BRAC UNIVERSITY
DEPT. OF COMPUTER SCIENCE AND ENGINEERING
COURSE NO.: CSE250
Circuits and Electronics Laboratory

Experiment No. 3
Name of the Experiment: Verification of Superposition Principle.

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OBJECTIVE:

To verify experimentally the Superposition theorem which is an analytical technique of determining currents in a circuit with more than one emf source.

THEOREM:

In a linear circuit containing multiple independent sources and linear elements (e.g., resistors, inductors, capacitors), the voltage across (or the current through) any element when all the sources are acting simultaneously may be obtained by adding algebraically all the individual voltages (or the currents) caused by each independent source acting alone, with all other sources deactivated.

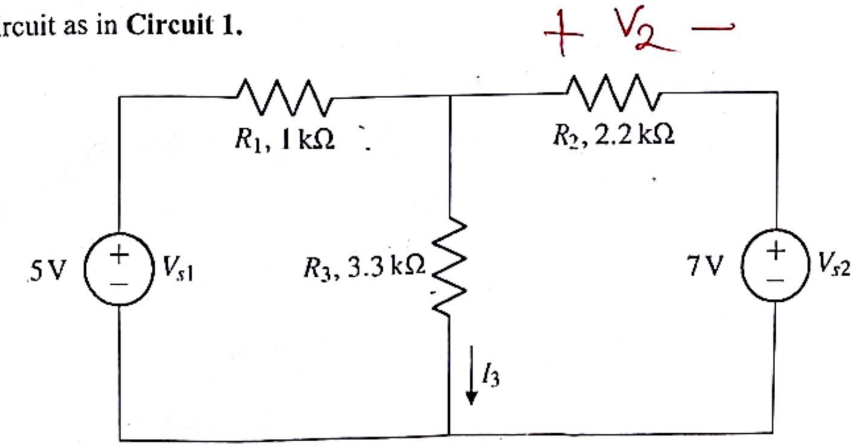
An ***independent voltage source*** is deactivated (made zero) by **shorting it** and an **independent current source** *is deactivated* (made zero) by **open circuiting it**. However, if a dependent source is present, it must remain active during the superposition process.

APPARATUS:

- Two DC power supplies.
- One multimeter.
- Resistors: 1 kΩ, 2.2 kΩ, 3.3 kΩ

PROCEDURES:

- Set up the circuit as in **Circuit 1.**



Circuit 1

2. Calculate the **power associated** with R2 and R3 separately using the experimentally measured values of currents and voltages when:

- Only V_1 source is active.
- Only V_2 source is active.
- Both V_1 and V_2 sources are active.

And verify, whether the superposition theorem is verified or not in this case. If not, comment on the reasons.

$R_1 = 1.990\,k\Omega$, $R_2 = 2.191$, $R_3 = 3.269\,k\Omega$

$V_1 = 5V$, $V_2 = 7V$

When V_1 is active,

We have, $V_2' = 2.835\,V$

$\therefore I_2' = \frac{V_2'}{R_2} = \frac{2.835}{2.191} = 1.2939\,mA$

$\therefore P_2' = V_2' I_2' = 3.6682\,mW$

Now we have, $I_3' = 0.870\,mA$

$\therefore V_3' = I_3' R_3 = 0.870 \times 3.264 = 2.839\,V$

$\therefore P_3' = V_3' \times I_3' = 2.470\,mW$

When V_2 is active,

We have $V_2'' = -5.19\,V$

$\therefore I_2'' = \frac{V_2''}{R_2} = -2.368\,mA$

$\therefore P_2'' = V_2'' I_2'' = 12.2899\,mW$

Again, $I_3'' = 0.554\,mA$

$\therefore V_3'' = I_3'' R_3 = 1.808\,V$

$\therefore P_3'' = V_3'' I_3'' = 1.001\,mW$

When both sources are active,

$V_2 = -2.355\,V$

$\therefore I_2 = \frac{V_2}{R_2} = -1.074\,mA$

$\therefore P_2 = V_2 I_2 = 2.531\,mW$

Again, $I_3 = 1.424\,mA$

$\therefore V_3 = I_3 R_3 = 4.647\,V$

$\therefore P_3 = V_3 \times I_3 = 6.618\,mW$

② P.T.O

Verification:

The superposition theorem can be verified if

$$I_2 = I_2' + I_2''$$

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

from calculations,

$I_2' = 1.2939 mA$, $I_2'' = -2.368 mA$

$\therefore I_2 = -1.074 mA$

Here, the end value of I_2 is almost close to the calculative value we have got, ($I_2 = -1.0741 mA$).

