ELECTRONICS (ETEN1000)

STUDENT NUMBER: **22663281**

NAME: **Dhrubo Jouti das Troyee**

GROUP : **August 8, 2024, 12:00 to 2:00 pm**

LABORATORY: **Laboratory 2: Basic Electrical Circuits**

LABORATORY SUPERVISOR: **Mr. King Su Chan**

LABORATORY PARTNERS: Amiru Ekmin indeepa Student Id: 20818694

DATE PERFORMED: 08.08.2024

DATE DUE: **15.08.2024**

DATE SUBMITTED: **13.09.2024**

I hereby declare that the calculation, results, discussion and conclusions submitted in this report is entirely my own work and have not copied from any other student or past student.

Student Signature:

Basic Electrical Circuits

INTRODUCTION

The lab is design to study of fundamental electrical circuits, in particular the behaviour of series and parallel resistor combinations and the concepts of voltage and current dividers. Ohm's law and Kirchhoff's voltage and current rules are two basic concepts that the lab desire to highlight through hands-on exploration with resistors and circuit connections. This lab also emphasizes how vital accuracy and safety are during electrical circuit analysis.

AIM

The goals of this lab are to measure voltage and current in circuits, analyse the behaviour of series and parallel resistors, and compare theoretical and actual values. The lab offers practical experience with measurement instruments and circuit design

SUMMARY

In this lab, total resistance, voltage, and current were measured after resistor circuits in series and parallel were established. The theoretical values were calculated and compared to the practical results. Due to measurement differences and resistor tolerances, there were some inconsistencies found.

CIRCUIT

CIRCUIT 1: Series Connection of Resistors and Voltage Divider

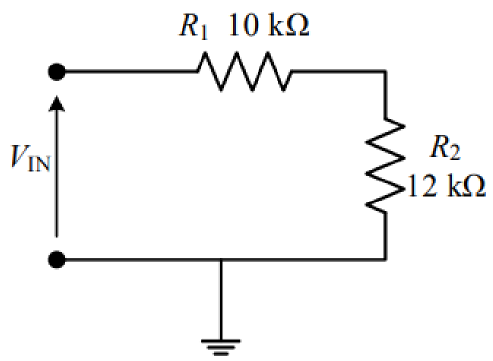


FIGURE 1: Series Connection

A simple circuit has been established in series by using two resistors (10 KΩ and 12K Ω) on a breadboard, as displayed in the above image.

