Lab Experiment #1

Ohm's Law & Introduction to Basic Equipment and Components

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Contents

Chapter 1

Overview

The primary objective of this laboratory session was to acquaint ourselves with the fundamental equipments, components commonly used in electronic laboratories and Ohm's Law. The lab exercises were designed to reinforce theoretical concepts through practical experimentation. This report documents our findings and analyses from the conducted experiments.

Chapter 2

Pre-Lab Work

The purpose of this pre-lab work is to prepare for this experiment (Laboratory Experiment #1) in the ESD Capsule. This lab aims to familiarize students with basic electronic equipment and components commonly used in laboratory settings. The tasks involve theoretical analysis, LTspice simulations, and practical measurements using laboratory instruments.

The pre-lab work is divided into three parts: theoretical analysis, LTspice simulations, and resistor colour-code calculation.

Outcomes of these pre-lab works will not be shown here explicitly, but will be used in the next pages of this paper with the experimental part results.

2.1 Theoretical Analysis

We analyzed each circuit theoretically and calculated the expected values based on the provided circuit configurations and component values.

2.2 LTspice Simulations

Using LTspice, we implemented each circuit and conducted simulations to verify the expected outcomes. The simulation results were appropriately labeled and aligned with the theoretical analysis.

2.3 Resistor Colour Code

We determined the color codes of resistors using the Resistor Colour Code and showcased the calculation process to identify the resistance values.

Chapter 3

Exercises

3.1 Exercise 1: Resistance Measurement

3.1.1 Objective

The objective of this exercise is to measure the resistance of a resistor using a digital multimeter and compare the measured value with the calculated value.

3.1.2 Equipment

- Digital Multimeter (DMM)
- Resistors (470Ω, $1k\Omega$, $4.3k\Omega$)
- Breadboard
- Power Supply

3.1.3 Procedure

1. We have connected each resistor to the breadboard and measured the resistance using the digital multimeter.

2. We have calculated the each resistor value using the values according to this table:

Color	1st Band	2nd Band	3rd Band	Multiplier (Ω)	Tolerance (%)
Black	0	0	0	1	-
Brown	1	1	1	10	±1
Red	2	2	2	100	±2
Orange	3	3	3	1,000	-
Yellow	4	4	4	10,000	-
Green	5	5	5	100,000	±0.5
Blue	6	6	6	1,000,000	±0.25
Violet	7	7	7	10,000,000	±0.1
Gray	8	8	8	100,000,000	±0.05
White	9	9	9	1,000,000,000	-
Gold	-	-	-	0.1	±5
Silver	-	-	-	0.01	±10

Table 3.1: Resistor Color Code Table [1]

- In order to calculate the resistance value of a resistor using the color code, we can use the following formula:

$$\text{Resistance} = (1^{st}\ \text{Band} \times 10 + 2^{nd}\ \text{Band}) \times \text{Multiplier}$$

- These are the results of the calculations:

Resistor	Color Code
$R_1 = 470\Omega$	Yellow-Violet-Brown
$R_2 = 1k\Omega$	Brown-Black-Red
$R_3 = 4.3k\Omega$	Yellow-Orange-Red

