AMERICAN INTERNATIONAL UNIVERSITY–BANGLADESH (AIUB)

FACULTY OF SCIENCE & TECHNOLOGY

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

ELECTRICAL CIRCUIT LAB - 1

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Section: W, Group: 2

LAB REPORT ON

Study of Superposition Theorem

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Submitted By

Name	ID	Contribution
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3. KAZI ABDULLAH JARIF	22-46386-1	Theoretical Calculation, Result and Discussion, Conclusion, Experimental Procedure
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1. Introduction:

The superposition theorem states that in a linear bilateral multi-source DC circuit, the current through or voltage across any particular element may be determined by considering the contribution of each source independently, with the remaining sources replaced with their internal resistance. The contributions are then summed, paying attention to polarities, to find the total value. Superposition cannot in general be applied to non-linear circuits or to non-linear functions such as power.

The objective of this exercise is to-

1. investigate the application of the superposition theorem to multiple DC sourcecircuits in terms of both voltage and current measurements.
2. examine the power measurement.

2. Theory and Methodology:

The principle of superposition is applicable only for linear systems. The concept of superposition can be explained mathematically by the following response and excitation principle:

$$i_1 \rightarrow v_1$$

$$i_2 \rightarrow v_2$$

$$i_1 + i_2 \rightarrow v_1 + v_2$$

Then, the quantity to the left of the arrow indicates the excitation and to the right, the system response. Thus, we can state that a device, if excited by a current $i1$ will produce a response $v1$. Similarly, an excitation $i2$ will cause a response $v2$. Then if we use an excitation $i1 + i1$, we will find a response $v1 + v2$.

The principle of superposition has the ability to reduce a complicated problem to several easier problems each containing only a single independent source.

Superposition theorem states that,
In any linear circuit containing multiple independent sources, the current or voltage at any point in the network may be calculated as algebraic sum of the individual contributions of each source acting alone.

When determining the contribution due to a particular independent source, we disable all the remaining independent sources. That is, all the remaining voltage sources are made zero by replacing them with short circuits, and all remaining current sources are made zero by replacing them with open circuits. Also, it is important to note that if a dependent source is present; it must remain active (unaltered) during the process of superposition.

Action Plan

i. In a circuit comprising of many independent sources, only one source is allowed to beactive in the circuit, the rest are deactivated (turned off).

ii. To deactivate a voltage source, replace it with a short circuit, and to deactivate a currentsource, replace it with an open circuit.

iii. The response obtained by applying each source, one at a time, are then added algebraically to obtain a solution.

Limitations:

Superposition is a fundamental property of linear equations and,
therefore, can be applied to any effect that is linearly related to the cause. That is, we want to point out that, superposition principle applies only to the current and voltage in a linear circuit, but it cannot be used to determine power because power is a non-linear function.

3.Apparatus:

- Trainer board
- Digital multimeter
- DC source
- Resistors: 4.5k, 6.5k, 9.8k, 21.5k, 32.6k [1 pcs]
- Connecting wire

4.Precautions:

To consider the effect of one voltage source the other must be replaced with a wire. Simply switching off the connection does not give the correct circuit configuration.
Sometimes the ammeters don't work properly so to determine current take the voltage drop across the resistor and divide by the resistance value to obtain the current passing throughthat element or branch. Always mention the units when taking the readings or doing the calculations.

5.Experimental procedure:

Circuit Diagram:

1. We need to implement the circuit of figure 12.
2. Then we need to remove the supply voltage E2 by a short circuit.
3. Then we measured the node voltage VA. Need to Be sure to note the polarity.
4. Then we reconnected the supply voltage E2.

5. Again we removed the supply voltage E1 by short circuit.
6. Then measured the node voltage VA. Be sure to note the polarity.
7. Then we reconnected the supply voltage E1.
8. We measured node voltage VA. Need to be sure to note the polarity.
9. Completed table 6.1 and check the deviation between experimental and theoretical values.

