EE1302: INTRODUCTION TO ELECTRICAL ENGINEERING

LABORATORY 02

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REG No. : EG/ 2021/ 4433

SEMESTER: 01

DATE : 05 /10 /2022

TABLE 1: SUMMATIVE LABORATORY FORM

Semester	01
Module Code	EE1302
Module Name	Introduction to Electrical Engineering
Lab Number	02
Lab Name	VERIFICATION OF CIRCUIT LAWS
Lab conduction date	2022.09.28
Report Submission date	2022.10.05

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1 Observation

TABLE 2 : CALCULATED EXPERIMENTAL VALUES USING KIRCHOFF'S CURRENT LAW AND VOLTAGE LAW

	Vs1 (V)	Vs2 (V)	R1 (Ω)	R2 (Ω)	R3 (Ω)	I1 (A)	I2 (A)	I3 (A)	V1 (V)	V2 (V)	V3 (V)
1	9	16	38	68	38	0.055	0.130	0.180	2.10	8.4	8.6
2	12	18	42	74	40	0.089	0.125	0.205	3.60	8.0	10.5
3	15	20	20	30	20	0.230	0.300	0.500	4.50	8.8	10.0
4	16	20	22	28	16	0.285	0.350	0.600	6.20	9.4	9.2

TABLE 3 : CALCULATED ERRORS USING THEORETICAL VALUES AND EXPERIMENT VALUE

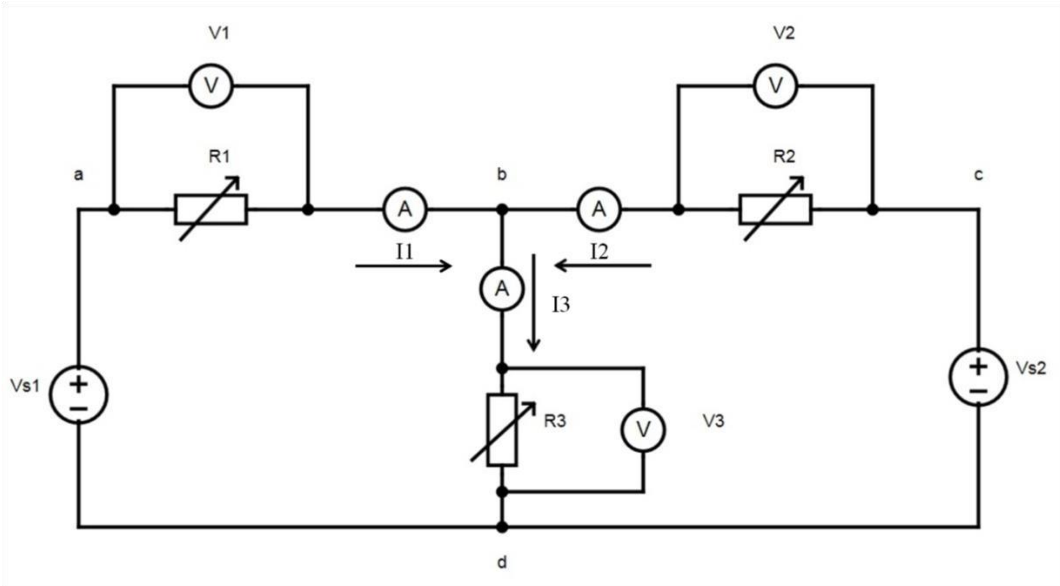
		Theoretical (V)	Experimental (V)	Error %		Theoretical (A)	Experimental (A)	Error %
1	V1	1.976	2.1	-6.275	I1	0.052	0.055	-5.769
	V2	8.796	8.4	4.502	I2	0.132	0.130	1.515
	V3	7.030	8.6	-22.333	I3	0.185	0.180	2.703
2	V1	3.486	3.6	-3.270	I1	0.084	0.089	-7.229
	V2	9.472	8.2	13.429	I2	0.129	0.125	2.344
	V3	8.480	10.5	-23.821	I3	0.212	0.205	3.302
3	V1	4.360	4.5	-3.211	I1	0.219	0.230	-5.505
	V2	9.360	8.8	5.983	I2	0.313	0.300	3.846
	V3	10.620	10.0	5.838	I3	0.531	0.500	5.838
4	V1	5.960	6.1	-2.349	I1	0.271	0.285	-5.5166
	V2	9.940	9.4	5.433	I2	0.36	0.350	1.408
	V3	10.032	9.2	8.293	I3	0.63	0.600	4.306

