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

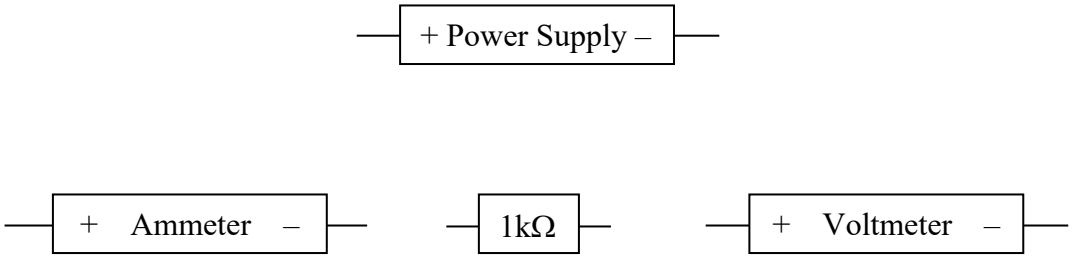
LAB 1 : USE OF EQUIPMENTS

ACTIVITY SHEET

Name : Young, James Yang Student number : 20740589 LAB Session : LA4

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.

Assume your student ID is

2	0	1	2	3	4	5	6
a	b	c	d	e	f	g	h

g=8
h=9
e=0
f=5

Please set the maximum voltage to Y volt, where Y = (g × 10 + h) mod 5 + 4
Please set the maximum current to 0.Z A, where Z = (e × 10 + f) mod 2 + 2

Example:
For above student ID, the maximum voltage will be = (5 × 10 + 6) mod 5 + 4 = 5V
For above student ID, the maximum current will be = (3 × 10 + 4) mod 2 + 2 = 2 → 0.2A

What is the maximum Voltage, Current and Power that delivered by the power supply from the setting according to your student ID? **Show your calculation**.

Voltage : $(8\cdot10+9)\%5+4 = 4+4 = 8V$

Current : $Z = (0\cdot10+5)\%2+2 = 1+2 = 3$, so max is 0.3A

Power : $P=VI = 8V\cdot0.3A = 2.4W$

Now,

Turn on the Power supply
Enable the output

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 outputs and set the maximum current to 0.Z A by the current knob.**

Take the 100Ω from the box, measure the actual resistance using a multimeter.

Ans: 99.9 Ω

Connect the 100Ω resistor across the +ve and –ve terminals, read the voltage and the current drawn from the power supply from the power supply display, hence calculate the power delivered by the power supply.

Ans: $P=0.08A\cdot8V = 0.64W$

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

Ans: CV

Now, refer to PRE-LAB, measure the Voltage, Current across the 100Ω resistor by using DMM, hence calculate the power dissipated by the 100Ω resistor.

Ans: V= 8.06V I= 0.0799 A P= 0.644 W

Does power delivered by the power supply equals to the power dissipated by the resistor? Is the conservation of energy holds?

Ans: Yes, since power supplied ≈ power dissipated so conservation of energy holds.

Repeat the previous steps with a 10Ω resistor.

Take the 10Ω from the box, measure the actual resistance from the multimeter.

Ans: 10.1 Ω

Connect the 10Ω resistor across the +ve and –ve terminals, which mode (CC or CV) is the power supply operates in?

Ans: CC

From the display, read the voltage and the current drawn from the power supply.

Ans: V= 3.2 I= 0.3

Why the displayed voltage value differs from the value that you set (i.e Y Volt) before?

Ans: Since max current is 0.3A, and R=10Ω, so V= IR ≈ 3V.

Calculate the power dissipated by the 10Ω resistor.

Ans: P= 3.2V · 0.3A = 0.96 W

2. Keep the same setting but **change the 10Ω resistor to a wire connecting the 2 output terminals.**

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

Ans: CC

From the display, read the voltage and the current drawn from the power supply.

Ans: V= 0V I= 0.3A

Why the displayed voltage value differs from the value that you set (i.e Y Volt) before?