Source	**V_A Theory**	**V_A Experimental**	**Deviation**
E1 only(10V)	3.17	3.084	0.086
E2 only(15V)	6.942	7.46	0.6
E1 & E2	10.12	10.54	0.51

Table 6.1

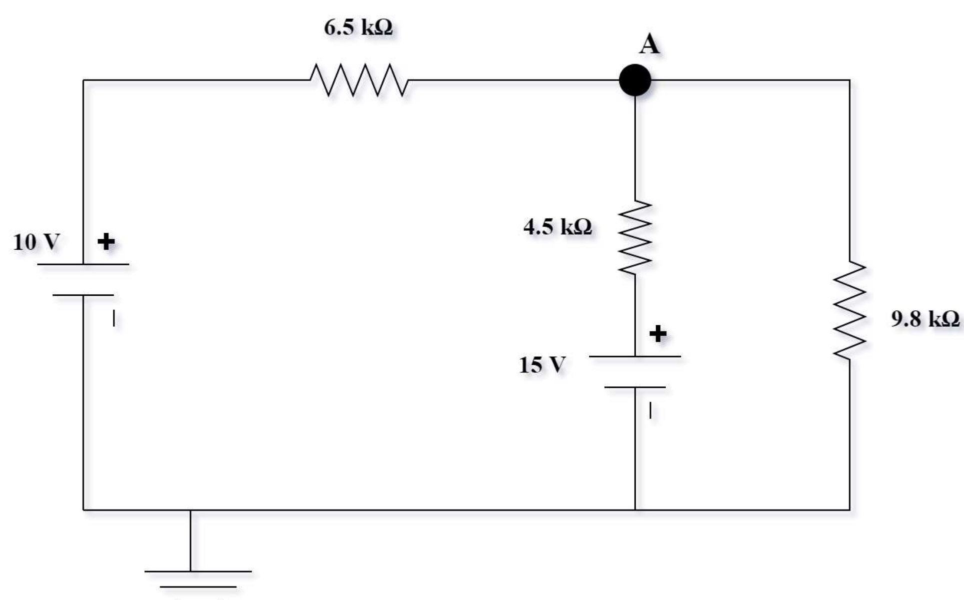

Fig 12

10. Now we need to Implement the circuit given in figure 13.

11. Then we repeated procedure steps 2 to 9 but measure the IR4 current and PR4 power across R4 resistor. Be sure to note the direction of IR4 current flow.

