International University

School of Electrical Engineering

Principle of EE1 Laboratory

EE052IU

[Lab 2]

Kirchhoff's Current and Voltage Laws

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GRADING GUIDELINE FOR LAB REPORT

Number	Content		Score	Comment
1	**Format (max 9%)**			
	– Font type	Yes No		
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	– Table of contents	Yes No		
	– Header/Footer	Yes No		
	– List of figures (if exists)	Yes No		
	– List of tables (if exists)	Yes No		
	– Lab report structure	Yes No		
2	**English Grammar and Spelling (max 6%)**			
	– Grammar	Yes No		
	– Spelling	Yes No		
3	**Data and Result Analysis (max 85%)**			
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Nomenclature

V_{DD} = DC Voltage Source

V_{dd} = AC Voltage Source

I_{ref} = Reference Current

Theoretical Background

1. The relationship of Ohm’s Law

Ohm’s Law establishes a fundamental relationship between voltage, current, and resistance in electrical circuits. The equation $V=I\cdot R$ and $V=I\cdot R$ illustrates this relationship.

2. The Kirchhoff’s Current Law (KCL)

Kirchhoff’s Current Law asserts that the total current entering a junction in an electrical circuit is equal to the total current leaving the junction. This principle, expressed as :$\sum I\_in=\sum I\_out$, forms the basis for analyzing current distribution in complex circuits. The laboratory endeavors to experimentally verify and comprehend the application of KCL

$$\sum \text{Loop} = 0$$

KVL aids in understanding voltage relationships within circuits. The objective is to experimentally confirm and grasp the implications of KVL in practical scenarios.

3. The Kirchhoff’s Voltage Law (KVL)

Kirchhoff’s Voltage Law posits that the total voltage around any closed loop in a circuit is equal to the sum of the individual voltage drops. Mathematically represented as

4. The equivalent resistance

Exploring the concept of equivalent resistance involves determining a single resistance value that represents the combined effect of resistors in a circuit. For series circuits, the equivalent resistance (Req, series) is the sum of individual resistances. In parallel circuits, the reciprocal of the equivalent resistance (,1/Req, parallel is the sum of reciprocals of individual resistances. The laboratory seeks to experimentally determine and analyze equivalent resistances in both series and parallel configurations.

Experimental Procedure

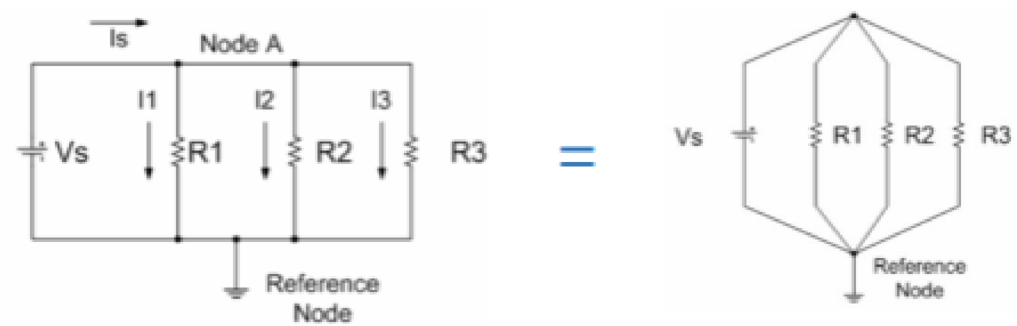

Figure 1

Using the adjustable D.C. power supply and circuit bread board, connect the resistors into a two-node circuit.All four circuit elements are connected between those two nodes, and the source voltage Vs is across each of the three resistors. Let R1 = 8.2 kΩ, R2 = 15 kΩ, and R3 = 39 kΩ.

Table 1

	Color	Nominal value	Actual values
R1	Grey-red-red-gold	8.2k	8.2k
R2	Brown-green-orange-gold	15k	14.85k
R3	Orange-white-orange-gold	39k	38.27k

Table 2

Value	Measured	Calculated	Differences
Is	1.959mA	0.0034A	53.779 %
I1	1.925mA	0.002A	3.822%
I2	1.077mA	0.001A	7.415%
I3	0.410mA	0.0004A	2.469 %

