Spring 2023

EEE/ETE 141L

Electrical Circuits-I Lab (Sec-19)

Faculty: Mr. Saif Ahmed (SfA)

Instructor: Md. Rabiul Karim Khan

Lab Report 03: Loading Effect of Voltage Divider Circuit.

Date of Performance:
12 March, 2023

Date of Submission:
02 April, 2023

Group no.: 05

1. Anindita Das Mishi – 2211364642
2. Sarith Chowdhury – 2212551642
3. Joy Kumar Ghosh – 2211424642
4. Md. Mehedi Hossain - 1922225642
5. Anisa Akter Meem - 2212538042

Experiment Name: Loading Effect of Voltage Divider Circuit

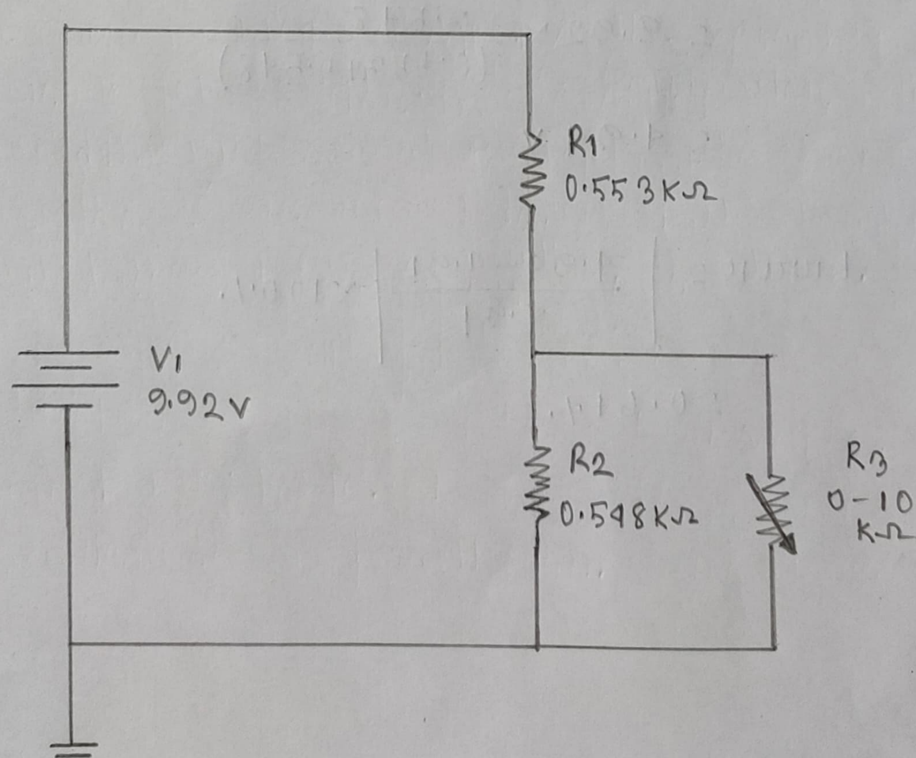
Objectives:

- To analyze how the voltage divider circuit behaves when there is no load resistance connected.
- Evaluate the performance of voltage divider circuit due to loading.

Apparatus:

- Breadboard
- Resistors (2x 560Ω)
- Variable Resistor (0-10 KΩ)
- Digital Multimeter (DMM)
- DC Power Supply
- Wires

Circuit Diagram:



Data Table:

Table 01:

RL	Vout (V) (Measured)	Vout (V) (calculated)	% Error
No Resistor	4.91	4.94	0.61%
1.01K	3.87	3.88	0.26%
3.99 K	4.60	4.62	0.43%
6.99K	4.73	4.75	0.42%
10.02K	4.80	4.81	0.21%

Theoritical Vout Calculation:

$V_{in} = 9.92\ V$
$R_1 = 0.553\ k\Omega$
$R_2 = 0.548\ k\Omega$

without load,

$$V_{out} = V_{in} \frac{R_1}{R_1+R_2}$$

$$= 9.92 \times \frac{0.548}{(0.553+0.548)}$$

$$= 4.94\ V$$

$$\text{Error} = \left| \frac{4.94-4.91}{4.94} \right| \times 100\%$$

$$= 0.61\%$$

With load,

when, $R_3 = 1.01\ k\Omega$

$$V_{out} = V_{in} \frac{(R_2 \parallel R_3)}{R_1 + (R_2 \parallel R_3)}$$

$$= 9.92 \times \frac{(1/0.548 + 1/1.01)^{-1}}{0.553 + (1/0.548 + 1/1.01)^{-1}}$$

$$= 3.88\ V$$

$$\text{Error} = \left| \frac{3.88 - 3.87}{3.88} \right| \times 100\%$$

$$= 0.26\%$$

when, $R_3 = 3.99\ k\Omega$

$$V_{out} = V_{in} \frac{(R_2 \parallel R_3)}{R_1 + (R_2 \parallel R_3)}$$

$$= 9.92 \times \frac{(1/0.548 + 1/3.99)^{-1}}{0.553 + (1/0.548 + 1/3.99)^{-1}}$$

