UM-SJTU JI VE215 Lab#1

We will test some properties of DC circuits in this lab.

• Please hand in your post-lab assignment before the due date. Please do your post-lab assignment following the requirements in each problem. Both hand-written and printed are accepted.

• You are encouraged to print this lab manual and then finish the post-lab questions on it. For pictures or diagrams, you may print it in a paper, cut it down and paste on this worksheet.

Instruments

DC power supply (**Agilent E3631A** or **MOTECH LPS 305**)

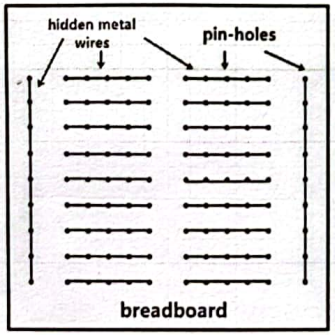
Multi-meter

Resistors of **50Ω** and **100Ω**

Light-Emitting Diode (LED)

Breadboard and Wires

Instruments Introduction



For **breadboards**, the picture above shows its inner structure. The nodes represent the pin-hole and the blue lines represent the metal wires hidden inside the board.

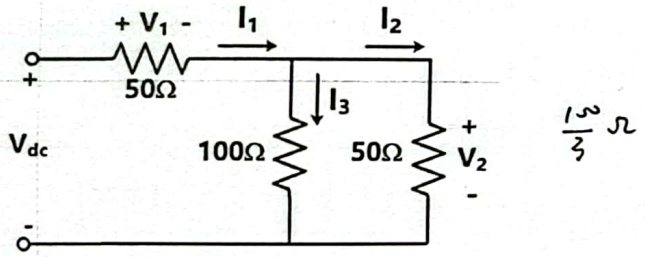
For **multi-meters**, please rotate the knob from "**off**" to the required function (including DC current, DC voltage, resistance, AC current, AC voltage) with the proper measuring range according to your measurement.

- For DC voltage measurement, please rotate the knob of multi-meter from "**off**" to " $\overline{\mathbf{V}}$ (or $\overline{\mathbf{mV}}$)" and connect the two ports in parallel with the element to be measured.
- For DC current measurement, please rotate the knob of multi-meter from "**off**" to " $\overline{\mathbf{A}}$ (or $\overline{\mathbf{mA}}$)" and connect it in series with the element to be measured, in other words, please connect it directly inside the circuit.
- For resistance measurement, please rotate the knob of multi-meter from "**off**" to "**Ω**" and connect the element to be measured in parallel with the multi-meter **independently**. **Caution: Please do not measure the resistance of elements when it's connected in the circuit otherwise the result will be disturbed.**

Mention that for some categories of multi-meters, you need to press the "scale" button if changing the measurement scale. Please try it and contact the TAs for help for any problems.

Problem #1 Basic Circuit Theory

Please connect the following circuit on your breadboard.



$\frac{100}{3}\Omega$

Please set the DC power supply V_{DC} to 3V and then open it. Then, please measure the values of I_1, I_2, I_3, V_1 and V_2 using multi-meter and complete the following table:

Notations	I_1	I_2	I_3	V_1	V_2
Values	35.44mA	22.9mA	11.65mA	1.795V	1.196V

Please do not break your circuit since we will use the same circuit in the next problem

Post-Lab Questions for (P1)

(1) What's the relationship among I_1, I_2 and I_3 according to your measurement? Which circuit law could be verified based on that result?

$I_1 : I_2 : I_3 \approx 3 : 2 : 1 \quad (I_1 = I_2 + I_3)$

~~Ohm's law~~

KCL

(2) What's the relationship among V_{DC}, V_1 and V_2 according to your measurement? Which circuit law could be verified based on that result?

$V_{DC} : V_1 : V_2 \approx 5 : 3 : 2 \quad (V_{DC} \approx V_1 + V_2)$

KVL

(3) What's the value of I_2/I_3 according to your measurement? How can the result verify the current division law of the parallel connected resistors?