Ans: Since there is no resistance, so by ohm's law V=0V and I can be any value.

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

Ans: V=0V I= 0.3A

3. **Configure the Power Supply to series mode and output –Y Volt to +Y Volt**, connect a **470Ω** resistor to the output terminals, **set appropriate current so that the Power Supply operates in CV mode**. Measure the voltage, current across the 470Ω resistor and hence calculate the power delivered to the 470Ω resistor.

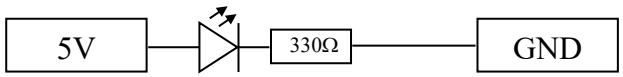
Ans: V=16V I=0.03A P=0.48W

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

B. Digital Circuit:

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

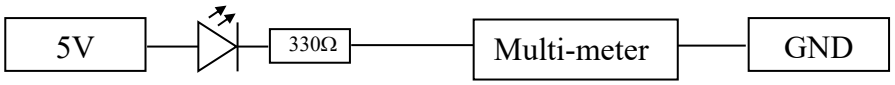
2. In your breadboard, build the following circuit.



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: (5-0.7)/330Ω = 13mA

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

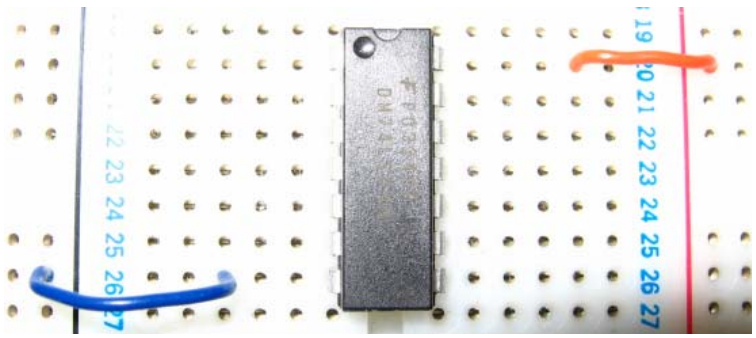


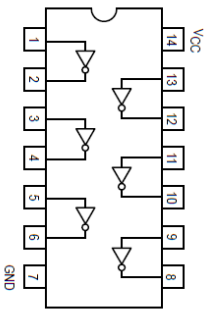
Ans: 12mA

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: It is valid as the measured value is close to the calculated value.

Now, consider a 74LS04 IC.





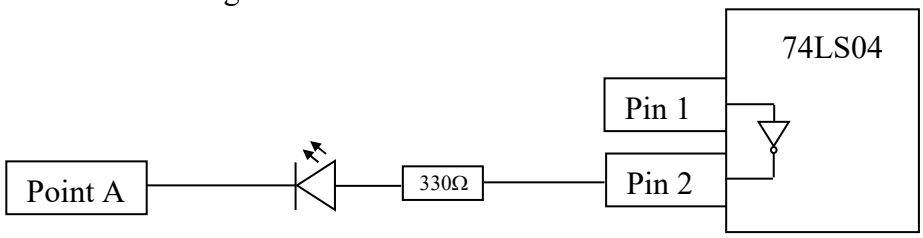
3. Connect Pin 1 to GND, measure the voltage at Pin 2. What is the voltage at Pin 2?

Ans: 4.46V

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

Ans: 0.15V

5. Now, make the following connections:



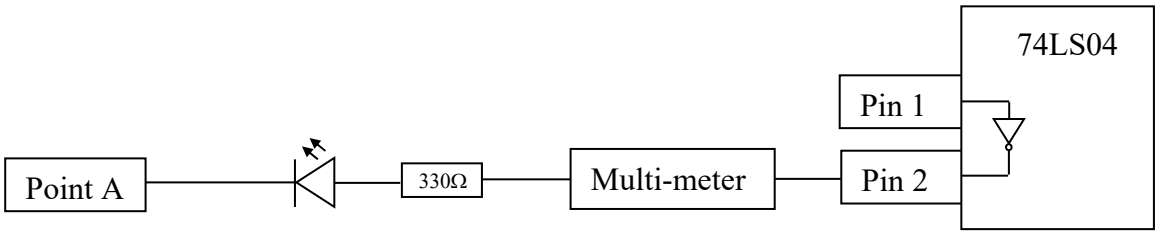
In order to light up the LED, what should Pin 1 and Point A connected to?