$$= 4.62\ V$$

$$\text{Error} = \left| \frac{4.62 - 4.60}{4.62} \right| \times 100\%$$

$$= 0.43\%$$

When, $R_3 = 6.99\ k\Omega$

$$V_{out} = V_{in} \frac{(R_2 \| R_3)}{R_1 + (R_2 \| R_3)}$$

$$= 9.92 \times \frac{(1/0.548 + 1/6.99)^{-1}}{0.553 + (1/0.548 + 1/6.99)^{-1}}$$

$$= 4.75\ V$$

$$\text{Error} = \left| \frac{4.75 - 4.73}{4.75} \right| \times 100\%$$

$$= 0.42\%$$

When, $R_3 = 10.02\ k\Omega$

$$V_{out} = V_{in} \frac{(R_2 \| R_3)}{R_1 + (R_2 \| R_3)}$$

$$= 9.92 \times \frac{(1/0.548 + 1/10.02)^{-1}}{0.553 + (1/0.548 + 1/10.02)^{-1}}$$

$$= 4.81\ V$$

$$\text{Error} = \left| \frac{4.81 - 4.80}{4.81} \right| \times 100\%$$

$$= 0.21\%$$

Graph:

N/A

Result Analysis:

After this experiment, we found that the voltage accross a component suddenly drops whenever we add a resistor parallel to that component. Then, when we increase the resistor value, the total resistor increases, and the voltage rises. So, we can control the voltage of a component by adding a variable resistor parallet to that component.

Questions and Answers:

01. When there was no loading resistor in our circuit, Vout in R2 was 4.91 volts. Whenever, we add the variable resistor with a valve of 1.01 K ohms in parallel, the total resistance at that point decreases and the voltage drops to 3.87 volts. Then, when we increase and the voltage rises to 4.60 volts. As we connected the variable resistor in parallel connection, the total resistance of that point must be less than the lower resistor. In this case, the the lower resistor is R2. So we can't get the previous voltage again, but we can control the voltage up to <4.91 volts. So, we can now control the voltage of R2 by changing the value of the variable resistor.

02. All calculation showed in Data Table Section.

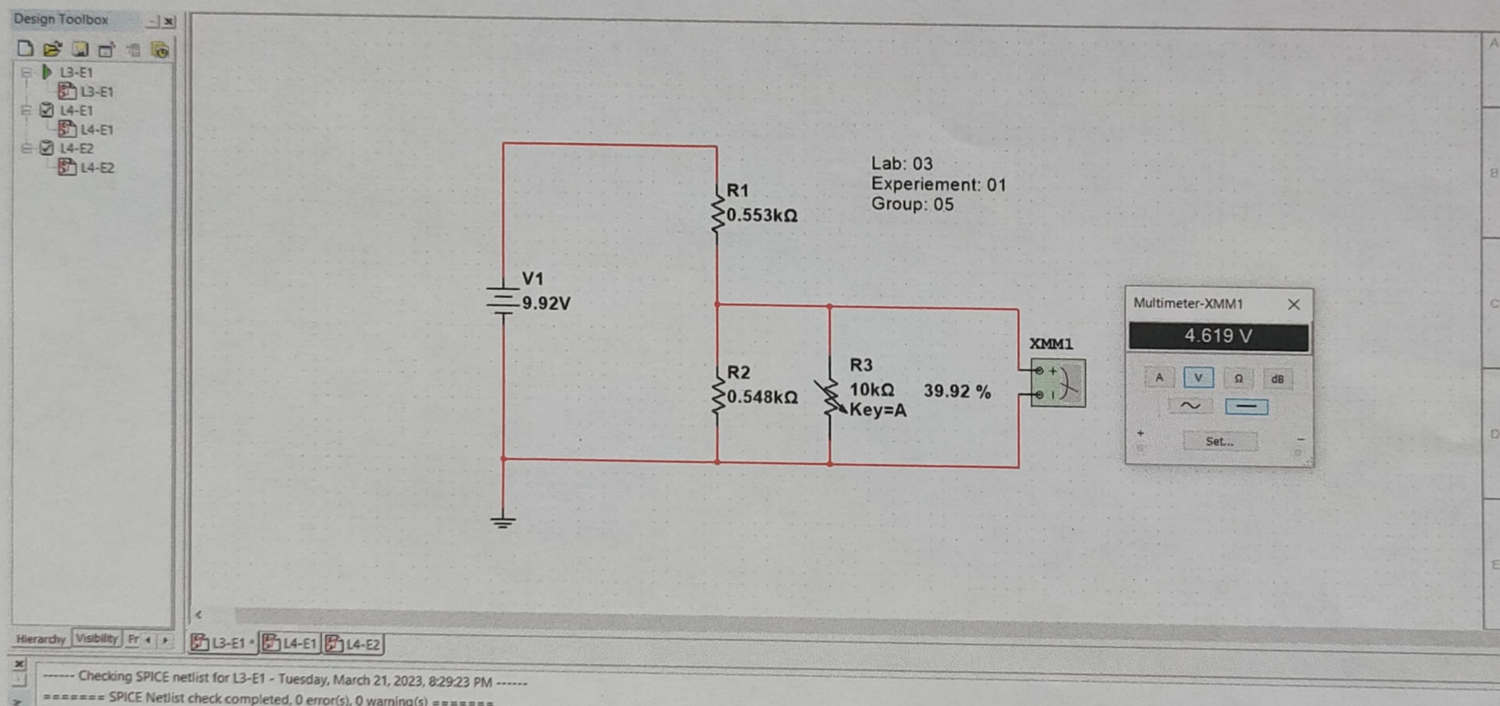
03. Our measured data and theoretically calculated data are appoximately the same. we found a minimal margin of errrom of about 0.21-0.61%. only. This error may happen due to wires resistance; variable resistors may increase by a bit of resistance so, our voltage divider circuit supports the theory of the loading effect.