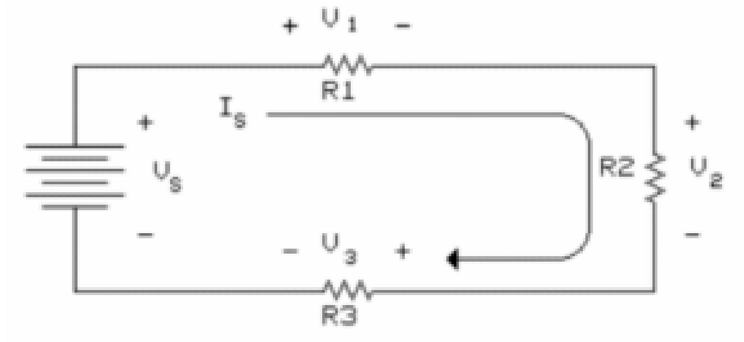

Figure 2

Using the adjustable D.C. power supply and the circuit bread board, connect the resistors into a circuit. Note that the three resistors are in series so that the same current (Is) flows through each resistor. Let R1 = 1.5 kΩ, R2 = 820 Ω, and R3 = 2.2 kΩ.

	Color	Nominal	Actual
R1	Brown-green-red-gold	1.5k	1.5k
R2	Grey-red-brown-gold	820	0.807
R3	Red-red-red-gold	2.2k	2.2k

Table 3

Value	Calculated	Measured	Differences
Is	3.3mA	3.5mA	5.882%
V1	5.3V	5.25V	0.948%
V2	2.8V	2870mV	2.469%
V3	7.8V	7.7V	1.290%

Table 4

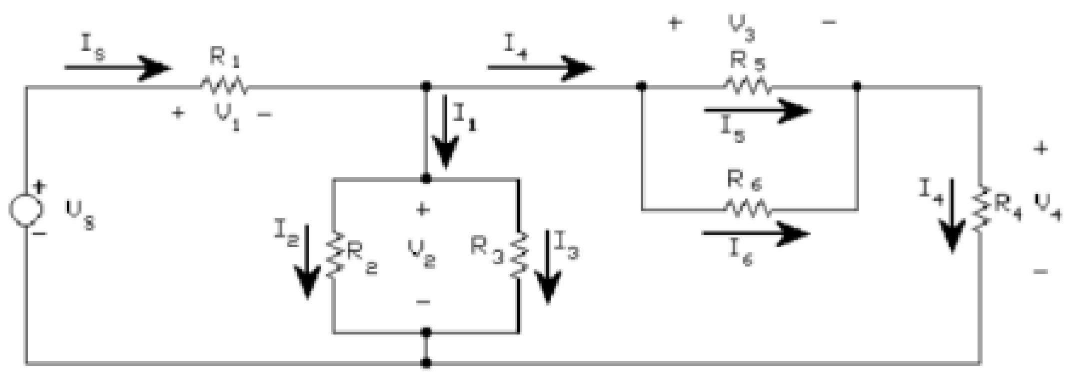

Figure 3

Table 5

	Color	Nominal	Actual
R1	Brown-red-red	1.2k	1.17k
R2	Orange-orange-red	3.3k	3.2k
R3	Orange-orange-red	3.3k	3.2k
R4	Red-violet-red	2.7k	2.6k
R5	Green-blue-red	5.6k	5.5k
R6	Yellow-violet-red	4.7k	4.6k

Table 6

Value	Calculated	Measured	Differences
I2	8.144mA	8.1mA	0.17%
V1	9.773V	9.79V	0.20%
V2	10.23V	13.5V	31.64%
V3	10.23V	13.5V	31.64%
V4	5.24V	5.5V	5.33%
I1	12.12mA	16.7mA	27.3%
I2	6.061mA	4.08mA	32.7%
I3	6.061mA	4.08mA	32.7%
I4	7.407mA	7.068mA	4.5%
I5	2.181mA	2.216mA	1.6%

I6	2.508mA	2.57mA	2.59%

Apply node voltage:

