UM-SJTU JI 2024 FA 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**)

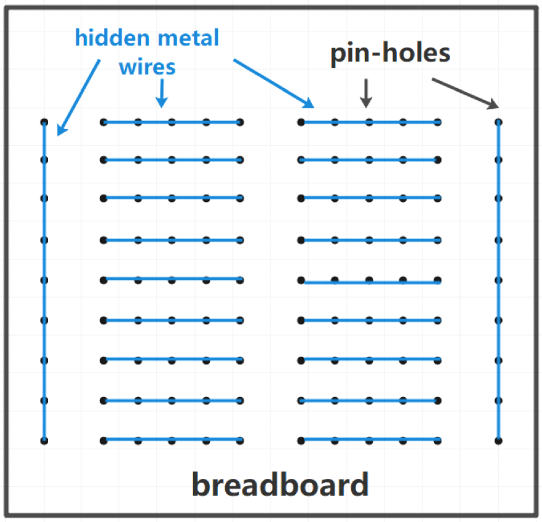
Multi-meter

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.

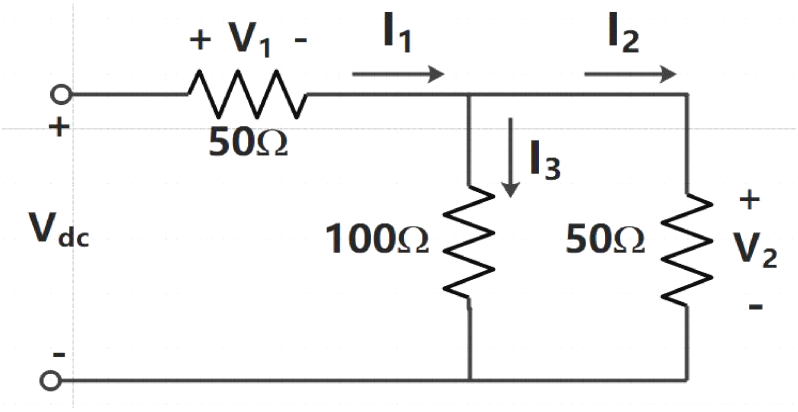
For **multi-meters**, please rotate the knob from "**off**" to the required function (including DC current, DC voltage, resistance, AC current, AC voltage) with the proper measuring range according to your measurement.

- 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.



Please set the DC power supply $\mathbf{V_{DC}}$ to **3V** and then open it.

Then, please measure the values of $\mathbf{I_1}$, $\mathbf{I_2}$, $\mathbf{I_3}$, $\mathbf{V_1}$ and $\mathbf{V_2}$ using multi-meter and complete the following table:

Notations	$\mathbf{I_1}$	$\mathbf{I_2}$	$\mathbf{I_3}$	$\mathbf{V_1}$	$\mathbf{V_2}$
Values	0.037	0.024	0.013	1.784	1.184

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 $\mathbf{I_1}$, $\mathbf{I_2}$ and $\mathbf{I_3}$ according to your measurement? Which circuit law could be verified based on that result?

① $I_1 = I_2 + I_3$

② KCL.

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

① $V_{DC} = V_1 + V_2$.

② KVL.

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

$\frac{I_2}{I_3} = \frac{0.024A}{0.013A} \approx 1.8 \approx \frac{R_3}{R_2} = 2$.

i.e. $I_2 : I_3 = R_3 : R_2 = G_2 : G_3$,

which verifies the current division law.