Discussion:

In this experiment, we analyze the voltage divider circuit behaves when there is a loading resistance connected in parallel connection. we saw how the voltage changes with the loading resistance value. Most importantly, we can now control the voltage of a component by adding a variable resistor in a parallel connection. In this experiment, we face some problems related to the variable resistor. To set its value at a particular point was too difficult; sometimes, it auto changed its resistance. We managed to keep it steady and completed the experiment within the time.

Attachment:

01. Signed Data Table.
02. Simulation using multisim.


Design Toolbox
L3-E1
L3-E1
L4-E1
L4-E1
L4-E2
L4-E2
Lab: 03
Experiement: 01
Group: 05
R1
0.553kΩ
V1
9.92V
R2
0.548kΩ
R3
10kΩ
Key=A
39.92 %
XMM1
Multimeter-XMM1
4.619 V
A
V
Ω
dB
Set...
Hierarchy
Visibility
L3-E1
L4-E1
L4-E2
------ Checking SPICE netlist for L3-E1 - Tuesday, March 21, 2023, 8:29:23 PM ------
======= SPICE Netlist check completed, 0 error(s), 0 warning(s) =======

- **Now say we connect an output load, R_3 in parallel to R_2 :**

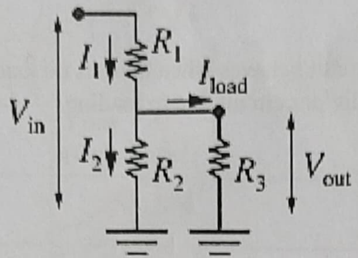


Figure 2: With Output Load Connected.

⇒ Do you think keeping the values of resistors same would still give Vout=3V from Vin=5V ?
Let's check:

Since you have a Load resistance parallel to R_2 , your Voltage divider formula to find Vout is:

$$V_{out} = V_{in}\frac{(R_2 // R_3)}{R_1+(R_2 // R_3)} \tag{2}$$

Let $R_3 = 10k$.
$R_2 \; // \; R_3 = 2.31k$

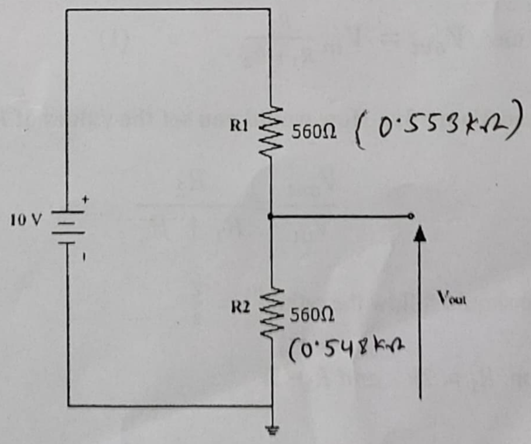
$\rightarrow V_{out} = 2.68\ v$

So, our Designed value was 3v, but connecting a load resistor reduced it to 2.68v.

Design Criteria:

To minimize the loading effect, choose the load resistor to be much larger than its parallel resistor.
If R_3 is much greater than R_2 then $R_2 \; // \; R_3$ (parallel combination of R_2 *and* R_3) is approximately equal to R_2

Circuit Diagram:



NORTH SOUTH UNIVERSITY

DEPARTMENT OF ELECTRICAL & COMPUTER ENGINEERING

Electrical Circuit I Lab

Data Collection for Lab 3:

Group No. ________
Instructor's Signature [illegible] 12/03/2

Table 1:

RL	Vout (V) (Measured)	Vout (V) (Calculated)	%Error
No resistor	4.91	4.94	0.61%
1k (1.01)	3.87	3.88	0.26%
4k (3.99)	4.60	4.62	0.43%
7k (6.99)	4.73	4.75	0.42%
10k (10.02)	4.80	4.81	0.21%

Report Question:

1. Explain the loading effect of your circuit (i.e explain how does your Vout vary with increasing Load resistor)
2. Showing all steps in details, theoretically calculate the value of Vout for each load resistor.
3. Comparing the theoretical data to the experimental data, comment how far the loading effect of your circuit supports the theory.