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 power supply through pin 1

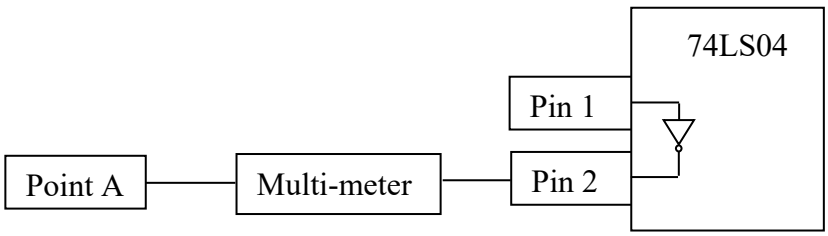
Now, use a multi-meter to measure the current. Please note the +ve and –ve terminals of the multi-meter.



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: 3.5 m A. 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?

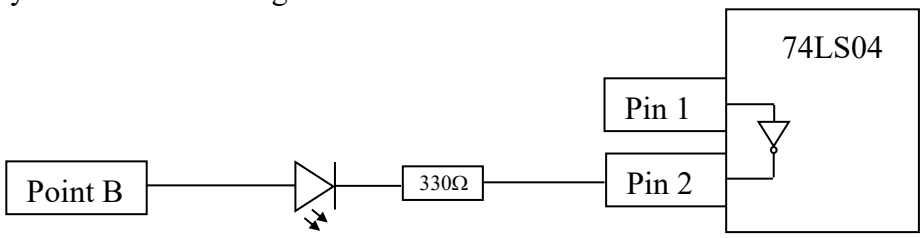


Ans: Current shown on multi-meter: 54 m A. Direction: (out from / into) Pin 2

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: P: 4.46V · 0.054A = 0.24W

6. Now, try to make little changes:



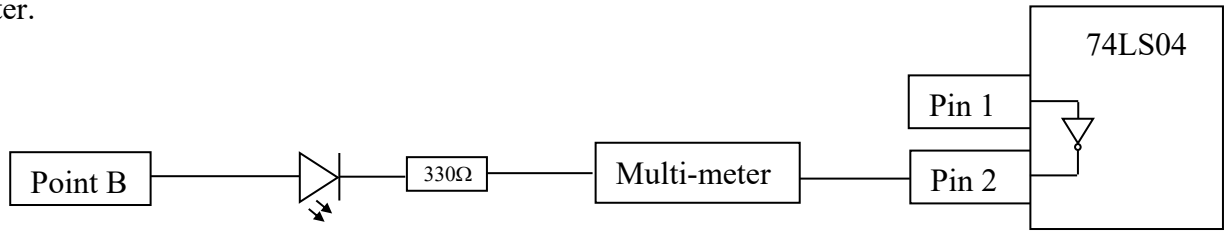
In order to light up the LED, what should Pin 1 and Point B connected to?

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 power supply through point B

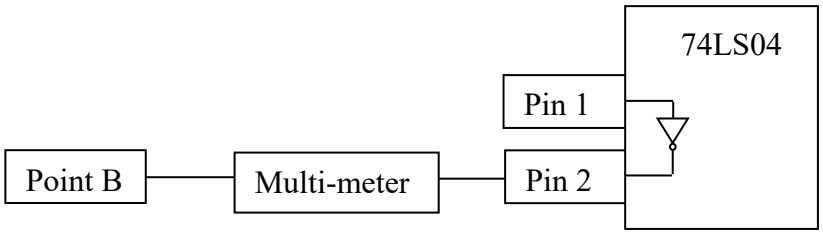
Now, use a multi-meter to measure the current. Please note the +ve and –ve terminals of the multi-meter.