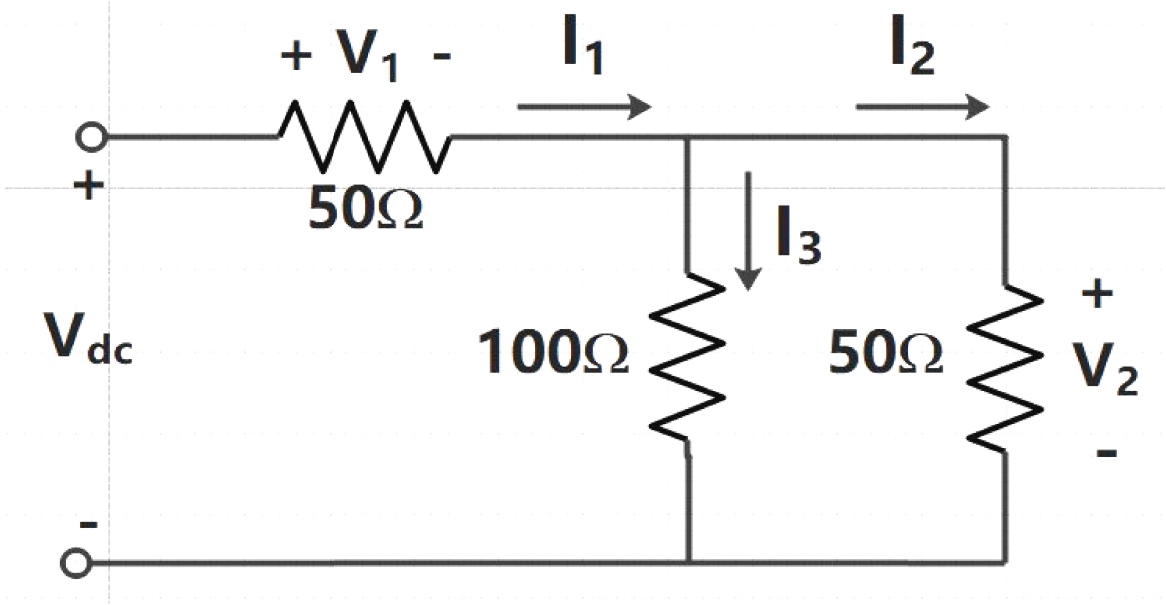
(4) What's the value of $\mathbf{V_1/V_2}$ according to your measurement? How can the result verify the voltage division law of the series connected resistors?

$\frac{V_1}{V_2} = \frac{1.794V}{1.194V} \approx 1.5 = \frac{R_1}{R_{eq}} = \frac{R_1}{\frac{R_2 R_3}{R_2 + R_3}} = \frac{50}{\frac{50 \times 100}{50+100}} = 1.5$

which verifies the voltage division law.

Problem #2 Ohm's Law

Please use the same circuit as your problem 1.

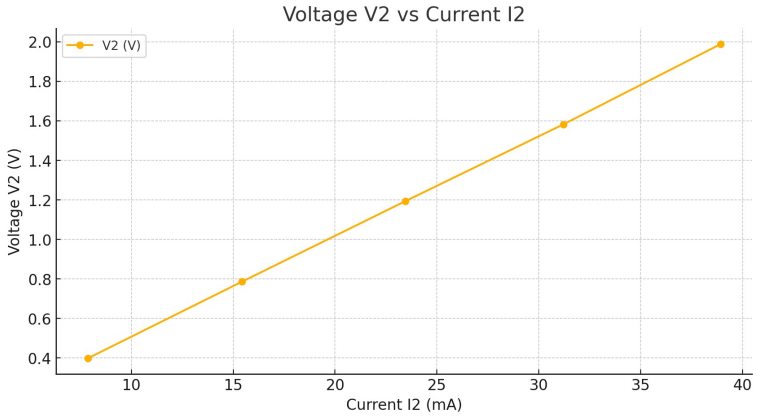


Please set the DC power supply $\mathbf{V_{DC}}$ to **1V, 2V, 3V, 4V, 5V** and measure the values of $\mathbf{I_2}$ & $\mathbf{V_2}$ corresponding to each $\mathbf{V_{DC}}$. Please complete the following table during your experiment.

Source Voltage $\mathbf{V_{DC}}$	$\mathbf{I_2}$	$\mathbf{V_2}$
1V	7.86 mA.	0.398 V.
2V	15.45mA.	0.786 V.
3V	23.46mA.	1.194 V.
4V	31.20mA.	1.592 V.
5V	38.72mA.	1.988 V.

