

Report Experiment 1: Electrical Measurement

Aidilfitri bin Sawalludin, A19EE0313 | Amirul Irfan bin Zaidi, A19EE0317 |

Amir Zafran bin Mohd Shahrizan, A19EE0426

GROUP 16, SEEE2133-10,

School of Electrical Engineering, Faculty of Engineering, Universiti Teknologi Malaysia

Abstract – This report analyzed the data between calculated value and simulation value. This experiment used two methods to obtain the value of Voltage (V) and Current (I) passes through the resistors which are theoretical calculation and simulation process. For theoretical calculation, we used Ohm’s Basic Law, Kirchhoff’s Voltage Laws, Kirchhoff’s Current Laws and also both current and voltage divider rule. Whereas, simulation data is obtained through a simulation from an online software called Tinkercad. At the end of the experiment, we found out that theoretical calculation and simulation results were almost identical.

Keywords – Basic Law, Ohms Law, Kirchhoff’s Current Law, Kirchhoff’s Voltage Laws, Current Divider Rule, Voltage Divide Rule, Tinkercad.

I. INTRODUCTION

Ohm’s Law is one of the fundamental techniques in electrical and electronic analysis which states that the current, I flowing through a conductor is proportional to the voltage, V applied across it and inversely proportional to Resistance, R [1]. Kirchhoff’s Voltage Laws (KVL) and Kirchhoff’s Current Laws (KCL) were both expanding the idea of Ohm’s Law. KVL says that the sum of voltages around a loop is zero. The total work done on a charge carrier by electric forces in supply components must equal the total work done by the charge carrier in other components by the time it has gone round the circuit once. KCL states that current flowing into a node must be equal to current flowing out of it [2]. This is because referencing the fundamental concept of physics, charge (energy) will always be conserved, neither created nor destroyed. Tinkercad is a circuit simulation program that runs on a web browser and widely used for the ease of use and free modelling pricing.

II. METHODOLOGY

The circuit in-used is from Question 14 but the value of the resistors is modified into two times of its original value.

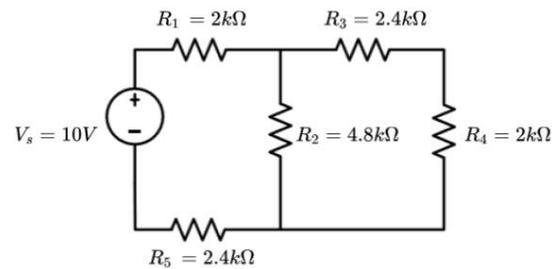


Figure 1: Question 14 Circuit (Modified Resistor Value) Design

A. Theoretical Calculation

To calculate the values of voltage and current on each resistor, we have used Ohm’s Law, KVL, KCL, Current Divider Rule & Voltage Divider Rule.

1) Find Resistor Equivalent, R_{eq}

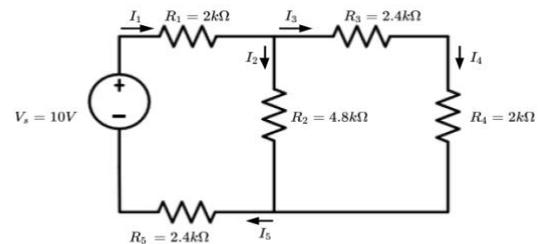


Figure 2: Circuit Original Design

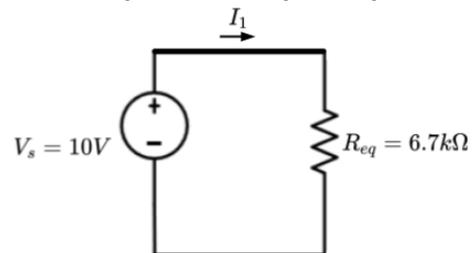


Figure 3: Circuit Equivalent

$$R_{eq} = [(R_3 + R_4) || R_2] + R_1 + R_5$$

$$= 6.7k\Omega$$

2) Using Basic Law to Find Total Current I_T

$$\begin{aligned} I_T &= \frac{V_s}{R_{eq}} \\ &= \frac{10}{6.7k} \\ &= 1.49mA \end{aligned}$$

3) Using Voltage Divider Rule to Find Voltage Across V_{234} or V_{new}

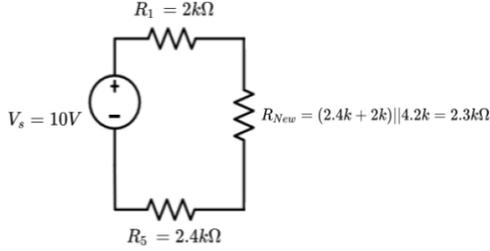


Figure 4: Circuit Design to find V_{234}

$$\begin{aligned} V_{New} &= \left(\frac{R_{New}}{R_1 + R_{New} + R_5} \right) V_s \\ &= \left(\frac{2.3k}{6.7k} \right) 10 \\ &= 3.43V \end{aligned}$$

4) Find Current Across Each Components Resistors using Basic Law & Current Divider Rule

$$\begin{aligned} I_1 &= I_T \\ &= 1.49mA \end{aligned}$$

$$\begin{aligned} I_2 &= \frac{V_{New}}{R_2} = \frac{3.43V}{4.8k\Omega} = 715\mu A \\ I_3 &= \frac{V_{New}}{R_3 + R_4} = \frac{3.43}{2.4k + 2k} = 779\mu A \end{aligned}$$

$$\begin{aligned} I_4 &= I_3 = 779\mu A \\ I_5 &= I_2 + I_4 = 779\mu + 715\mu = 1.49mA \end{aligned}$$

