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**Lab Report**

**Semester:** Summer-2024

**Course Title:** Electrical Circuits **Course Code:** CSE209

**Sec:** 01

**Expt No: 06**

**Expt Name: Verification of Superposition Theorem**

**Group No: 07**

**Submitted by-**

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**Objective:**

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

**Theory:**

Superposition theorem works for linear circuits. The superposition theorem states that if a linear circuit contains more than one source, the voltage across or the current through any element may be determined by algebraically adding the contribution of each source acting alone with other sources remaining inactive. A voltage source is made inactive by setting its voltage value to zero (or by replacing it with a short circuit).

A diagram of electrical circuits

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**Pre-lab report question:**

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

Answer:

Here,

IL = i3

By using method of inspection for mesh analysis,

(33+47+33) i1-33 i2-0=10-5………. (1) -33i1 + (33+47+47)i2 – 47i3 = 5+5 ……….(2)

0 – 47i2 + (47+68)i3 = -5 ……….(3)

Solving equations(1),(2), and (3),

I1 = 0.0722A

I2=0.0959A

I3=-0.0042689A

=- 4.2689mA

Here,

IL1= i3

By using the method of inspection for mesh analysis,

(33+47+83) i1 -33i2 – 0 = 10 …… (1) -33i1 +(33+47+47)i2 – 47i3 = 0 ……(2)

0 – 47i2 + (47+68) i3 = 0……. (3)

So, i3= IL1

= 0.012159A

= 12.16 mA

Here,

IL2 = i3

By using method of inspection for mesh analysis,

(33+47+33) i1 – 33i2 – 0 = -5 ……… (1) -33i1 + (33+47+47) i2 – 47i3 = 5……(2)

0 – 47i2 + (47+68) i3 = 0 …… (3)

So, i3 = IL2

= 0.01739A

= 14.74 mA

Here, IL3 = i3

(33+47+33) i1 - 33i2 – 0 = 0 …… (1)

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

0- 47i2 + (47+68) i3 = -5……. (3)

So, i3 = IL3

= -0.0311678A

= -31.168 mA

IL1 + IL2 + IL3

= 12.16 + 14.74 – 31.168

= - 4.268 mA

= IL

(showed)

**Experimental Datasheet:**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Measu  red Value of E1 (V) | Measure  d Value of  E2 (V) | Measur ed Value of  E3 (V) | Measur ed value of IL with all  sources active (mA) | Measure  d value of IL1 with all  sources active (mA) | Measur ed value of IL2 with only E2 active (mA) | Measur ed value of IL3 with only E2 active (mA) | Measure  d values of resistors  (Ω) |
| 10 | 5 | - 5 | 3 | 12.2 | 15 | -31.4 | R1 =32  R2 =46  R3 =32  R4 =46  R5 =46  RL =67 |

**Pre-lab data:**

**Answer to the post-lab questions:**

1. Calculate the values of IL, IL1, IL2, and IL3 of the circuit of Figures 1 through 4 using the measured values of E1, E2, E3, R1, R2, R3, R4, R5, and RL. From 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.
2. Solve the circuits of Figures 1 through 4 using PSpice. Include the PSpice circuits with only currents shown. From the PSpice solution show that the superposition theorem holds. Compare the PSpice solutions with the theoretical solutions and comment on any discrepancy found.

**Answer 1:**

Measured values are:

E1 = 10V, E2 = 5V, E3 = -5V

R1 = 32Ω , R2 = 46Ω , R3 = 32 Ω , R4 = 46 Ω , R5 = 46 Ω , RL = 67 Ω,

IL = -4.2 mA, IL1 = 12.2 mA, IL2 = 15 mA, IL3 = -31.4 mA

The Superposition Theorem,

IL = IL1 + IL2 + IL3

= (12.2 + 15 – 31.4) mA

= -4.2 mA

= IL

So, the Superposition Theorem holds.

Comparison between calculated values and measured values:

|  |  |
| --- | --- |
| Calculated Values | Measured Values |
| IL = -4.268 mA | IL = -4.2 mA |
| IL1 = 12.16 mA | IL1 = 12.2 mA |
| IL2 = 14.74 mA | IL2 = 15 mA |
| IL3 = -31.168 mA | IL3 = -31.4 mA |

Here are the discrepancies in points for each value:

* For IL = Measured – Calculated = (-4.2) – (-4.268) = 0.068
* For IL1 = Measured – Calculated = (12.2) – (12.16)= 0.04
* For IL2 = Measured – Calculated = (15) – (14.74) = 0.26
* For IL3 = Measured – Calculated = (-31.4) – (-31.168)= -0.232

The discrepancies between calculated and measured values in an electrical circuit can be due to various factors, including

* Measurement Accuracy: Precision and accuracy of the measuring instruments used can cause errors. Slight inaccuracies in measuring voltage and current can lead to discrepancies.

* Tolerances in Components: Real-world electronic components have tolerances, which means their actual values can vary slightly from their nominal or rated values

* Temperature Effects: Some electronic components, like resistors, can have their values change with temperature. If the components heat up during operation, their resistance may change, affecting the circuit's behavior.

* Wiring and Connection Resistance: Resistance in the wires and connections can lead to voltage drops, especially in low-resistance circuits.

* Assumptions in Circuit Models: Circuit calculations often rely on idealized circuit models, which may not perfectly represent real-world conditions. Assumptions made during calculations can introduce errors.

* Environmental Factors: Environmental conditions, such as electromagnetic interference or fluctuations in the power supply, can affect measurements and cause discrepancies.

* Human Error: Mistakes in setting up the circuit or taking measurements can lead to inaccuracies.

**2. Answer:**

A diagram of a circuit

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**Figer 1:** Circuit with all sources active.

A diagram of a circuit

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**Figer 2:** Circuit with E1 sources active

A diagram of a circuit

Description automatically generated

**Figer 3:** Circuit with E2 sources active

A diagram of a circuit

Description automatically generated

**Figer 4:** Circuit with E3 sources active

From Figure-1, IL = -4.269mA

From Figure-2, IL1 = 12.16 mA From Figure-3, IL2 = 14.74 mA

From Figure-4, IL3 =- 31.17 mA

The superposition theorem is,

IL = IL1 +IL2 + IL3

= 12.16 + 14.74 - 31.17

= -4.26mA

= IL

Comparison between the PSpice values and theoretical values:

|  |  |
| --- | --- |
| PSpice values | Theoretical Values |
| IL = -4.269mA | IL = -4.268 mA |
| IL1= 12.16 mA | IL1= 12.16 mA |
| IL2= 14.74 mA | IL2= 14.74 mA |
| IL3= -31.17 mA | IL3= -31.168 mA |

Here are the discrepancies in points for each value:

* For IL = Calculated – Experimental = (-4.268) – (-4.269) = -0.001
* For IL1 = Calculated – Experimental = (12.16) – (12.16) = 0
* For IL2 = Calculated – Experimental = (14.74) – (14.74) = 0
* For IL3 = Calculated – Experimental = (-31.168) – (-31.17) = -0.002