Post-Lab Questions for (P2)

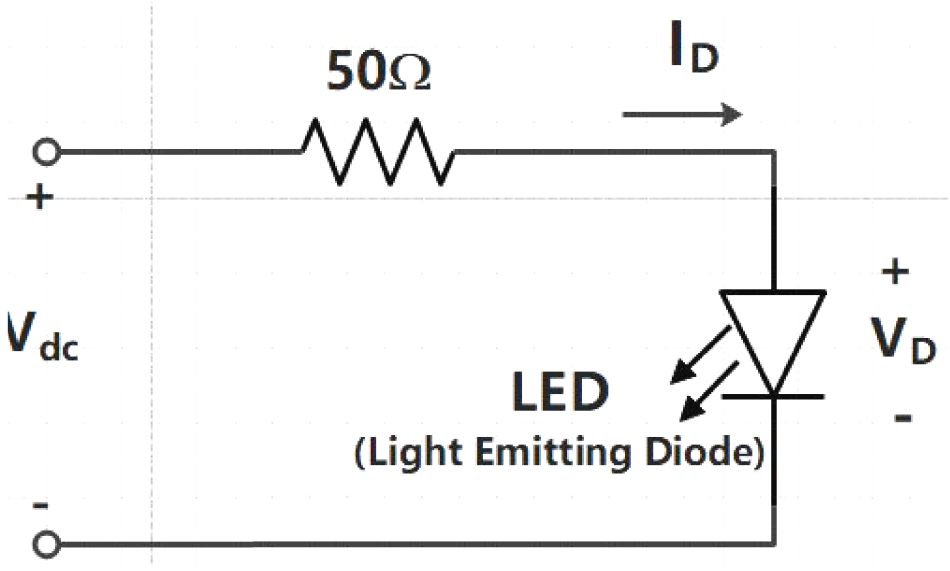
(1) Please plot the curve of $\mathbf{V_2}$ and $\mathbf{I_2}$. Explain: How can this curve verify the Ohm's law?



From the curve we can find that V_2 is proportional to I_2 which fits Ohm's law, i.e. $R_2 = \frac{V_2}{I_2}$.

Problem #3 Non Linear Circuit

Please connect the following circuit on your breadboard.



Please set the DC power supply $\mathbf{V_{DC}}$ to **1.0V, 1.2V, 1.4V,**

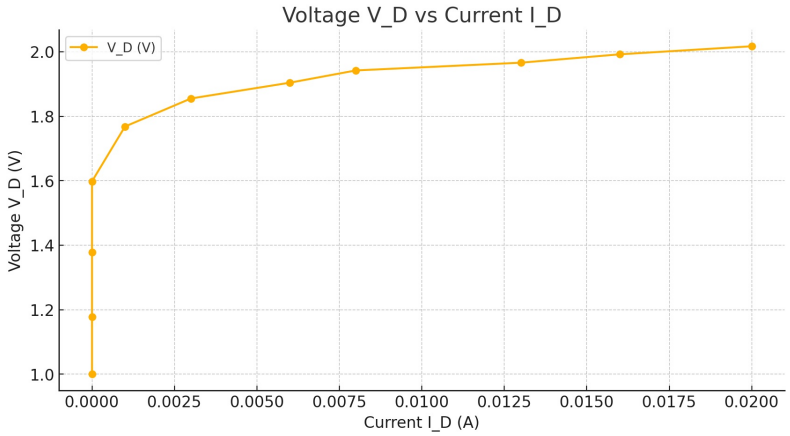
1.6V… 2.8V and **3.0V** and measure the values of $\mathbf{I_D}$ & $\mathbf{V_D}$ corresponding to each $\mathbf{V_{DC}}$.

Please complete the table next page during your experiment.

Source Voltage $\mathbf{V_{DC}}$	$\mathbf{I_D}$	$\mathbf{V_D}$
1.0V	0.000A	1V
1.2V	0.000A	1.198V
1.4V	0.000A	1.398V
1.6V	0.000A	1.598V.
1.8V	0.001A	1.769V
2.0V	0.003A	1.855V
2.2V	0.006A	1.904V
2.4V	0.009A	1.962
2.6V	0.013A.	1.966V.
2.8V	0.016A	1.992 V
3.0V	0.020A	2.017 V.

Post-Lab Questions for (P3)

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



It isn't a linear fit, because this is a non-purely resistive circuit which doesn't obey Ohm's law.

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

Protect the circuit. If there isn't the 50Ω resistor, the current may be too high as we don't know the exact value of the resistence of the LED, when the power supply voltage is too high, there is a risk of the circuit being burnt out.

References

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