Table 3.2: Color Codes for Given Resistors

3. We have measured the resistor values using the digital multimeter and these are the results:

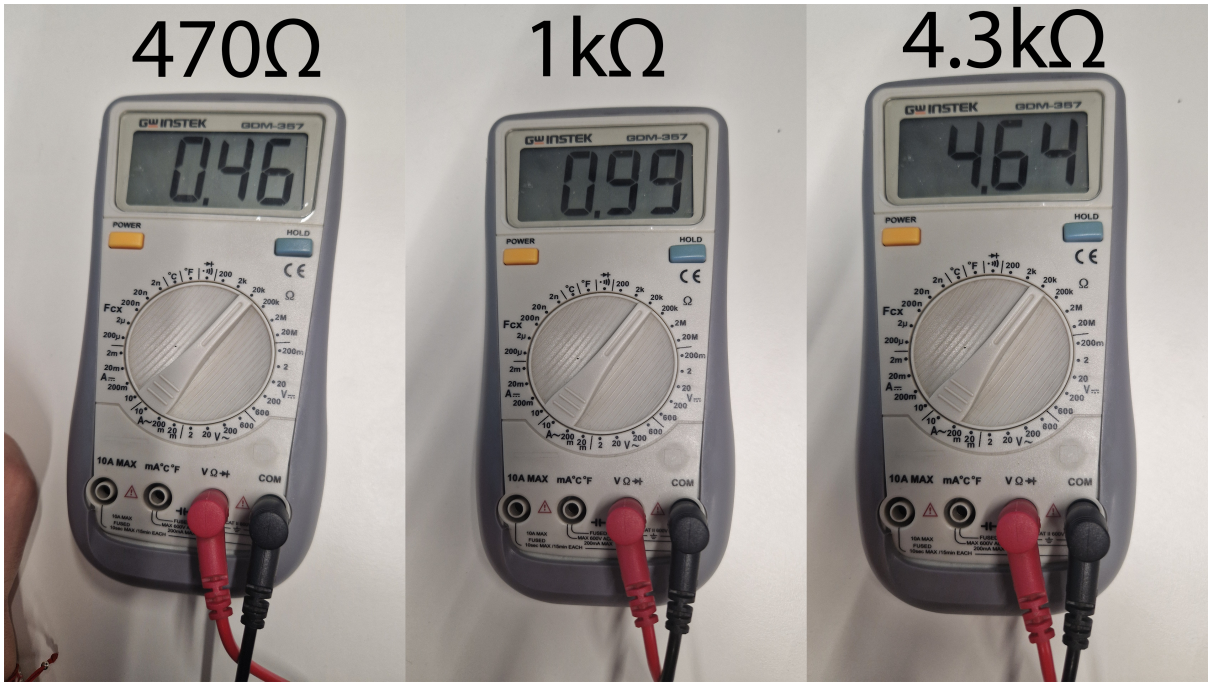

Figure 3.1: Resistor Measurements Using Digital Multimeter

Expected	Calculated	Color Code
$R_1 = 470\Omega$	460Ω	Yellow-Violet-Brown
$R_2 = 1k\Omega$	$0.99k\Omega$	Brown-Black-Red
$R_3 = 4.3k\Omega$	$4.64k\Omega$	Yellow-Orange-Red

Table 3.3: Real Measured Values of Resistors According to the Figure#3.1

3.1.4 Results

We have measured the resistance of the resistors and compared the results with the expected values and the measured values are close to the calculated values. The differences between the measured and calculated values are due to the tolerance of the resistors. The tolerance of the resistors are $\pm 5\%$ and $\pm 1\%$. The measured values are within the tolerance range.

3.2 Exercise 2: Series Circuit Analysis

3.2.1 Objective

The purpose of this exercise is to measure the voltage and current values of a circuit in which resistors are connected in series.

3.2.2 Equipment

- Digital Multimeter (DMM)
- Resistors ($1k\Omega$, $4.3k\Omega$)
- Breadboard
- Power Supply
- Wires (Jumper Cables & Crocodile Clips)