TABLE 4 : THEORETICAL AND EXPERIMENTAL VALUES OF SUPERPOSITION THEOREM

	I1 (A)		I2 (A)		I3 (A)	
	Theoretical	Experimental	Theoretical	Experimental	Theoretical	Experimental
1	0.200	0.195	-0.067	-0.070	0.133	0.125
2	-0.033	-0.035	0.167	0.165	0.133	0.130
3	0.166	0.160	0.100	0.095	0.267	0.255

2 Calculation

FIGURE 1: CIRCUIT DIAGRAM TO TEST KIRCHHOF'S CURRENT AND VOLTAGE LAWS (CIRCUIT 1)



Applying Kirchhoff's Current law for node b:

$$I_1 + I_2 - I_3 = 0 \longrightarrow 2$$

Applying Kirchhoff's voltage law for mesh 1 :

$$I_1R_1 + I_3R_3 = V_{S1} \longrightarrow 2$$

Applying Kirchhoff's voltage law for mesh 2 :

$$I_2R_2 + I_3R_3 = V_{S2} \longrightarrow 3$$

By solving the above three equations we can find I_1, I_2 *and* I_3 values.

Then V_1, V_2, and V_3 should be found.

$$V_1 = I_1 \times R_1$$

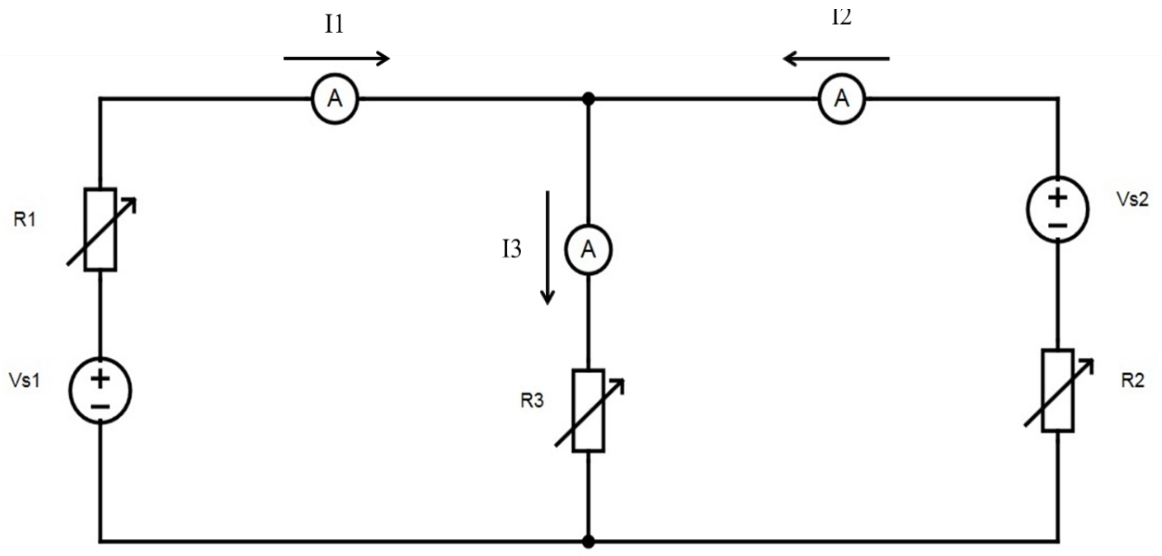
$$V_2 = I_2 \times R_2$$

$$V_3 = I_3 \times R_3$$

Then should be calculated error using the below equation.

$$\text{Error} = \frac{\text{Theoritical value} - \text{Experimental value}}{\text{Theoritical value}} \times 100\%$$

FIGURE 2 : CIRCUIT DIAGRAM TO TEST SUPERPOSITION THEOREM (CIRCUIT 2)



First, we should find the current through each branch with the only V_{S1} voltage source. So, we should Remove V_2 from the above circuit and calculate values for I_1, I_2, and I_3

$$I_1' = \frac{V_{S1}}{\frac{R_2 \times R_3}{R_2 + R_3} + R_1}$$

$$I_2' = I_1' \times \frac{R_3}{R_3 + R_2}$$

$$I_3' = I_1' - I_2'$$

Then, we should find the current through each branch with the only V_{S1} voltage source. So, we should Remove V_2 from the above circuit and calculate values for I_1, I_2, and I_3

$$I_2'' = \frac{V_{S2}}{\frac{R_1 \times R_3}{R_1 + R_3} + R_2}$$

$$I_1'' = I_2'' \times \frac{R_3}{R_3 + R_1}$$

$$I_3'' = I_2'' - I_1''$$

As per Superposition theorem

$$I_3 = I_3' + I_3''$$

$$I_2 = I_2' - I_2''$$

$$I_1 = I_1' - I_1''$$

2.1 Specimen Calculation

FOR KIRCHHOFF'S VOLTAGE AND CURRENT LAWS

Considering the third data set;