~~$I_2 =$~~ ~~I_3~~ $\frac{I_2}{I_3} = 1.973$

~~$I_2 R_2 = I_1 R_1$~~ $\frac{R_2}{R_3} = \frac{100\Omega}{100\Omega} = \frac{1}{2}$

Thus $I_2 R_2 \approx I_3 R_3$

(4) What's the value of V_1/V_2 according to your measurement? How can the result verify the voltage division law of the series connected resistors?

$\frac{V_1}{V_2} = 1.501$

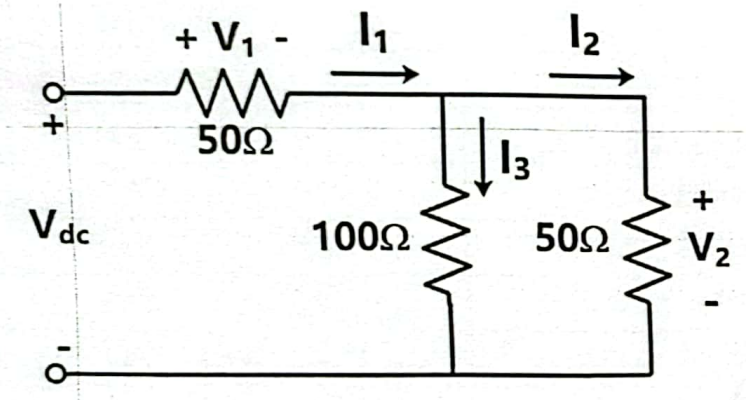
$\because R_2 = 50 \| 100 = \frac{100}{3}$

$\frac{R_1}{R_2} = \frac{3}{2} = 1.5$

Thus $\frac{V_1}{R_1} \approx \frac{V_2}{R_2}$

Problem #2 Ohm's Law

Please use the same circuit as your problem 1.



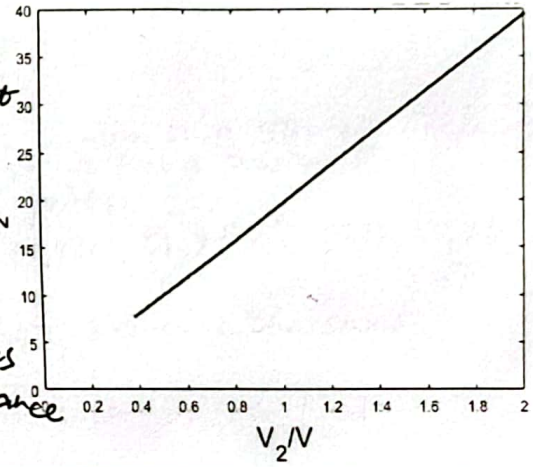
Please set the DC power supply V_{DC} to 1V, 2V, 3V, 4V, 5V and measure the values of I_2 & V_2 corresponding to each V_{DC}. Please complete the following table during your experiment.

Source Voltage V_{DC}	I_2	V_2
1V	7.78mA	0.388 V
2V	15.56mA	0.800 V
3V	23.61mA	1.200 V
4V	31.50mA	1.600 V
5V	39.39mA	1.999V

Post-Lab Questions for (P2)

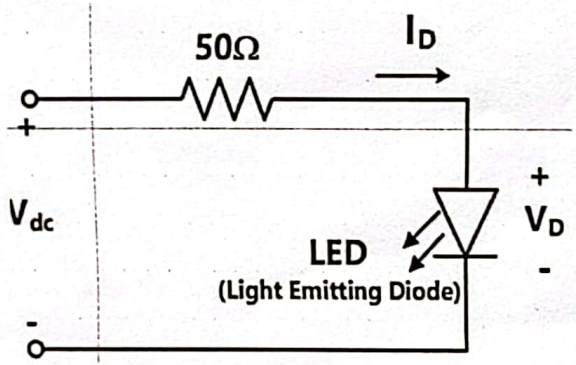
(1) Please plot the curve of V_2 and I_2. Explain: How can this curve verify the Ohm's law?