3.2.3 Procedure

1. We have made the circuit analysis using LTspice and these are the results:

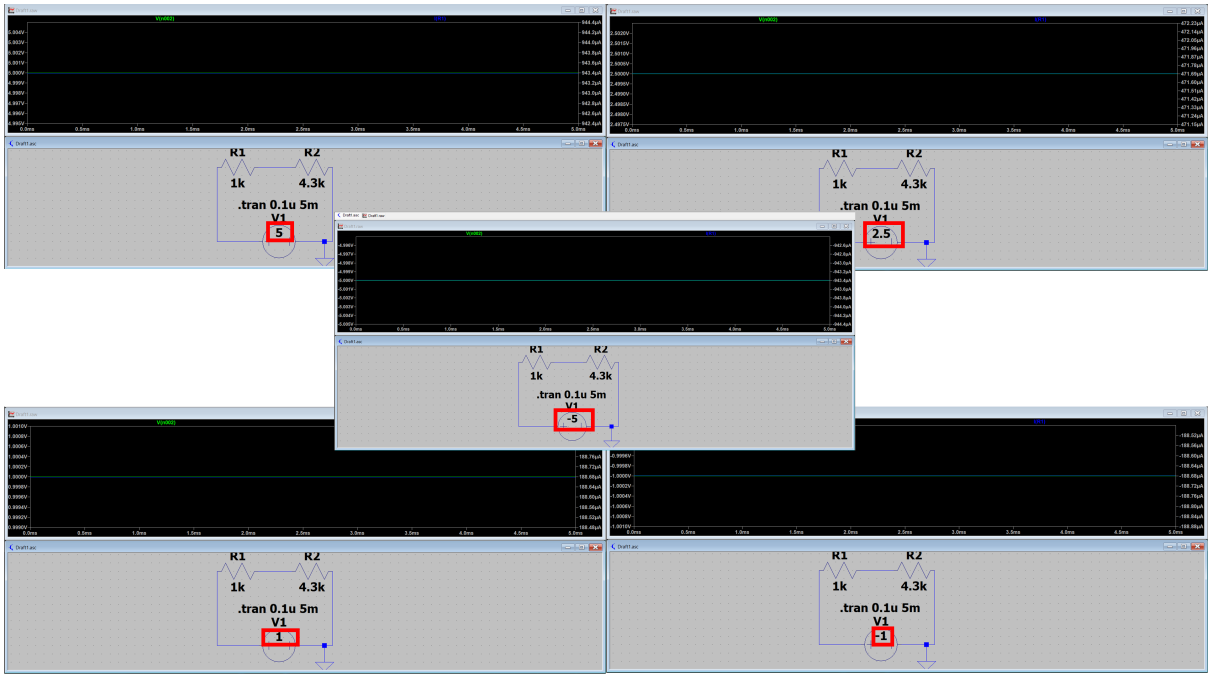

Figure 3.2: Circuit Diagram & Calculations

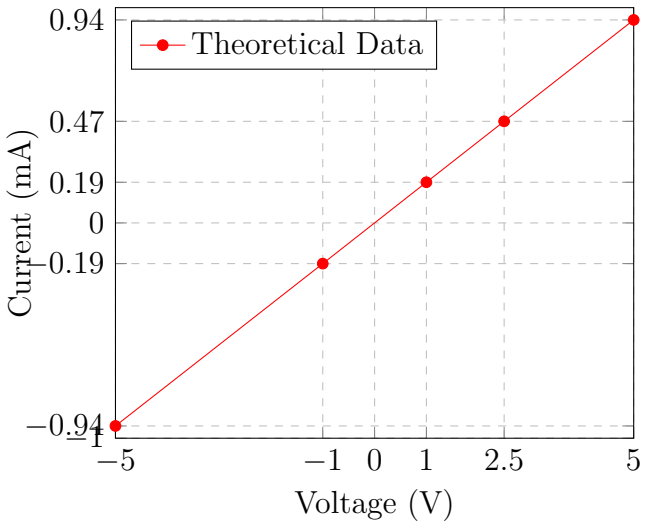

Figure 3.3: Voltage-Current Graph of the Theoretical Circuit

2. We have connected the resistors in series on the breadboard as shown in the figure below:

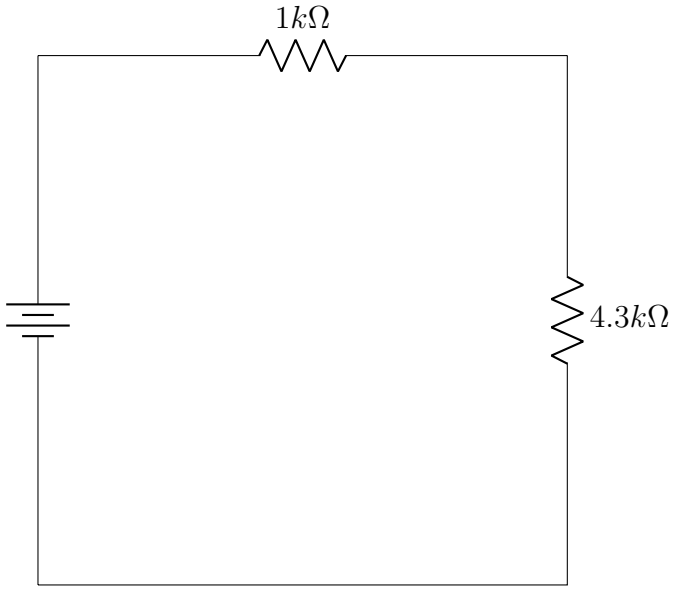

Figure 3.4: Series Circuit with Two Resistors

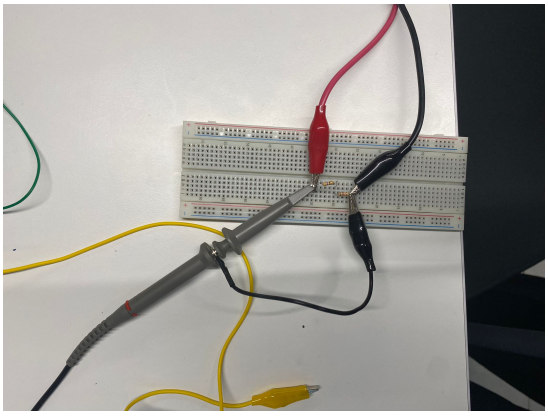

Figure 3.5: Circuit Connection on Breadboard

Figure 3.6: Power Supply Connection

3. We have measured the current values and these are the results:

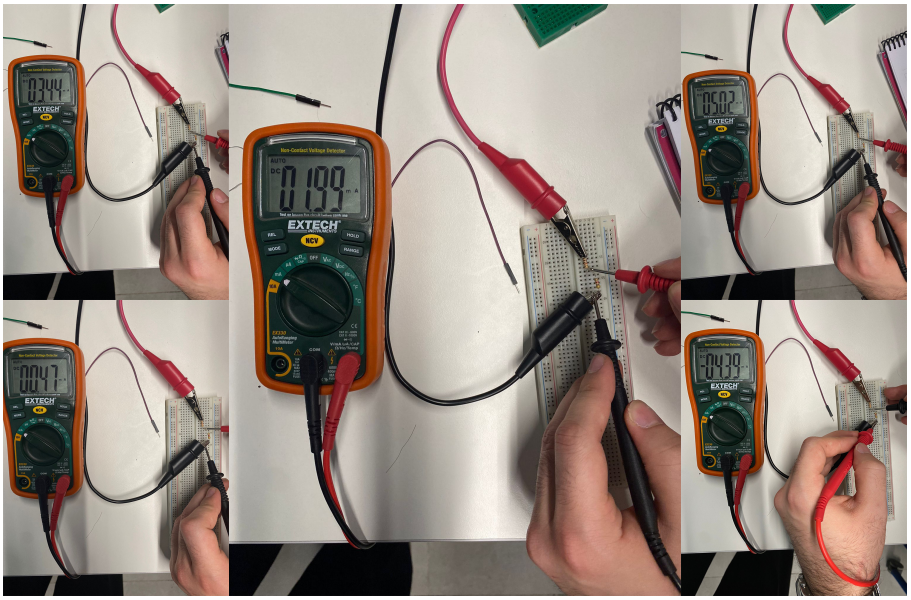