Node 1: (v1-20)/R1 +v1/(R2//R3)+v1/(R5//R6+R4) = 0

=> V = 9.158V

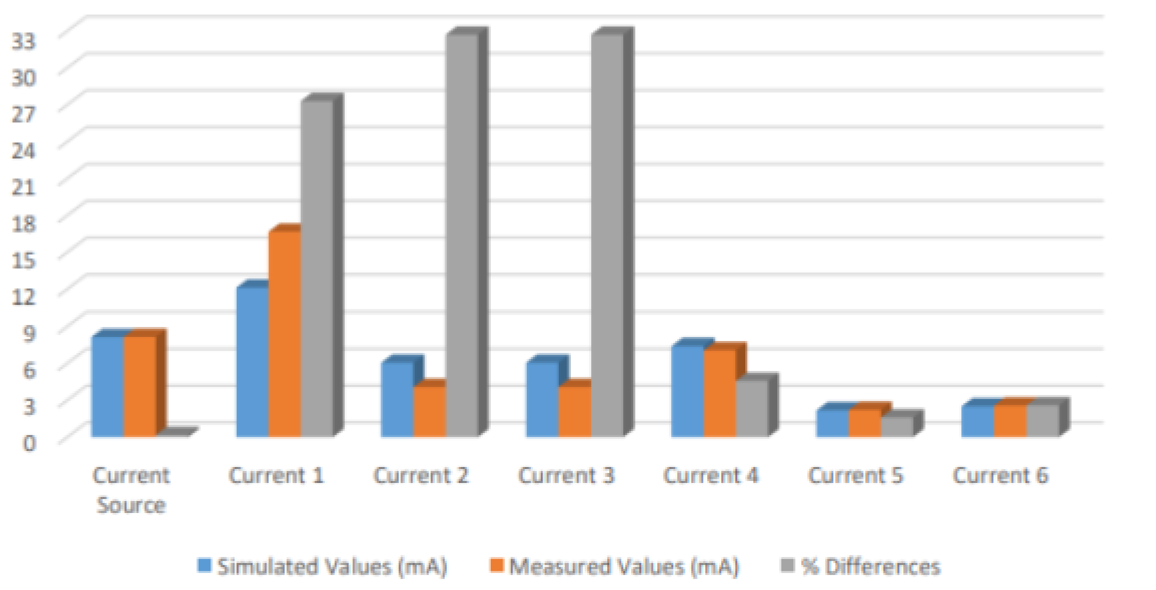

Figure 4

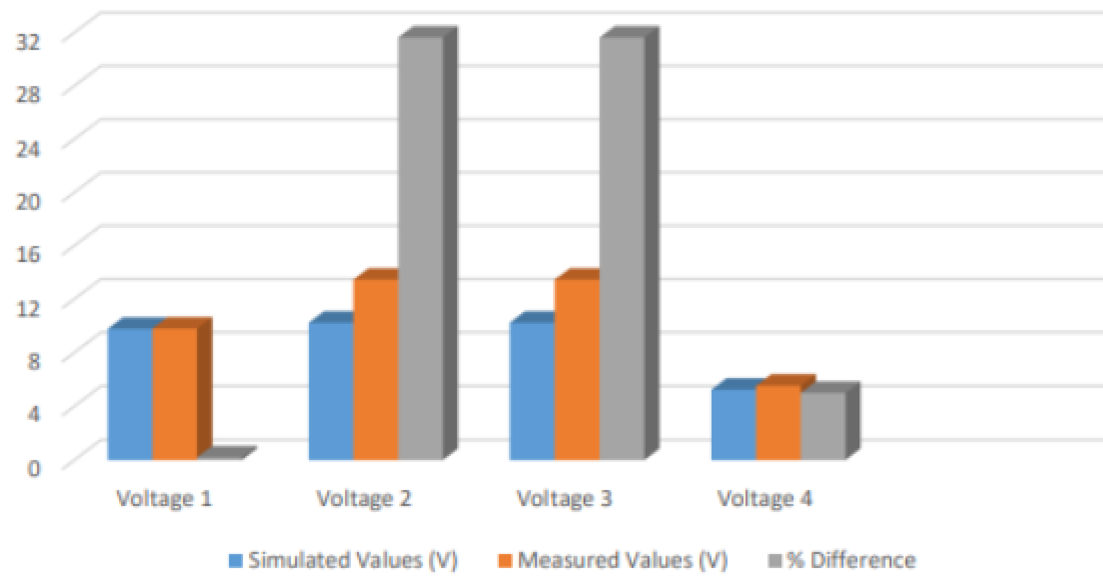

Figure 5

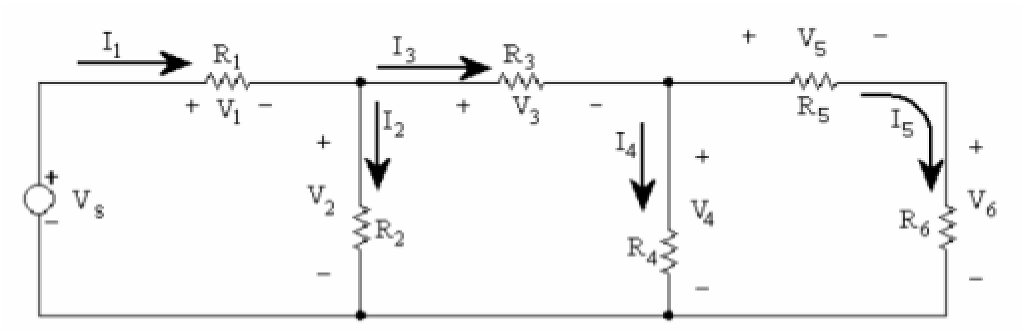

Figure 6

Table 7

	Color	Nominal	Actual
R1	Brown-red-red	1.2k	1.18k
R2	Green-blue-red	5.6k	5.58k
R3	Orange-orange-red	3.3k	3.25k
R4	Yellow-violet-red	4.7k	4.66k
R5	Red-violet-red	2.7k	2.68k
R6	Brown-red-red	1.2k	1.15k

Value	Calculated	Measured	Differences
V1	6.048V	8.196V	26.2%
V2	13.95V	7.455V	5.68%
V3	8.467V	4.345V	3.80%
V4	5.485V	5.13V	6.47%
V5	3.786V	3.599V	4.95%
V6	1.699V	1.55V	8.29%
I1	5.054mA	4.569mA	9.6%
I2	3.571mA	3.369mA	6.01%
I3	3.682mA	3.535mA	3.98%
I4	4.255mA	3.948mA	7.21%
I5	16.67mA	16.223mA	2.68%

