East West University

Lab Report

Semester: Summer-2025

Course Title: Electrical Circuits

Course Code: CSE209

Sec: 01

Expt No: 05

Expt Name: Verification of Superposition Theorem.

Group No: 05

Submitted by-

Md. Arifur Rahman Razu

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Submitted to-

Dr. Sarwar Jahan
Associate Professor
Department of CSE
East West University

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Title: Verification of Superposition Theorem.

Objectives:

1. To verify superposition theorem theoretically, experimentally and using PSpice simulation.

Theory (Summary):

The superposition theorem is used for linear circuits with multiple sources. It says that the voltage across or current through any element can be found by considering one source at a time and turning off the others (replacing voltage sources with short circuits). After finding the individual effects, we add them up algebraically to get the final result. In this experiment, we applied the superposition theorem to a circuit with three voltage sources and calculated the total current by adding the contributions from each source separately.

Circuit Diagram:

$E_1 = 10\text{V}\ E_2 = 5\text{V}\ E_3 = 5\text{V}$

$\text{R}_1 = 33\Omega\ R_2 = 47\Omega\ R_3 = 33\Omega\ R_4 = 47\Omega\ R_5 = 47\Omega\ R_L = 68\Omega$

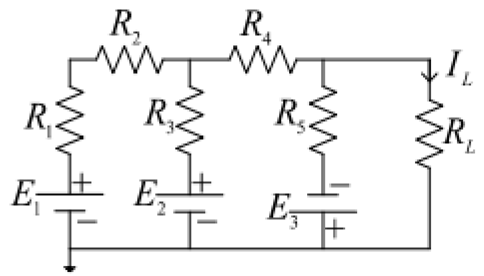


Figure 1. Circuit with all sources active.

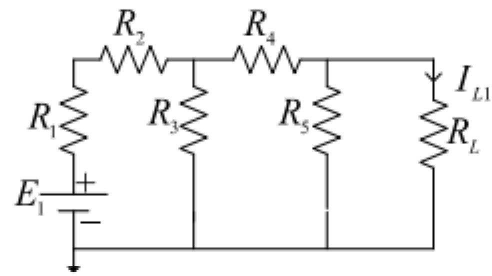


Figure 2. Circuit with E_1 source active.

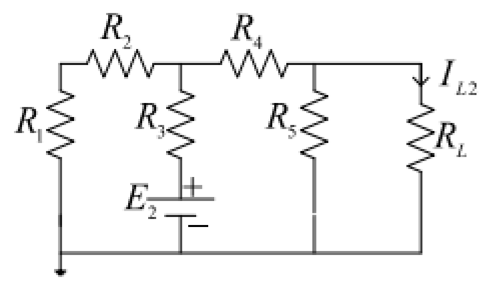


Figure 3. Circuit with E_2 source active.

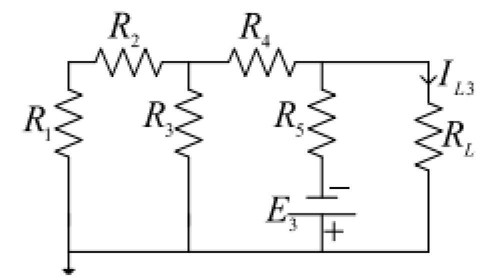


Figure 4. Circuit with E_3 sources active.

Post-Lab:

1. Theoretically calculate the values of IL, IL2 and IL3 of circuits from figure 1 through 4. From the calculated values , show that the superposition theorem holds, that is, IL = IL1 + IK2 + IL3

ANS:

Figure 1,

Applying KVL at mesh1 , mesh 2, and mesh 3

$(33+47+33)i1 - 33i2 = 10-5$ ….(1)

$-33i1 + (33+47+47)i2 - 47i3 = 5+5$ ….(2)

$-47i2 + (47+68)i3 = -5$ ….(3)

By solving

IL = i3 = -4.269 mA

Figure 2,

Applying KVL in mesh1,mesh2,mesh3,

$(33+47+33)i1 - 33i2 = 10$ …(1)

$-33i1 + (33+47+47)i2 -47i3 = 0$…(2)

$-47i2 + (47+68)i3 = 0$ ….(3)

By solving,

I3 = IL1 = 12.16 mA

Figure 3,

Applying KVL at mesh 1,2 and 3,

$(33+47+47)i1 -33i2 = -5$ …(1)

$-33i1 + (33+47+47)i2 - 47i3 = 5$ ….(2)

$-47i2 + (47+68)i3 = 0$ ….(3)

By solving it,

$I3 = IL2 = 14.739$ mA

Figure 4,

Applying KVL i8n mesh1 mesh 2 and mesh 3,

$(33+47+33)i1 - 33i2 = 0$….(1)

$-33i1 + (33+47+47)i2 - 47i3 = 5$….(2)

$-47i2 + (47+68)i3 = -5$ ….(3)

By solving it ,

$I3 = IL3 = -31.168$mA

Now,

$IL1 + IL2 + IL\ 3 = 12.16 + 14.739 + (-31.168)$mA

$= -4.269$ mA

$= IL$

The superposition theorem is verified.