CIRCUIT 2: Parallel Connection of Resistors and Current Divider

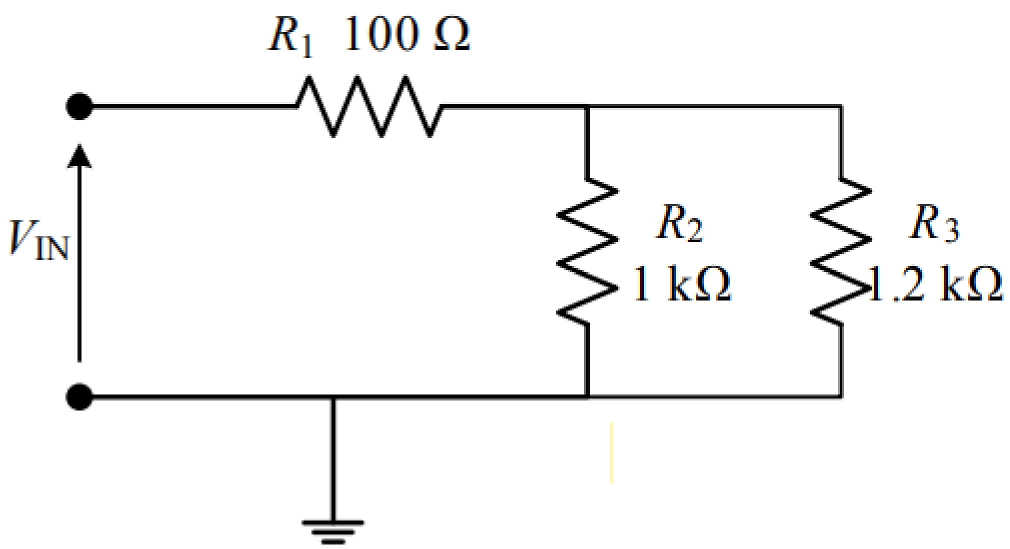


FIGURE 2: Parallel Connection

The circuit was constructed using provided resistor where $\boldsymbol{R_2}$ (1 kΩ) and $\boldsymbol{R_3}$ (1.2 K Ω) in parallel and $\boldsymbol{R_1}$ (100 Ω) in a series connection with them

RESULTS

Table 1 Resistor Color Codes

Resistor Value	Color Code from Prelab exercise	Color Code recorded in the Lab
100 Ω	Brown-Black-Brown-Gold	Brown-Black-Brown-Gold
1 kΩ	Brown-Black-Red-Gold	Brown-Black-Black-Black-Brown
1.2 kΩ	Brown-Red-Red-Gold	Red-Brown-Brown-Black-Red-Brown
10 kΩ	Brown-Black-Orange	Brown-Black-Orange-Gold
12 kΩ	Brown-Red-Orange	Red-Orange-Red-Black-Gold

Table 2 Series Connection of Resistors and Voltage Divider

Parameter	Theoretical Value from Prelab Exercise	Measured Value in the Lab
R_1	10 KΩ	9.835 k Ω
R_2	12 KΩ	12.017 k Ω
R_{Total}	22KΩ	21.857 k Ω
V_{IN}	11 V	10.55 V
V_{R1}	5 V	4.7349 V
V_{R2}	6V	5.784 V
V_{IN}	$11\ V_{p-p}$	11 V
V_{R1} (oscilloscope)	5 V	4.9178 V
V_{R2} (oscilloscope)	6V	6.0625V

Table 3 Parallel Connection of Resistors and Current Divider

Parameter	Theoretical Value from Prelab Exercise	Measured Value in the Lab
R_{Total}	0.64545 k Ω	0.64491 KΩ
I_{IN}	15.49 mA	15.395 mA
I_{R2}	8.45 mA	8.209mA
I_{R3}	7.045 mA	6.973 mA

DISCUSSION

Several significant findings were noted when analysing the series circuit results which is Figure 1. The R_1 resistance, had the accuracy of 99.20% when comparing with the theoretical value which is 10 KΩ and the experimental result which is 9.835 k Ω. In the same way, 98.88% accuracy was obtained for $\boldsymbol{R_2}$ when comparing its theoretical value (12 KΩ) and experimental value (12.017 kΩ). Comparing the overall Total Resistance to the theoretical value (22KΩ), the resistance total $\boldsymbol{R_{Total}}$ attained an amazing accuracy of 99.72% with the experimental value (21.857kΩ).

Moreover, when comparing the voltage measurements by DMM to their theoretical value (11V), the input voltage $\boldsymbol{V_{IN}}$ displayed a 99.70% accuracy with the experimental value (10.55 V). A 99.90% precision was attained for $\boldsymbol{VR_1}$ between its theoretical value of 4 V and 4.7349 V, the experimental value. Although the precision between theoretical value (6V) and the experimental value (5.784 V) of $\boldsymbol{V_{R2}}$ was 99.78%.

However, there were minor variations noted in the measured voltage for $\boldsymbol{V_{IN}}$, when applying a 1 kHz sinusoidal signal with a peak-to-peak voltage of **11 V** and then using the oscilloscope to record the same results. Little temperature differences or little adjustments made to the oscilloscope's settings could be the cause of the observed variations. When comparing the experimental value of 4.9178V for $\boldsymbol{VR_1}$ to the theoretical value of 5V, the findings revealed an accuracy of 98.80%. Furthermore, $\boldsymbol{VR}_2$ demonstrated perfect precision, as its theoretical value of 6 V matched the experimental finding of.0625V.