12. Then we completed table 6.2 and 6.3 and check the deviation between experimental and theoretical values.

13. Then we will figure out power and complete table 6.3.

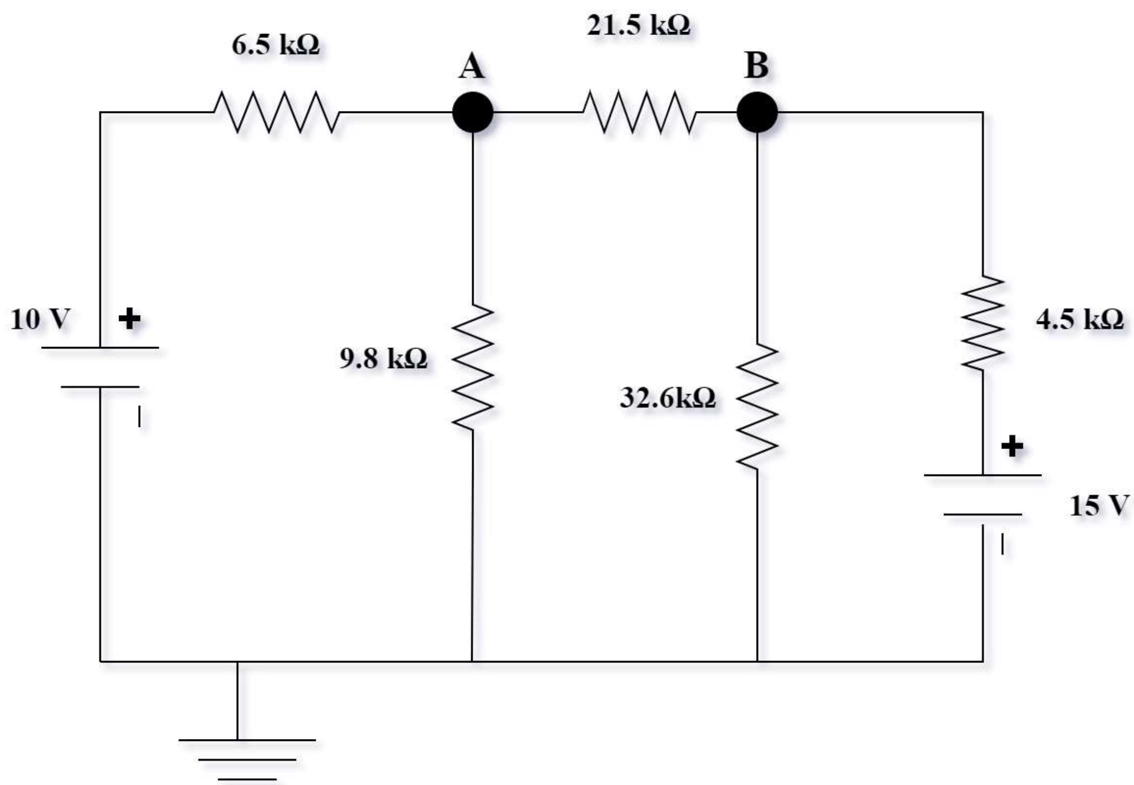

Fig 13

6. Theoretical Calculation:

Here,
R1=6.8k
R2=4.7k
R3=10k
R4=22k
R5=33k

For table 6.1

When E1 active,

$R_T = R_1 + (R2 \| R3) = 6.8 + (\frac{4.7\times 10}{4.7+10}) = 9.998k$

$V_A = 10\times(\frac{(\frac{4.7\times 10}{4.7+10})^{-1}}{9.998}) = 3.198V$

When E2 active,

$R_T = R_2 + (R1||R3) = 4.7 + (\frac{6.8\times 10}{6.8+10}) = 8.748k$

$I = E2/R_T = 15/8.748 = 1.715mA$

$I3 = \frac{R_2}{R_2+R_3} \times I = \frac{6.8}{6.8+1} \times 1.715 = 0.694Ma$

$V_A = I3 \times R3 = 6.942V$

<u>For table 6.2</u>

When E1 active,

$R_T = [\ \{(R2\ ||R5) + R4\}\ ||\ R3] + R1 = 7.23 + 6.8 = 14.031k$

$I = E1/R_T = 10/14.031 = 0.712\ mA$

$I_{R4} = \frac{10}{10+(22+\frac{4.7\times 33}{4.7+33})} \times 0.712 = 0.277mA$

When E2 active,

$R_T = [\ \{(R1\ ||\ R3) + R4\}\ ||\ R5] + R2 = 19.257k$

$I2 = E2/R_T = 0.779mA$

$I_{R4} = \frac{33}{33+(\frac{6.8\times 33}{6.8+33}+2\ )} \times 0.779 = 0.435mA$

<u>For table 6.3</u>

For E1

$P = IR4^2 \times R4 = 0.277^2 \times 22 = 1.689\ kW$

For E2

$P = IR4^2 \times R4 = 0.435^2 \times 22 = 4.163\ kW$

For E1 and E2

$P = IR4^2 \times R4 = 0.158^2 \times 22 = 0.55kW$

7. Results and Discussion:

Source	I_{R4} Theory	I_{R4} Experimental	Deviation
E1 only	0.277	0.23	0.047
E2 only	0.435	0.5	0.065
E1 & E2	0.158	0.27	0.112

Table 6.2

Source	P_{R4} (kW)
E1 only	1.689
E2 only	4.163
E1+E2	0.55

Table 6.3

Discussion:

- The trainer board and the multimeter were checked before the start of the experiment.
- The resistor was placed properly according to the figure.
- The value of the voltage was increased gradually as applying a large voltage can damage the resistors.
- Finally, all the data was placed in the data table. For the given equation, a result was obtained.

8.Conclusion:

In this experiment the data/findings were interpreted and determine to the extent to which the experiment was successful in complying. The goal was initially set. The ways of the study were improved, investigated, and described by measuring, converting, and calculating the circuit of super position theorem.

8. <u>Reference(s):</u>

1. Robert L. Boylestad, ”Introductory Circuit Analysis”, Prentice Hall, 12th Edition, New York, 2010, ISBN 9780137146666.