$$20I_1 + 20I_3 = 15 \longrightarrow (1)$$

$$30I_2 + 20I_3 = 20 \longrightarrow (2)$$

$$I_1 + I_2 - I_3 = 0 \longrightarrow (3)$$

By solving 1, 2, and 3 equations:

$$I_1 = 0.2188A$$

$$I_2 = 0.3125A$$

$$I_3 = 0.5313A$$

Hence

$$V_1 = I_1R_1$$

$$V_1 = 0.2188 \times 20$$

$$V_1 = 4.376V$$

$$V_2 = I_2R_2$$

$$V_2 = 0.3125 \times 30$$

$$V_2 = 9.375V$$

$$V_3 = I_3R_3$$

$$V_3 = 0.5313 \times 20$$

$$V_3 = 10.626V$$

Then we can calculate errors using our theoretical values and the experimental values.

$$\text{Error} = \frac{\text{Theoritical value} - \text{Experimental value}}{\text{Theoritical value}} \times 100\%$$

$$\text{Error of } \mathrm{I}_3 = \frac{0.531 - 0.500}{0.531} \times 100\%$$

$$= 5.8380\%$$

FOR SUPERPOSITION THEOREM

Considering the first data set of table 1.2;
By removing $V_{S2;}$

$$I_1' = \frac{14}{\frac{30 \times 15}{30 + 15} + 60}$$

$$I'_1 = 0.2 \text{ A}$$

$$I_2' = 0.2 \times \frac{15}{15 + 30}$$

$$I_2' = -\, 0.0667\ A$$

$$I_3' = 0.133\text{A}$$

By removing $V_{S1;}$

$$I_2^{"} = \frac{7}{\frac{60 \times 15}{60 + 15} + 30}$$

$$I_2^{"} = 0.1667\text{A}$$

$$I_1^{"} = 0.1667 \times \frac{15}{60 + 15}$$

$$I_1^{"} = -0.0333\text{A}$$

$$I_3^{"} = 0.1334\text{A}$$

As per the superposition theorem;

$$I_3 = 0.133 + 0.134$$

$$I_3 = 0.267A$$

3 Discussion

Q1.

Kirchhoff's current law states that the algebraic sum of the currents entering a node is zero at every instant. The KCL requesting figure 1;

Table 2.2 contains all the theoretical and experimental values. Columns 7, 8, and 9 represent theoretical values, experimental values, and error percentages, respectively. 52mA to 600 mA is the range of our measured readings. Comparing experimental and theoretical values yields results that are almost identical.

The errors are given by,

$$\text{Error} = \frac{\text{Theoritical value} - \text{Experimental value}}{\text{Theoritical value}} \times 100\%$$

Some errors had a positive value while others had a negative value.

Kirchhoff's voltage law states that the algebraic sum of all the voltages around a closed loop is zero at every instant. The KVL applying for figure 1;

Table 2.2 contains all the theoretical and experimental values. Columns 3, 4, and 5 represent theoretical values, experimental values, and error percentages, respectively. Our measurements range from 2.1 to 10.5 volts. Comparing experimental and theoretical values yields results that are almost identical. Some errors had a positive value while others had a negative value.

Q2.

In its most basic version, the superposition theorem asserts that the current in each branch of a linear network with multiple e.m.f. sources is the algebraic sum of the currents obtained by each source acting independently, with each other source being replaced by its corresponding impedance.

The superposition theorem states that a circuit with several voltage and current sources is comparable to the total of simpler circuits with a single source. We can turn off the sources so that we can collect the values and streamline the circuit system. In order to verify the theorem, we computed the theoretical current values for a circuit and contrasted them with the outcomes of the experiments. It can be shown that the theoretical and experimental values of the currents are comparable. Theoretical results can occasionally outperform experimental results, and vice versa. There are many other possible reasons for this. These mistakes might occur if we use flawless instruments but disregard all the resistors, conducting cables, and other parts they contain.

Even when employing KCL and KVL, circuits can still get pretty complex. On occasion, though, we can use the superposition theorem to simplify the circuits. The circuit is solved and the superposition theorem is implemented, with one independent source left out. Applying it to all of the sources and then totaling up everything you read will allow you to calculate the outcome. With the use of this theorem, any linear circuit with several sources can be investigated. A very useful technique for conducting circuit analysis is superposition.

When a circuit contains several electrical sources or inputs, use superposition. Consequently, the multi-source, multi-resistance challenging electric network is finally addressed utilizing the superposition theorem by considering and analyzing each source separately. The superposition theorem is essential for circuit analysis since it turns