Considering the parallel circuit results figure 2, the total resistance total $\boldsymbol{R_{Total}}$ displayed 100% accuracy between its theoretical value (0.64545 kΩ) and experimental value (0.64491 KΩ). The measured input current $\boldsymbol{I_{IN}}$ had a 99.63% accuracy, with the theoretical value being 15.49mA and the experimental value being 15.395 mA. The individual branch currents were also measured, with $\boldsymbol{I_{R1}}$ showing an accuracy of 99.55% between its theoretical value (8.45mA) and experimental value (8.209 mA), and $\boldsymbol{I_{R2}}$ showing an accuracy of 99.71% between its theoretical value (7.045 mA) and experimental value (6.973mA).

With few exceptions mainly due to small equipment tolerances and testing-related issues, the overall relationships for both total resistance and current were verified.

CONCLUSION

In conclusion, it can be said that compared to the theoretical calculations, the experiment's results showed an accuracy rate of approximately 99.53%, indicating remarkable accuracy. Most of the variations were small and remained within allowable bounds, so expressed as decimal numbers. Overall, the expected results were successfully achieved, highlighting the efficiency and reliability of the tools and measurement techniques used in the lab.

APPENDICES

1.1 Total resistance of figure 1: series connection

As $R_1 = 10K\Omega$ and $R_{2\,=}$ 12 kΩ in a series connection,

$$\boldsymbol{R_{Total}} = R_1 + R_2$$

$$=10\text{K}\,\Omega + 12K\Omega$$

$$= 22\text{K}\,\Omega$$

1.2 Voltage of $\boldsymbol{R_1}$

$\boldsymbol{V_{in}}$ = 11 V

$\boldsymbol{R_1} = 10K\Omega$ and $\boldsymbol{R}_{2\,=}$ 12 kΩ

$$\boldsymbol{V_{R_1}} = \left(\frac{\boldsymbol{R1}}{\boldsymbol{R1+R2}}\right)\boldsymbol{Vin}$$

$$\boldsymbol{V_{R_1}} = \left(\frac{\mathbf{10\ K\Omega}}{\mathbf{10K\,\Omega + 12\ K\,\Omega}}\right) \times \mathbf{11}\,\boldsymbol{V}$$

$$\boldsymbol{V_{R_1}} = \left(\frac{\mathbf{10\ K\Omega}}{\mathbf{22\ K\,\Omega}}\right) \times \mathbf{11}\,\boldsymbol{V}$$

$\boldsymbol{V_{R_1}}$ **= 5V**

1.3 Voltage $\boldsymbol{R_2}$

$\boldsymbol{V_{in}}$ = 11 V

$\boldsymbol{R_1} = 10K\Omega$ and $\boldsymbol{R}_{2\,=}$ 12 kΩ

$$\boldsymbol{V_{R_2}} = \left(\frac{\boldsymbol{R2}}{\boldsymbol{R1+R2}}\right)\boldsymbol{Vin}$$

$$\boldsymbol{V_{R_1}} = \left(\frac{\mathbf{10\ K\Omega}}{\mathbf{10K\,\Omega + 12\ K\,\Omega}}\right) \times \mathbf{11}\,\boldsymbol{V}$$

$$\boldsymbol{V_{R_1}} = \left(\frac{\mathbf{12\ K\Omega}}{\mathbf{22\ K\,\Omega}}\right) \times \mathbf{11}\,\boldsymbol{V}$$