Figure 3.7: Experimental Measurements of the Series Circuit

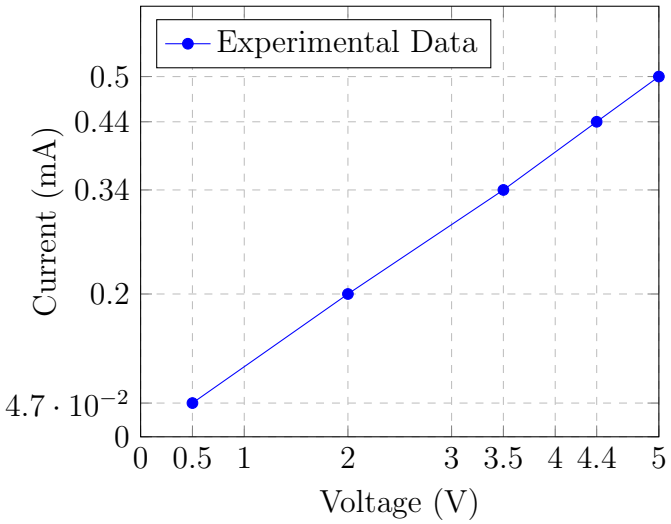

Figure 3.8: Voltage-Current Graph of the Experimental Circuit According to the Figure#3.7

4. We have compared the theoretical and experimental results and these are the results:

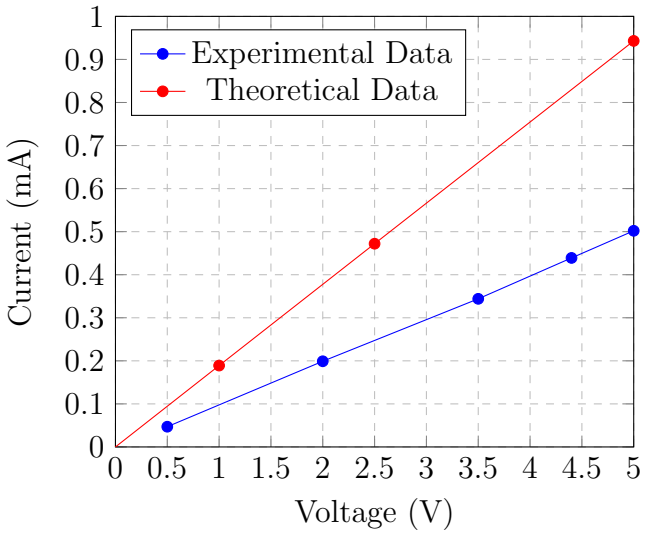

Figure 3.9: Voltage-Current Graph Comparasion

3.2.4 Results

We have measured the voltage and current values of the series circuit and compared the results with the theoretical values. The results are close to the theoretical values. The differences between the theoretical and experimental values are due to the tolerance of the resistors and the measurement errors.