Experimental datasheet:

Measured Value of E_1 (V)	**Measured Value of E_2 (V)**	**Measured Value of E_3 (V)**	**Measured value of I_L with all sources active (mA)**	**Measured value of I_{L1} with only E_1 active (mA)**	**Measured value of I_{L2} with only E_2 active (mA)**	**Measured value of I_{L3} with only E_3 active (mA)**	**Measured values of resistors (Ω)**
10V	5V	-5V	-3mA	14.5mA	14.8mA	-32mA	R_1=33 Ω R_2 = 46.5 Ω R_3=33 Ω R_4 = 46.Ω R_5=46 Ω R_L=67 Ω

Post Lab:

1. Calculate the values of I_L, I_{L1}, I_{L2}, and I_{L3} of the circuits of Figures 1 through 4 using the measured values of E_1, E_2, E_3, R_1, R_2, R_3, R_4, R_5, and R_L. The calculated values show that the superposition theorem holds. Compare these calculated values of currents with the experimental values and comment on any discrepancy observed.

Ans:

Here,

$E_1 = 10V$, $E_2 = 5V$, $E_3 = -5V$

$R_1 = 33\ \Omega$, $R_2 = 46.5\ \Omega$, $R_3 = 33\ \Omega$, $R_4 = 46\ \Omega$, $R_5 = 46\ \Omega$ and $R_L = 67\Omega$