$\boldsymbol{V_{R_1}}$ **= 6 V**

1.4 Total Resistance of the figure 2: Parallel Connection

$\boldsymbol{R_1}$ = 100 Ω

$\boldsymbol{R_2}$ = 1 K Ω

$\boldsymbol{R_3}$ = 1.2 K Ω

As ($\boldsymbol{R_2}$ || $\boldsymbol{R_3}$) + $\boldsymbol{R_1}$ **from the figure 2**

$$\boldsymbol{R_{Total}} = R_1 + (R_2 || R_3)$$

$$\boldsymbol{R_{Total}} = R_1 + \left(\frac{R_2 \times R_3}{R_2 + R_3}\right)$$

$$\boldsymbol{R_{Total}} = 100\ \Omega + \left(\frac{\mathbf{1}\ \text{K}\Omega \times \mathbf{1.2}\ \text{K}\Omega}{\mathbf{1}\text{K}\ \Omega + 1.2\ \text{K}\ \Omega}\right)$$

$$\boldsymbol{R_{Total}} = 100\ \Omega + \left(\frac{\mathbf{1.2}\ \text{K}\Omega}{\mathbf{2}.2\ \text{K}\ \Omega}\right)$$

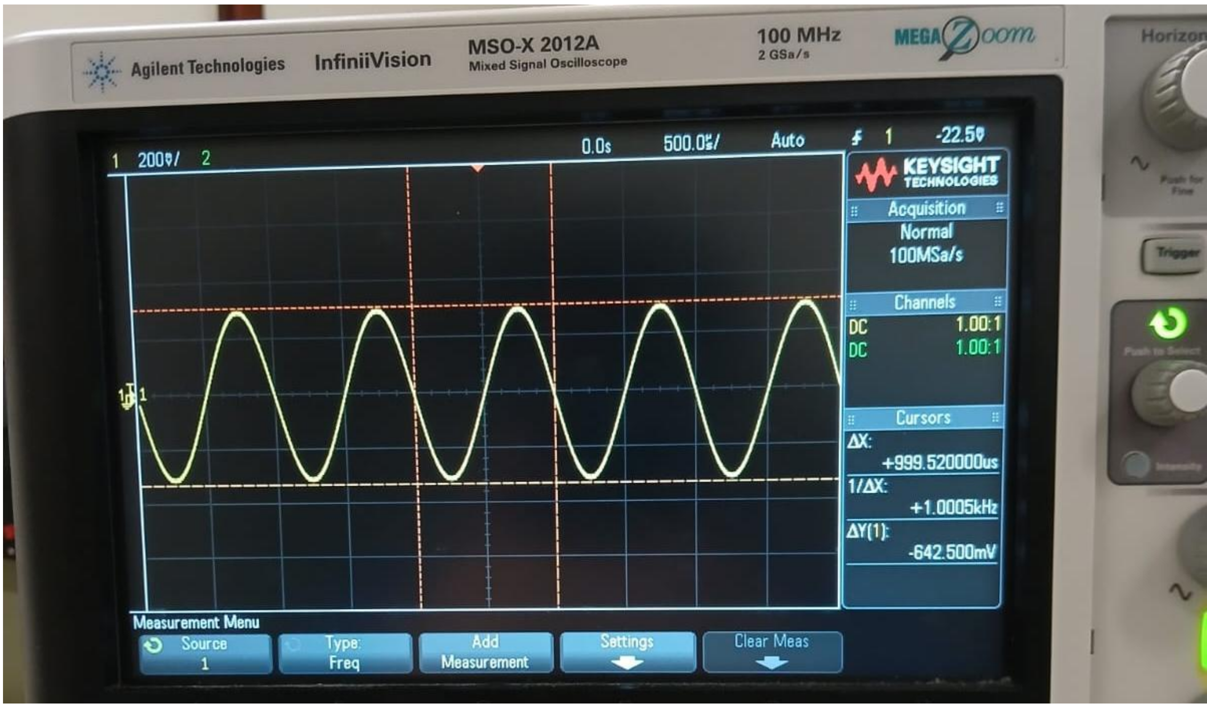
$$\boldsymbol{R_{Total}} = 100\ \Omega + 0.54545\ \text{K}\ \Omega$$