3.3 Exercise 3: Signal Generator Circuit Analysis

3.3.1 Objective

The purpose of this exercise is to learn how to use signal generator and ossiloscope.

3.3.2 Equipment

- Signal Generator (w/ equipments)
- Oscilloscope (w/ equipments)
- Breadboard
- Wires (Jumper Cables & Crocodile Clips)
- Resistors ($1k\Omega$, $4.3k\Omega$)

3.3.3 Procedure

1. We have made the circuit analysis using LTspice and these are the results:

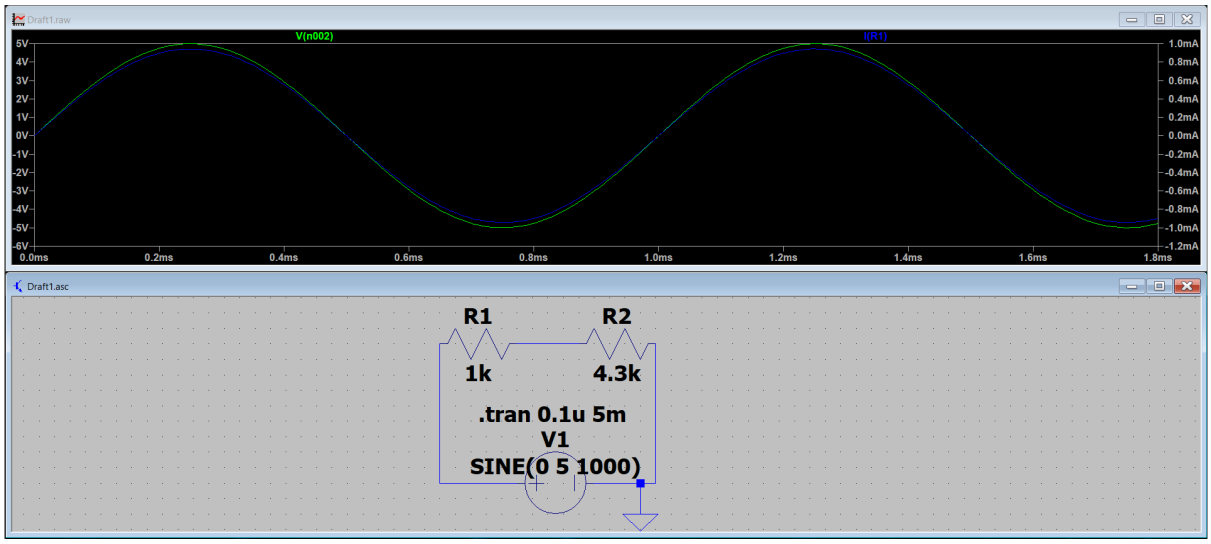

Figure 3.10: Circuit Diagram & Calculations

2. We have connected the resistors in series on the breadboard as shown in the figure below:

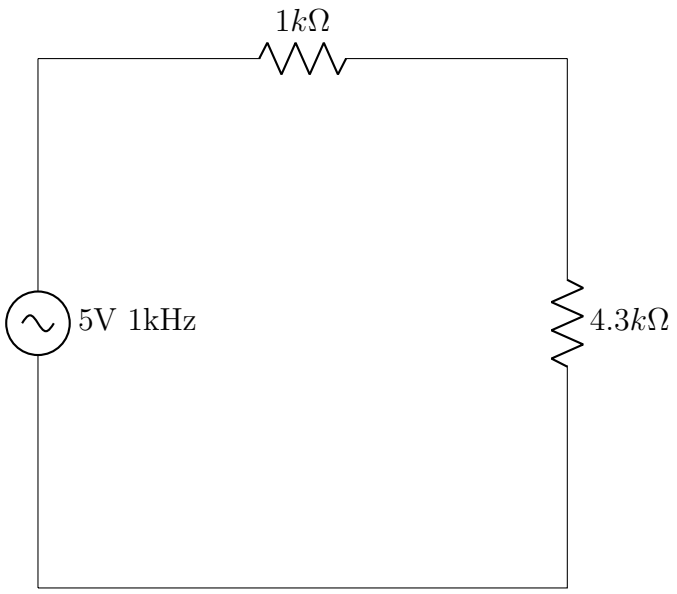

Figure 3.11: Series Circuit with Two Resistors

3. We have connected the signal generator to the circuit and measured the voltage using the oscilloscope. These are the results:

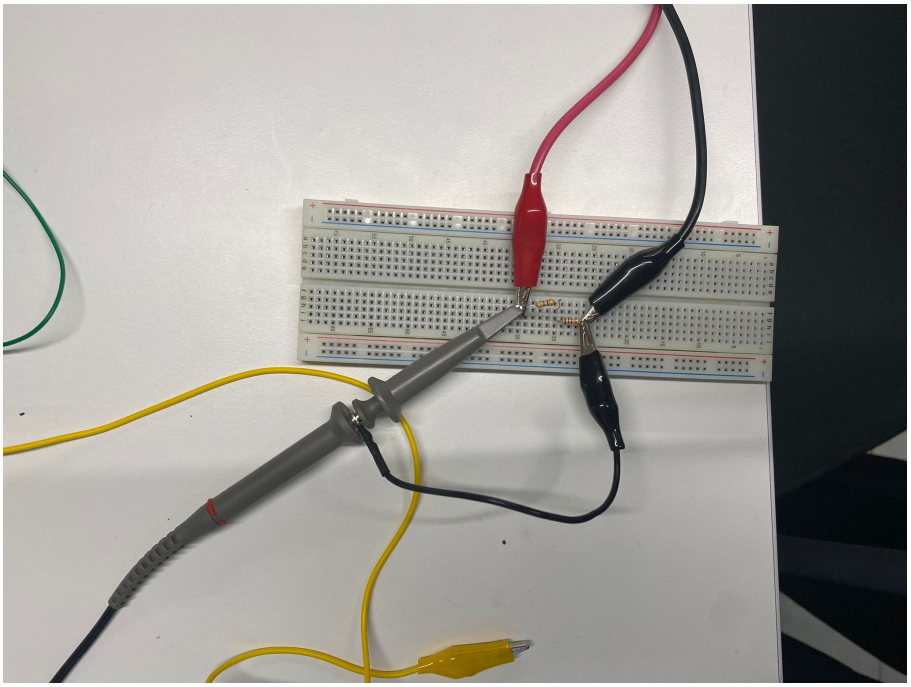

Figure 3.12: Oscilloscope Probe Connection

Figure 3.13: Signal Generator Set To Sinusodial@5V 1kHz

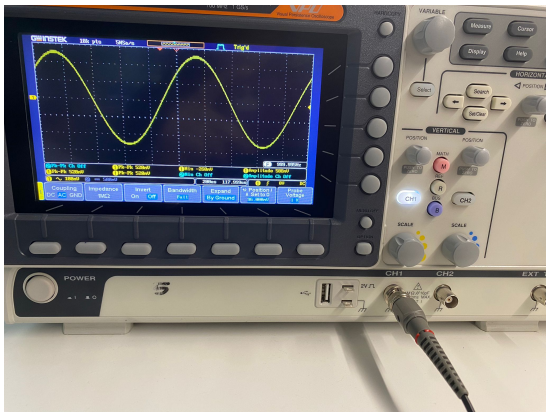

Figure 3.14: Oscilloscope Measurement Results

3.3.4 Results

We have successfully measured the voltage of the circuit using the oscilloscope. The measured voltage is close to the expected value. The differences between the expected and measured values are due to the tolerance of the resistors and the measurement errors.

3.4 Exercise 4: Parallel Circuit Analysis

3.4.1 Objective

The purpose of this exercise is to measure the voltage and current values of a circuit in which resistors are connected in parallel.

3.4.2 Equipment

- Digital Multimeter (DMM)
- Resistors ($1k\Omega$, $4.3k\Omega$)
- Breadboard
- Power Supply
- Wires (Jumper Cables & Crocodile Clips)

3.4.3 Procedure

1. We have calculated the equvalent resistance of the parallel circuit using the following formula:

$$R_{eq} = \frac{R_1 \times R_2}{R_1 + R_2} = \frac{1k\Omega \times 4.3k\Omega}{1k\Omega + 4.3k\Omega} = \frac{4.3M\Omega}{5.3k\Omega} = 0.811k\Omega$$