The curve is close to a straight line passing through the origin point, indicating that the point shares a close resistance



Problem #3 Non Linear Circuit

Please connect the following circuit on your breadboard.



Please set the DC power supply V_{DC} to 1.0V, 1.2V, 1.4V,

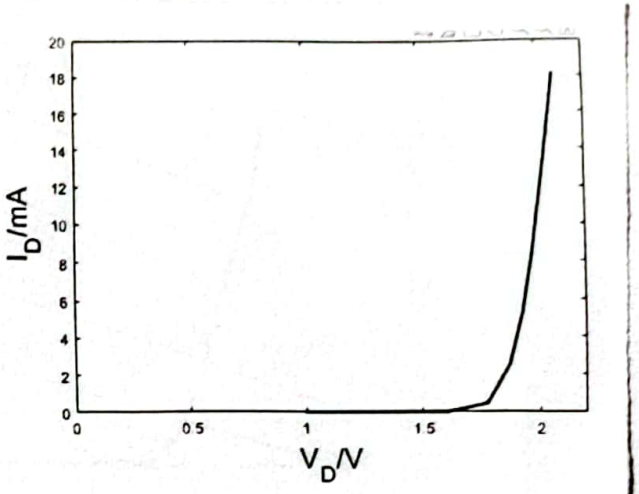
1.6V… 2.8V and 3.0V and measure the values of I_D & V_D corresponding to each V_{DC}.

Please complete the table next page during your experiment.

Source Voltage V_{DC}	I_D	V_D
1.0V	0.0μA	~~0.748V~~ 1.000V
1.2V	0.0μA	~~0.900V~~ 1.202V
1.4V	0.1μA	~~1.050V~~ 1.401V
1.6V	8.8μA ~~0.01mA~~	~~1.200V~~ 1.601V
1.8V	~~0.45~~ 0.45mA	~~1.350V~~ 1.774V
2.0V	2.54mA 9.96mA	~~1.425V~~ 1.870V
2.2V	5.30mA 10.93mA	~~1.644V~~ 1.97V
2.4V	8.36mA 11.79mA	~~1.760V~~ 1.97V
2.6V	11.5mA 12.3mA	~~1.86V~~ 2.006V
2.8V	14.79mA 12.66mA	~~1.920V~~ 2.00V
3.0V	18.09mA 12.98mA	~~1.965V~~ 2.071V

Post-Lab Questions for (P3)

(1) Please plot the curve of V_D and I_D. Is this LED a linear circuit element based on the curve you obtained? Why?



No. Because the image is not a straight line.

(2) What's the purpose of connecting the 50Ω resistor in series with the LED? What will happen if we do not connect it?

Protecting the LED from excess circuit

Due to too large circuit it may be broken.

Post-Lab Reflection Question

(1) Is your experimental result the same as your analysis (Need data as proof)? If not, how do you interpret this difference? What do you think is the source of the experimental error?

(2) What do you learn from this experiment? (e.g. what experimental procedures, how to debug, etc.)

(1) Basicaly, yes.

in P1(1), $I_2+I_3 = 34.64mA$

$I_1 = 35.44mA$ It is quite close

in P1(2) $V_1+V_2 = 2.991V$

$V_{DC} = 3V$ It is also quite close.

The minor difference may be caused by the bad contact or the hand touching the ammeter or reading before fully stabilising

(2). To debug, Use the ~~ammeter or the~~ electric meter to measure the data step by step, mesh by mesh to find out the bug.

In the field of experimental procedures, I learnt to ~~the~~ basic connection~~ing~~ with DC source and bread boards. Also, ~~to measure the~~ (like resistance) for better connection, something can be plugged into the breadboard for the meter to touch.

References

[1] *Circuits Make Sense*, Alexander Ganago, Department of Electrical Engineering and Computer Science, University of Michigan, Ann Arbor.