$$\boldsymbol{R_{Total}} = 100\ \Omega + (0.54545 \times 1000)\ \Omega$$

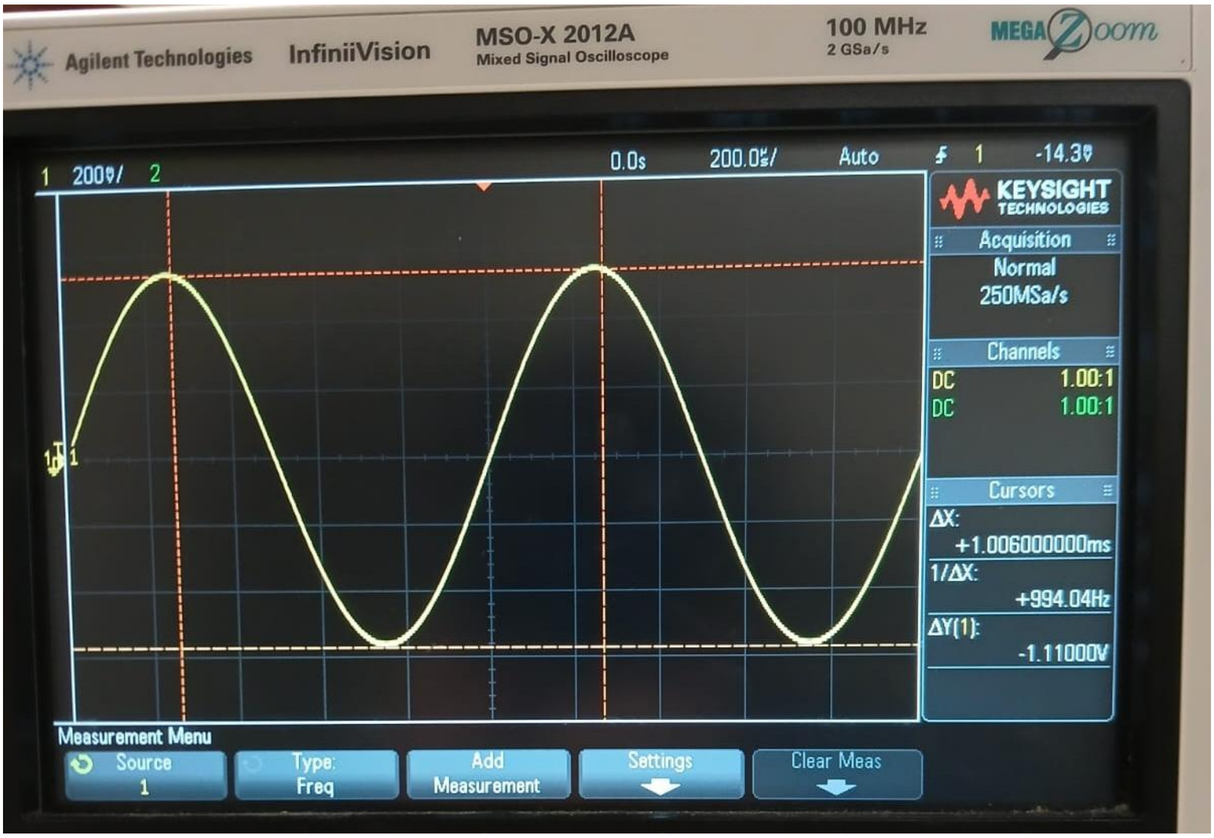
$$\boldsymbol{R_{Total}} = 100\ \Omega + 545.4545\ \Omega$$

$$\boldsymbol{R_{Total}} = 645.4545\ \Omega$$

1.5 Total Voltage Reading



1.6 R2 oscilloscope Reading



1.7 Total Input Current

From 1.4, $\boldsymbol{R_{Total}} = 645.4545\ \Omega$

Using Ohm's Law,

$$\boldsymbol{V = IR}$$

$$\boldsymbol{I = \frac{V}{R}}$$

$$\boldsymbol{I = \frac{10V}{645.4545\ \Omega}}$$

$$\boldsymbol{I = 0.0155\ A} = 15.49\ \text{mA}$$

1.8 Current across R_2

$\boldsymbol{R_1}$ = 100 Ω

$\boldsymbol{R_2}$ = 1 K Ω

R_3 = 1.2 K Ω

As (R_2 || R_3) + R_1 **from the figure 2**

Using Current divider Rule,

$$IR_2 = I \times \left(\frac{R_3}{R_2 + R_3}\right)$$

$$= \mathbf{0.0155\ A} \times \left(\frac{\mathbf{1.2}\ \mathrm{K\Omega}}{\mathbf{1}\mathrm{K\ \Omega} + 1.2\ \mathrm{K\ \Omega}}\right)$$

