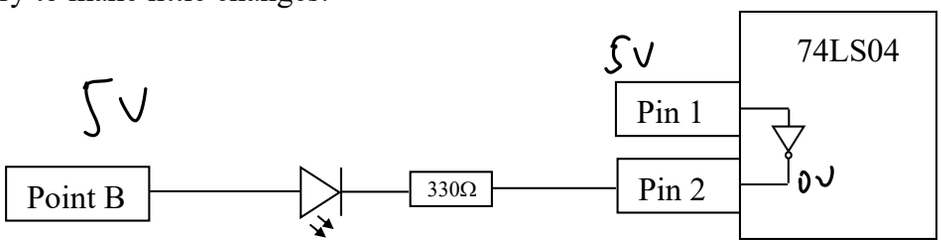


Ans: Current shown on multi-meter: 50 mA. Direction: (out from / into) Pin 2

The above method will allow you to know the maximum current supplied by the IC. With your answer from Part B3, deduce the maximum power you can get from Pin 2.

Ans: Maximum Power from Pin 2: 2.23 W (4.46 x 50m) = 2.23W

6. Now, try to make little changes:



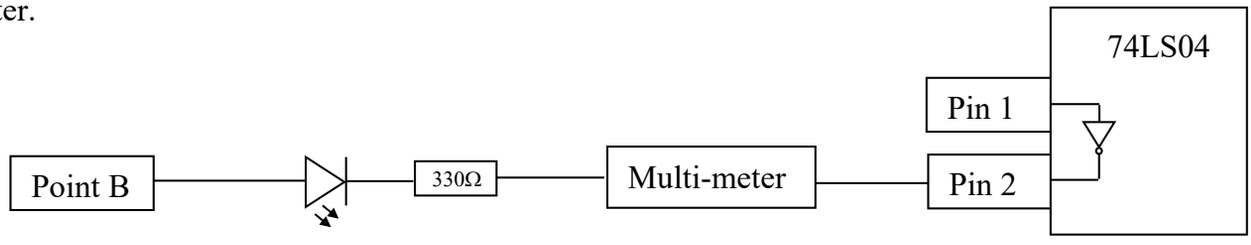
In order to light up the LED, what should Pin 1 and Point B connected to?

Ans: Pin 1 connected to (5V / GND), Point B connected to (5V / GND)

In this example, the power that lights up the LED comes from where?

Ans: Power comes from Point B

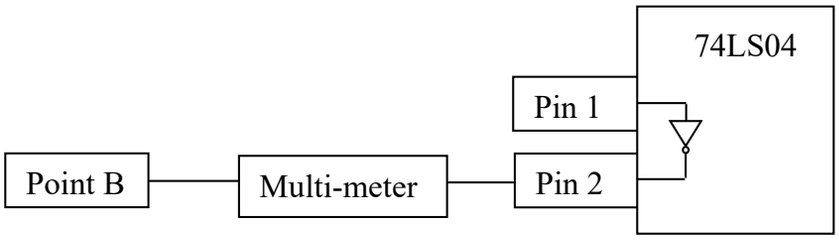
Now, use a multi-meter to measure the current. Please note the +ve and –ve terminals of the multi-meter.



What is the current shown on the multi-meter? Is the current flowing out from Pin 2 or flowing into the Pin 2?

Ans: Current shown on multi-meter: 2.5 μA. Direction: (out from / into) Pin 2

Now, try to directly connect pin 2 through the multi-meter to Point B, measure the current again. Is the current flowing out from Pin 2 or flowing into the Pin 2?



Ans: Current shown on multi-meter: ~157 mA. Direction: (out from / into) Pin 2

The above method will allow you to know the maximum current sink by the IC.
Refer to Start of Part B, the maximum current from the Power Supply is set to 0.3A. Does Pin 2 allow all the 0.3A current sink to it? Please comment.

Ans: No. There are a lot of electronic components on an IC and some are connected to GND, so some of the current flows elsewhere.

Check point 2, TA Signature for finishing Part B: _____

Check List

	Components / Equipment	Tested Result	
Part A	Power Supply	√ OK	□ NOT OK
	100Ω resistor	√ OK	□ NOT OK
	10Ω resistor	√ OK	□ NOT OK
	470Ω resistor	√ OK	□ NOT OK
Part B	LED	√ OK	□ NOT OK
	10Ω resistor	√ OK	□ NOT OK
	74LS04 IC	√ OK	□ NOT OK
	Digital Multimeter	√ OK	□ NOT OK
Part C	Motor	□ OK	□ NOT OK
	74LS04 IC	□ OK	□ NOT OK
	NPN Transistor	□ OK	□ NOT OK

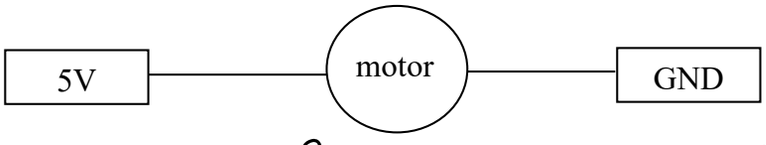
C. Transistor as an amplifier or a switch

1. Consider the independent mode and the master supply only. Set the voltage to **5V** by open circuit, set current to **0.35A** by shorting the outputs.