2. We have made the circuit analysis using LTspice and this is the results:

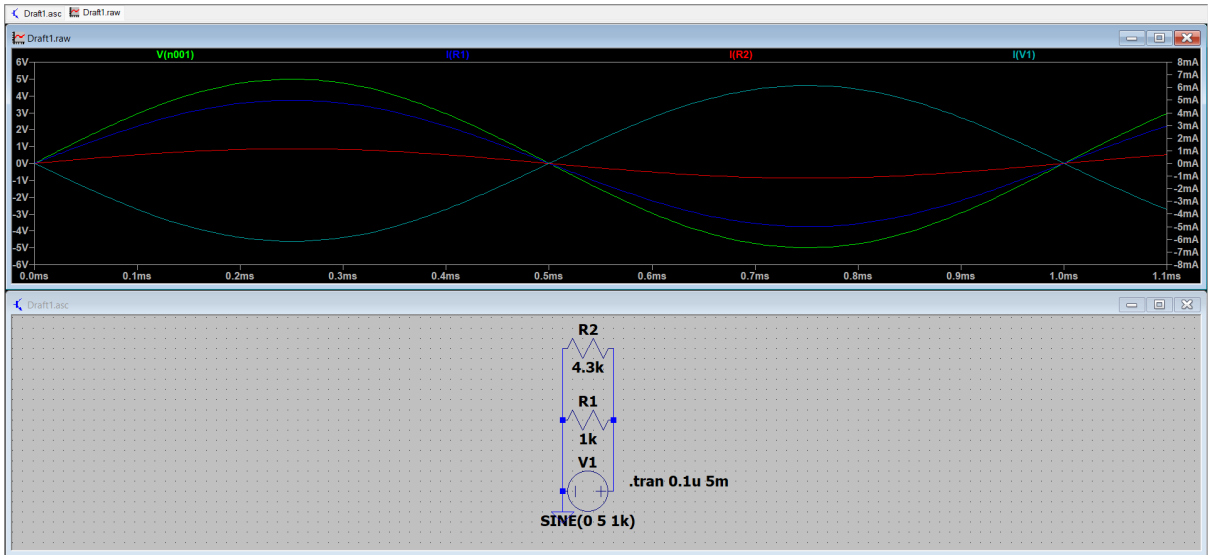

Figure 3.15: Circuit Diagram & Calculations

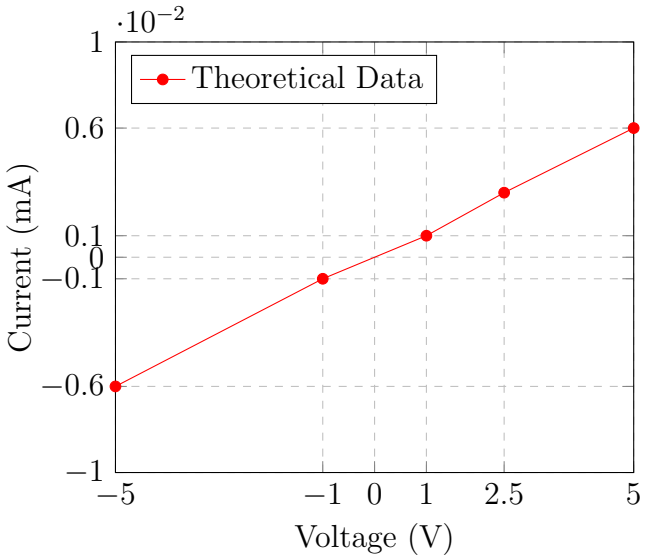

Figure 3.16: Voltage-Current Graph of the Theoretical Circuit

3. We have connected the resistors in parallel on the breadboard as shown in the figure below:

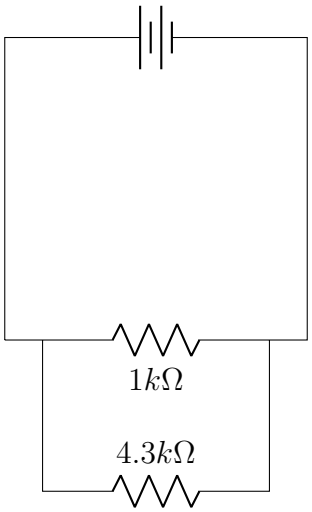

Figure 3.17: Parallel Circuit with Two Resistors

4. We have measured the current values and these are the results:

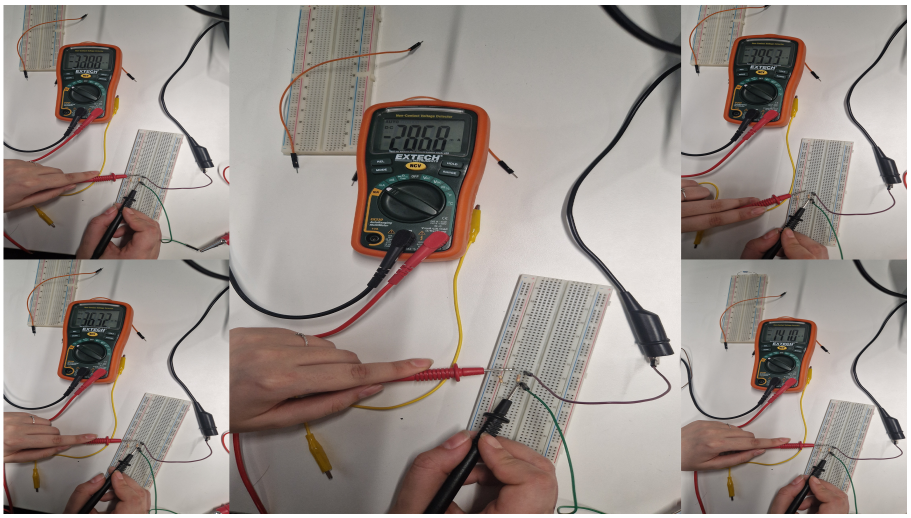

Figure 3.18: Experimental Measurements of the Series Circuit

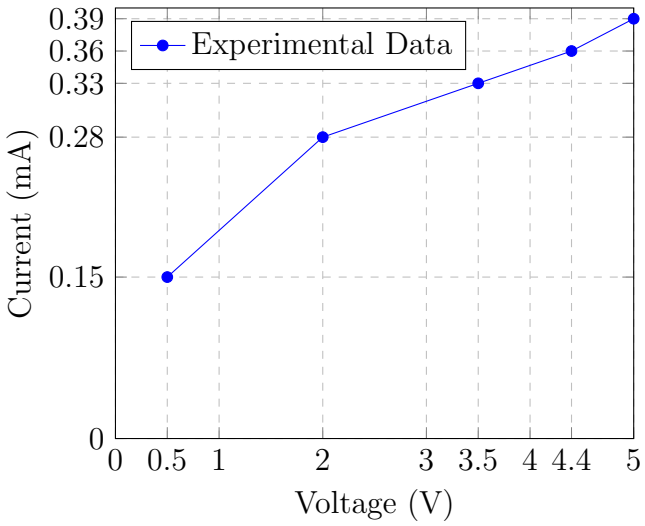

Figure 3.19: Voltage-Current Graph of the Experimental Circuit According to the Figure#3.18

5. We have compared the theoretical and experimental results and these are the results:

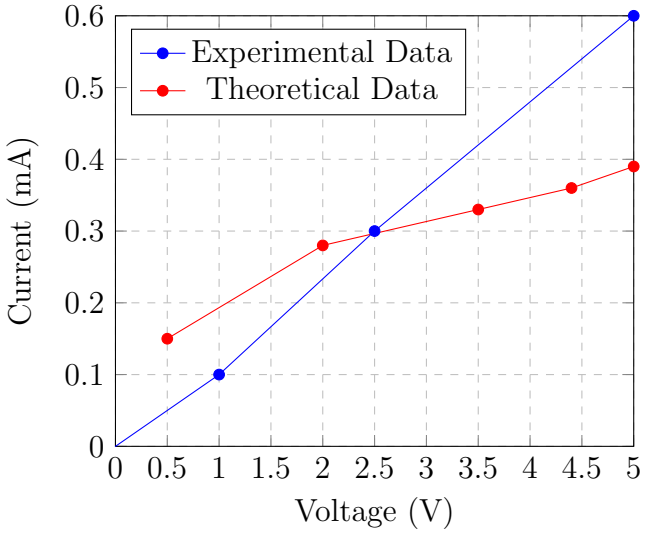

Figure 3.20: Voltage-Current Graph Comparasion

3.4.4 Results

We have measured the voltage and current values of the parallel circuit and compared the results with the theoretical values. The results are close to the theoretical values. The differences between the theoretical and experimental values are due to the tolerance of the resistors and the measurement errors.

Chapter 4

Conclusion

Through this laboratory session, we gained hands-on experience with essential electronic components and equipment. The experiments helped solidify our understanding of circuit behavior and the application of theoretical concepts in practical scenarios. Analysis of the measurement data provided valuable insights into the functioning of series and parallel circuits, as well as the verification of Ohm's law.

The results of the experiments were consistent with the theoretical predictions, with minor discrepancies attributed to the tolerance of the resistors and measurement errors. The voltage-current graphs of the experimental circuits closely resembled the theoretical graphs, confirming the accuracy of the measurements. The comparison of theoretical and experimental results demonstrated the practical application of Ohm's law and the importance of accurate measurements in circuit analysis.

Overall, the laboratory session was a valuable learning experience that enhanced our understanding of basic circuit concepts and measurement techniques. The hands-on experiments provided a practical perspective on the theoretical concepts, reinforcing our knowledge of circuit behavior and the application of Ohm's law. The session was an essential component of our learning process, and we look forward to applying the knowledge gained in future experiments and projects.

Bibliography

[1] Calculator.net. Resistor Calculator. https://www.calculator.net/resistor-calculator.html, Accessed March, 2024.