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: 8 mA. 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: 173mA. 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: $P = 4.46V \cdot 0.173A = 0.77W$

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

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

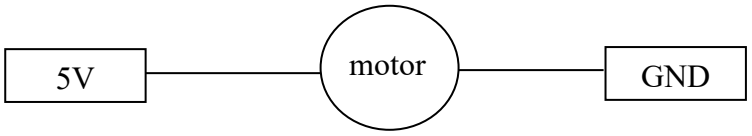
C. Transistor as an amplifier or a switch

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

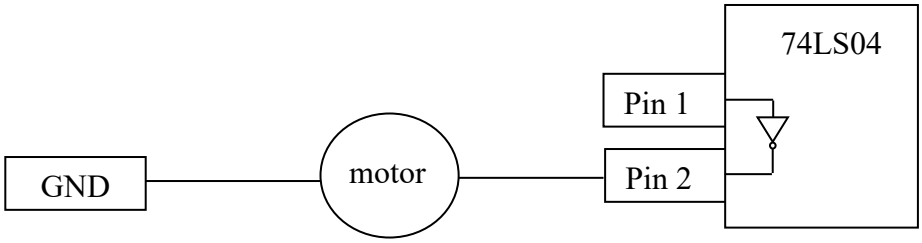
   Ans: Resistance of the motor 8.5Ω

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: 5V Current: 0.09A

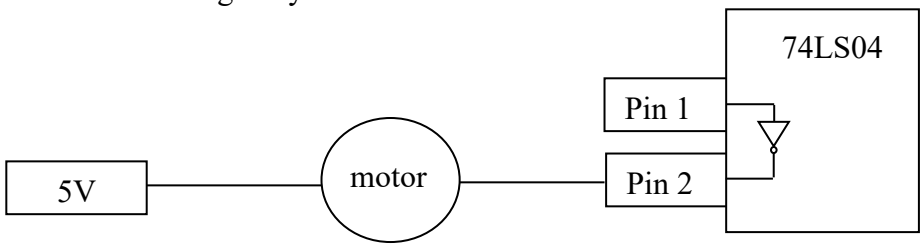
4. Use the circuit that you build from Part B, make the following connections:



   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, because the current to turn the motor is 0.09A but this connection only gives 0.06A, not enough.

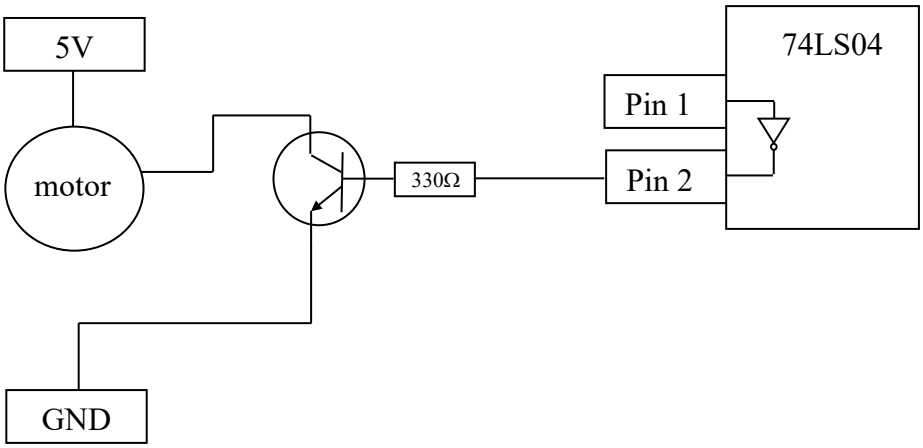
5. Now, make a little change to your circuit:



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, since there is not enough current to turn 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, because no current through base.

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, b/c the transistor makes overall resistance smaller so that there is more current.

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

Ans: I = 0.09A same as C 3

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

Ans: Power comes from: Power supply

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

Ans: Switch

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