$$= \mathbf{0.0155\ A} \times \left(\frac{\mathbf{1.2}\ \mathrm{K\Omega}}{2.2\ \mathrm{K\ \Omega}}\right)$$

$$= \mathbf{0.0155\ A} \times \left(\frac{\mathbf{1.2}\ \mathrm{K\Omega}}{2.2\ \mathrm{K\ \Omega}}\right)$$

$$= \mathbf{0.0155\ A} \times 0.5454\ K\Omega$$

$$= 0.0084537\ A$$

= 0.0084537 × $\mathbf{1000}$

= 8.45 mA

1.9 Current across R_3

R_1 = 100 Ω

R_2 = 1 K Ω

R_3 = 1.2 K Ω

As (R_2 || R_3) + R_1 **from the figure 2**

Using Current divider Rule,

$$IR_3 = I \times \left(\frac{R_2}{R_2 + R_3}\right)$$

$$= \mathbf{0.0155\ A} \times \left(\frac{\mathbf{1}\ \mathrm{K\Omega}}{\mathbf{1}\mathrm{K\ \Omega} + 1.2\ \mathrm{K\ \Omega}}\right)$$

$$= \mathbf{0.0155\ A} \times \left(\frac{\mathbf{1}\ \mathrm{K\Omega}}{2.2\ \mathrm{K\ \Omega}}\right)$$

$$= \mathbf{0.0155\ A} \times \left(\frac{\mathbf{1}\ \mathrm{K\Omega}}{2.2\ \mathrm{K\ \Omega}}\right)$$

$$= \mathbf{0.0155\ A} \times 0.45454\ K\Omega$$

= 0.00704545 A

= 0.00704545 A× $\mathbf{1000}$

= 7.045 mA

1.10 Total Relationship

$\boldsymbol{R_1}$ = 100 Ω

$\boldsymbol{R_2}$ = 1 K Ω

$\boldsymbol{R_3}$ = 1.2 K Ω

As ($\boldsymbol{R_2}$ **||** $\boldsymbol{R_3}$ **) +** $\boldsymbol{R_1}$ **from the figure 2**

$$\boldsymbol{R_{Total}} = R_1 + (\, R_2 \| \, R_3 \,)$$

$$0.64491 \text{ K}\,\Omega = R_1 + \left(\frac{R_2 \times R_3}{R_2 + R_3}\right)$$

$$0.64491 \text{ K}\,\Omega = 100\,\Omega + \left(\frac{\mathbf{1}\text{ K}\Omega \times \mathbf{1.2}\text{ K}\Omega}{\mathbf{1}\text{K}\,\Omega + 1.2\text{ K}\,\Omega}\right)$$

$$0.64491 \text{ K}\,\Omega = 100\,\Omega + \left(\frac{\mathbf{1.2}\text{ K}\Omega}{\mathbf{2}.2\text{ K}\,\Omega}\right)$$

$$0.64491 \text{ K}\,\Omega = 100\,\Omega + 0.54545 \text{ K}\,\Omega$$

$$0.64491 \text{ K}\,\Omega = 100\,\Omega + (0.54545 \times 1000)\,\Omega$$

$$0.64491 \text{ K}\,\Omega = 100\,\Omega + 545.4545\,\Omega$$

$$0.64491 \text{ K}\,\Omega = 645.4545\,\Omega$$

$$0.64491 \text{ K}\,\Omega = 0.64545 \text{ K}\,\Omega$$

REFERENCES

NIL