2. Measure the resistance of the motor

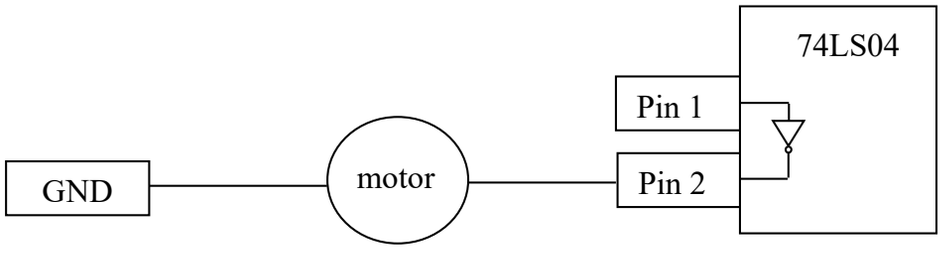
   Ans: Resistance of the motor 2.3Ω

3. Connect the 2 wires of the motor directly to the power supply. Read the voltage and current reading from the power supply.



   Ans: Voltage: 0.8V Current: 0.35A

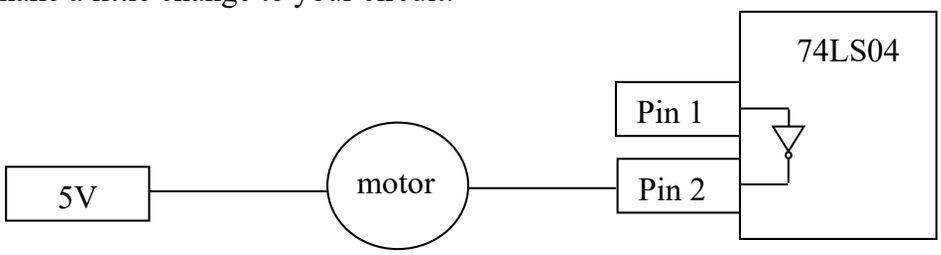
4. Use the circuit that you build from Part B, make the following connections:



   Will the motor turn when you connect the Pin 1 to GND? Please explain with the answer of you get from last task of Part B 5.

   Ans: No. The current of 50mA is insufficient to power the motor.

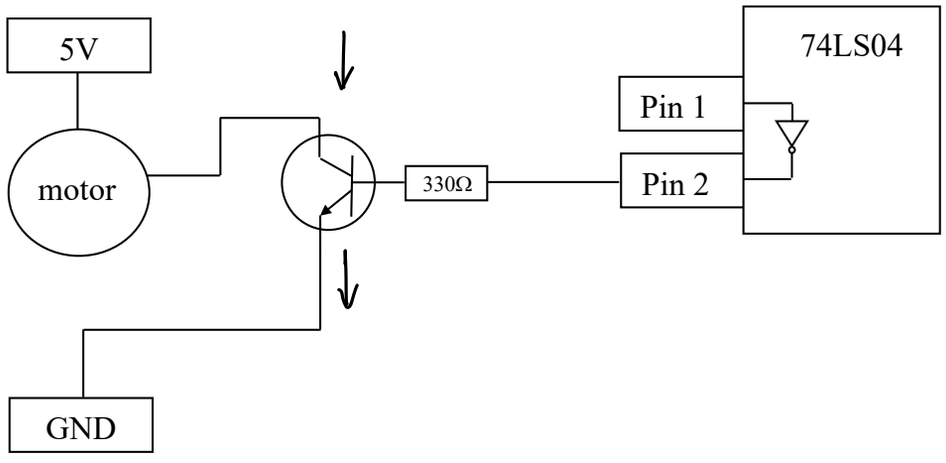
5. Now, make a little change to your circuit:



Will the motor turn when you connect the Pin 1 to 5V? Please explain with the answer of you get from last task of Part B 6.

Ans: No. Pin 2 only allows 157mA of power to sink, that amount of current is insufficient to power a motor.

6. Now, modify and adding a NPN transistor to your circuit as follows:



Will the motor turn when you connect the Pin 1 to 5V? Please explain with the properties of the transistor.

NOTE: You can try to rotate the motor a bit to facilitate the turning. Please pay ATTNETION that the transistor will becomes HOT during the rotation.

Ans: No. The 74LS04 chip will change 5V at pin 1 to 0V at pin 2. No power flows through the base of the transistor. As a result, no power is allowed through motor, as such motor doesn't spin.

Will the motor turn when you connect the Pin 1 to GND? Please explain with the properties of the transistor.

NOTE: You can try to rotate the motor a bit to facilitate the turning. Please pay ATTNETION that the transistor will becomes HOT during the rotation.

Ans: Yes. There is 5V at pin 2 and when power passes through the transistor, it allows the motor to be be powered and connected to ground, so the motor spins.

When the motor is on, read the current from the power supply, compare to your answer from Part C 3.

Ans: current = 0.3A

In this example, the power that makes the motor move comes from where?

Ans: Power comes from: The 5V power supply.

What is the role of Pin 1 of 74LS04 in this example?

Ans: Pin 1 acts as the switch, depending on the voltage value at Pin 1, the motor can be turned on and off.

Check point 3, TA Signature for finishing Part C: _____