$$i_3 = I_L = ?$$

Applying KVL at mesh 1, 2 and 3,

$$(33 + 46.5 + 33)i_1 - 33i_2 = 10 - 5 \ldots (1)$$

$$-33i_1 + (33 + 46 + 46)i_2 - 46i3 = 5 + 5 \ldots (2)$$

$$-46i_2 + (46 + 67)i_3 = -5 \ldots (3)$$

By solving equation (1), (2) and (3) we get,

$$i_3 = I_L = -3.2\ mA$$

Applying KVL at mesh 1, 2 and 3,

$$(33 + 46.5 + 33)i_1 - 33i_2 = 10 \ldots (1)$$

$$-33i_1 + (33 + 46 + 46)i_2 - 46i_3 = 0 \ldots (2)$$

$$-46i_2 + (46 + 67)i_3 = 0 \ldots (3)$$

By solving equation (1), (2) and (3) we get,

$$i_3 = I_{L1} = 14.6\ \ mA$$

Applying KVL at mesh 1, 2 and 3,

$$(33 + 46.5 + 33)i_1 - 33i_2 = -5 \ldots (1)$$

$$-33i_1 + (33 + 46 + 46)i_2 - 46i_3 = 5 \ldots (2)$$

$$-46i_2 + (46 + 67)i_3 = 0 \ldots (3)$$

By solving equation (1), (2) and (3) we get,

$$i_3 = I_{L2} = 15\ mA$$

Applying KVL at mesh 1, 2 and 3,

$$(33 + 46.5 + 33)i_1 - 33i_2 = 0 \ldots (1)$$

$$-33i_1 + (33 + 46 + 46)i_2 - 46i_3 = 5 \ldots (2)$$

$$-46i_2 + (46 + 67)i_3 = -5 \ldots (3)$$

By solving equation (1), (2) and (3) we get,

$$i_3 = I_{L3} = -32.8mA$$

Now,

$I_{L1} + I_{L2} + I_{L3} = (14.6 + 15 - 32.8)mA$ = -3.2mA = I_L

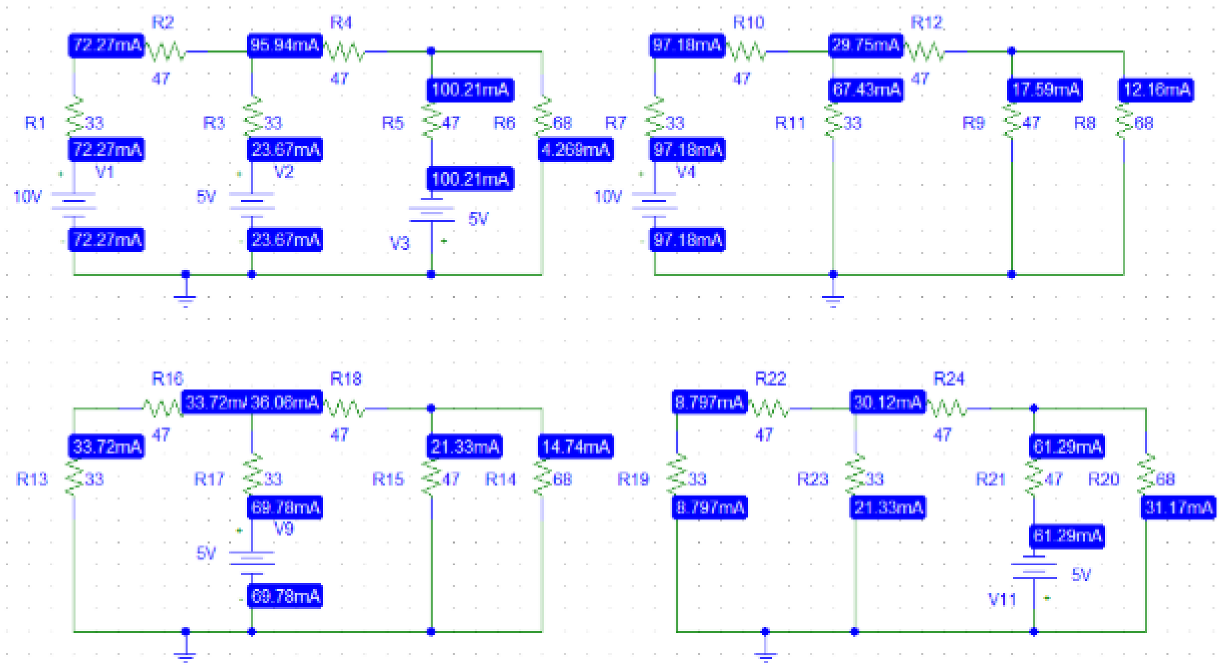
Hence, the Superposition theorem is verified.

Calculated values	**Experimental Values**
$I_{L1} = 14.6mA$	$I_{L1} = 14.5mA$
$I_{L2} = 15mA$	$I_{L2} = 14.8mA$
$I_{L3} = -32.8mA$	$I_{L3} = -32mA$
$I_L = -3.2mA$	$I_L = -3mA$

There is discrepancy because in experimental values there is error while measuring the exact value and also we did not got the exact value of the resistors. That is what the values are different.

2. Solve the circuits of Figures 1 through 4 using PSpice. Include the PSpice circuits with only currents shown. The PSpice solution show that the superposition theorem holds. Compare the PSpice solutions with the theoretical solutions and comment on any discrepancy found.

   Ans:



Here,

$$I_{L1} = 12.16mA$$

$$I_{L2} = 14.739mA$$

$$I_{L3} = 31.168mA = -31.168mA \ (At\ opposite\ direction)$$

So,

$I_{L1} + I_{L2} + I_{L3} = (12.16 + 14.739 - 31.168)mA$ = -4.269mA = I_L

So, it holds the superposition theorem.

Comparison between PSpice solutions with the theoretical solutions,

PSpice values	**Theoretical Values**
$I_{L1} = 12.16mA$	$I_{L1} = 12.16mA$
$I_{L2} = 14.739mA$	$I_{L2} = 14.739mA$
$I_{L3} = -31.168mA$	$I_{L3} = -31.168mA$
$I_{L} = -4.269mA$	$I_{L} = -4.269mA$

So, there is no discrepancy between PSpice values and theoretical values.

Discussion:

The experiment successfully verified the superposition theorem through theoretical calculation, experimental measurement, and PSpice simulation. Theoritical and PSpice results matched exactly, confirming the accuracy of analytical methods. Experimental results showed small discrepancies, mainly caused by resistor tolerances, measurement errors, and internal resistance of voltage sources, which are absent in the idealized models. Despite these differences, the measured ~~total~~ current closely matched the sum of individual source contributions, demonstrating the theorem's practical validity. This experiment highlights that while theory and simulation provide precise results, real-world measurements may very slightly due to non-ideal components and environmental factores.