Apply the mesh current

Loop 1: -20+1200i1+5600(i1-i2) = 0

Loop 2: 5600(i2-i1)+3300i2+4700(i2-i3) = 0

Loop 3: 4700(i3-i2)+i3(2700+1200) = 0

=> i1=5.054mA

=> i2=2.57mA

=> i3=1.4mA

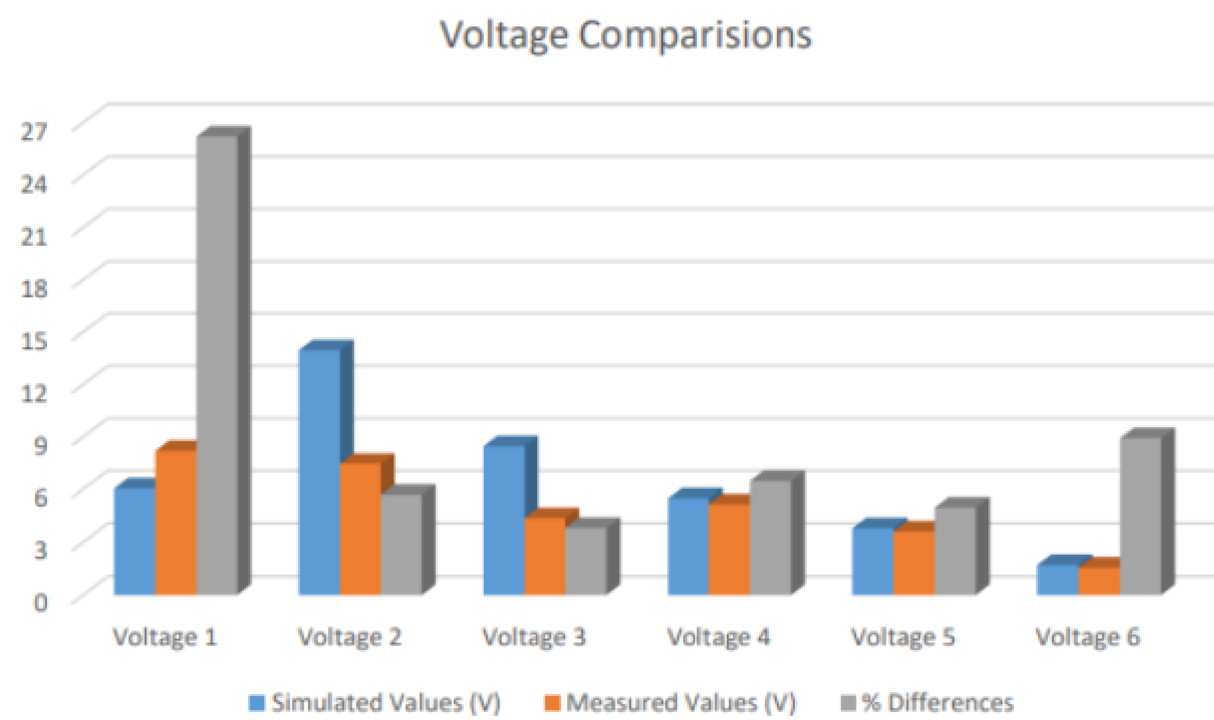

Figure 7

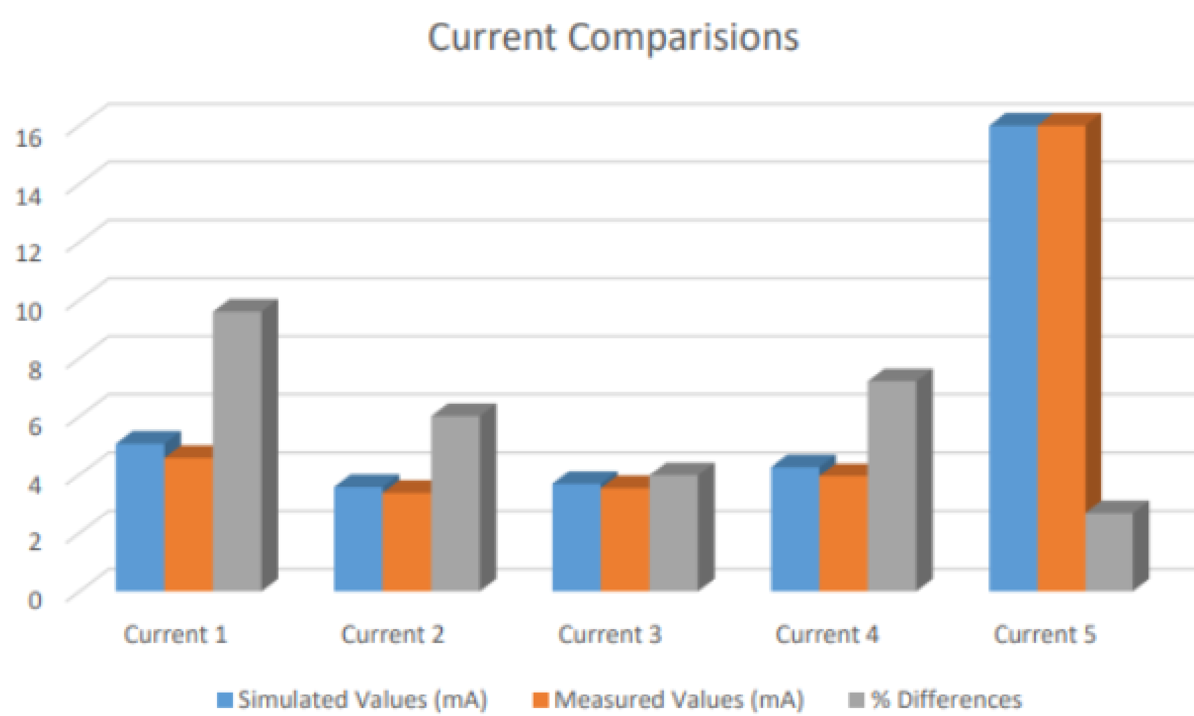

Figure 8

Experimental Results

In this section, describe the results. Remember to refer your reader to specific Figures, Tables and Appendices where applicable and show your calculations and data manipulation. Note that it is preferable to have Figures and Tables close to the text where they are discussed. The goal here is to report the results – ***NOT*** to discuss whether they are good or bad results. Usually the trends in a graph are pointed out, but not fully explained. The discussion of the trend is saved for the Discussion section.

Discussion of Results

Section 1A: The precision of our measurements underscores the success of the experimental setup. While there may be slight deviations, these can be attributed to factors such as resistor tolerances, subtle variations in experimental conditions, or inherent limitations in the measurement apparatus.
Section 1B: The measured values of current and voltage in the series circuit, with resistors R1 = 1.5 kΩ, R2 = 820 Ω, and R3 = 2.2 kΩ, closely mirror the calculated values, showing a range of differences between 2.838% to 3.930%. This consistency validates the application of Kirchhoff's Voltage Law (KVL) in explaining voltage distribution within the series configuration. Minor variations within this range can be attributed to practical factors like wire resistances and measurement limitations.
Section 1C: We can conclude that with a parallel resistor, there are the same % differences of measured values on current and voltage. Otherwise, with the first try, we make mistake on setting Output voltage (not the directly 16V), so they seem to be a large error on this section.
Section 2: After performing calculations and comparing them to the actual values, it is evident that there is a noticeable increase in the errors of the figures. It is acknowledged that the pace at which we worked on this lab segment was slow, particularly when attempting to identify resistors based on the provided table.