5) Find Voltage Across Each Components Resistors using Basic Law

$$\begin{aligned} V_1 &= I_1 R_1 = 1.49m \times 2k = 2.98V \\ V_2 &= I_2 R_2 = 715\mu \times 4.8k = 3.43V \end{aligned}$$

$$\begin{aligned} V_3 &= I_3 R_3 = 779\mu \times 2.4k = 1.87V \\ V_4 &= I_4 R_4 = 779\mu \times 2k = 1.56V \end{aligned}$$

$$\begin{aligned} V_5 &= I_5 R_5 = 1.49m \times 2.4k = 3.58V \end{aligned}$$

B. Simulation Data

1) Circuit Design, Current Measurements & Voltage Measurements

We design and simulate the Circuit using Tinkercad. To find the Current flowing through the resistor, we connect the multimeter in series with the resistor. On the other hand, we connect the multimeter in parallel with resistor to find its voltage.

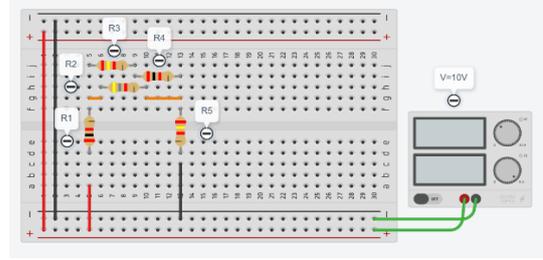


Figure 5: Circuit Design in Tinkercad

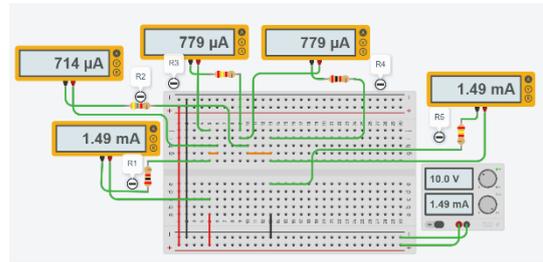


Figure 6: Current Measurements

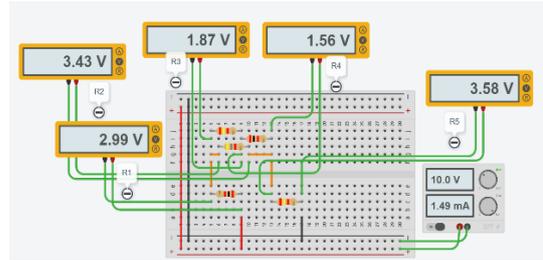


Figure 7: Voltage Measurements

III. RESULTS

Resistor	Calculated Current Value (A)	Measured Current Value (A)
R1	1.49m	1.49m
R2	715μ	714μ
R3	779μ	779μ
R4	779μ	779μ
R5	1.49m	1.49m

Table 1: Current Data

Resistor	Calculated Voltage Value (V)	Measured Voltage Value (V)
R1	2.98	2.99
R2	3.43	3.43
R3	1.87	1.87
R4	1.56	1.56
R5	3.58	3.58

Table 2: Voltage Data

IV. DISCUSSION

The value of Voltage and Current for all of the Resistors from both theoretical calculation and simulation are almost the same. The main reason on why does the results are almost identical and not entirely the same is because of we may round up to the nearest value in our theoretical calculation which is not as accurate and precise as the simulation. However, a real time or experimental data will have a slightly different in terms of the measured value due to the presence of internal resistance in the multimeter and tolerance of components in the circuit. When measuring voltage, an ideal multimeter should have infinite internal resistance. Whereas, when measuring current, an ideal ammeter should have zero internal resistance. Both of this ideal multimeter requirements are impossible to fulfill in a real-life scenario due to the said presences. Thus, this is why the calculated, the simulated and the would-be-measured data are almost identical but are not the same as one another.

V. CONCLUSION

In this experiment, we have done our theoretical calculation manually using the basic concepts of Circuit Theory and our simulation using Tinkercad, an online software to find the current and the voltage in all of the resistors as the Question required. As expected, we have found that the theoretical and simulation data are almost but not entirely the same because of the factor of accurate and precision in those two methods. We also discussed that a real-life measured data would also have the almost but not entirely same result due to the presences of internal resistance in the multimeter and tolerance in the components. In a conclusion, the current and voltage in each resistor using the theoretical, the simulation and the would-be-measured data are found to be almost identical to one another.

VI – REFERENCES

- [1] Gupta M. S. (1980). George Simon Ohm and Ohm's Law. *IEEE Transactions on Education*, 23(3), 156-162,
<https://doi.org/10.1109/TE.1980.4321401>
- [2] Isaac Physics. (n.d.). *Kirchhoff's Laws*.
https://isaacphysics.org/concepts/cp_kirchhoffs_laws
- [3] Electronics Tutorial. (n.d.). *Voltage Dividers*.
<https://www.electronicstutorials.ws/dccircuits/voltage-divider.html>
- [4] Electronics Tutorial. (n.d.). *Current Dividers*.
<https://www.electronicstutorials.ws/dccircuits/current-divider.html>
- [5] MrYap. (2020). *How to Use Multimeter in Tinkercad*. <https://youtu.be/VoXFDrIRp3U>
- [6] Abdul Rahim R. (2006). *Chapter 2: Analogue Instruments*. [PowerPoint Slides]
https://elearning.utm.my/20211/pluginfile.php/1055410/mod_resource/content/0/Ch2a%20Analogue%20Instruments.pptx