Again,

$I_3' = 0.870 mA$, $I_3'' = 0.554 mA$

$\therefore I_3 = 1.424 mA$

We see that the same case is happening here with I_3.

$\therefore$ The superposition theorem is verified.

3. Comment on the obtained results and discrepancies (if any). Find analytically, the current, I, using Superposition Principle, for V1 = V2 = 5 volts and R1, R2, R3 equal to their values recorded in **Table 1**.

$R_1 = 1.990 k\Omega$, $R_2 = 2.191 k\Omega$, $R_3 = 3.264 k\Omega$

When, V_1 is active,

$R_{eq} = R_1 + \left(\frac{1}{R_2} + \frac{1}{R_3}\right)^{-1} = 3.3009 k\Omega$

$\therefore V'_{R_1} = \frac{R_1}{R_{eq}} V_1 = \frac{1.990}{3.3009} \times 5 = 3.014 V$

$V'_{R_2} = \frac{\left(\frac{1}{R_2} + \frac{1}{R_3}\right)^{-1}}{R_{eq}} V_1 = \frac{1.3109}{3.3009} \times 5 = 1.985 V$

$V'_{R_3} = V'_{R_2} = 1.985 V$

$\therefore I'_{R_1} = \frac{V'_{R_1}}{R_1} = \frac{3.014}{1.990} = 1.5145 mA$

$I'_{R_2} = \frac{V'_{R_2}}{R_2} = 0.9059 mA$

$I'_{R_3} = \frac{V'_{R_3}}{R_3} = 0.6081 mA$

When V_2 is active, $R''_{eq} = R_2 + \left(\frac{1}{R_1} + \frac{1}{R_3}\right)^{-1} = 3.427 k\Omega$

$\therefore V''_{R_2} = \frac{R_2}{R_{eq}} = 3.1966 V$

$V''_{R_1} = \frac{\left(\frac{1}{R_1} + \frac{1}{R_3}\right)}{R_{eq}} = 2.9016 V$

$V''_{R_3} = V''_{R_1} = 2.9016 V$

$\therefore I''_{R_1} = \frac{V''_{R_1}}{R_1} = 1.282 mA$

$I''_{R_2} = \frac{V''_{R_2}}{R_2} = 1.4589 mA$

$I''_{R_3} = \frac{V''_{R_3}}{R_3} = 0.8889 mA$

When both active, $I_{R_1} = I'_{R_1} - I''_{R_1} = 0.2325 mA$

$I_{R_2} = I'_{R_2} - I''_{R_2} = -0.553 mA$

$I_{R_3} = I'_{R_3} + I''_{R_3} = 1.497 mA$

DISCUSSION:

1. Comment on the results obtained and discrepancies (if any).

We had to verify the superposition principle in this experiment. First of all, we had to place the negative sides of the voltage sources properly with the resistors. Then we took readings of the resistors, current and voltage values with multimeter. Then we just take one voltage source and connect the circuit accordingly. We did the same for the second voltage source as well. However, we mistook multiple times when getting the voltage value because we didn't see the negative sign at first. After figuring it out, the calculations came correct and we completed the experiment.

Data Table

Signature of lab faculty: Prityas

Date: 06-02-2023

Group No. : 06

Table 1: Circuits 1, 2 and 3

Observation	R_1 (kΩ)	R_2 (kΩ)	R_3 (kΩ)	I_3' with only V_1 active (mA)	I_3'' with only V_2 active (mA)	$I_3' + I_3''$ (mA)	I_3 with both V_1 and V_2 active (mA)
Experimental	1.990	2.191	3.264	0.870	0.554	1.424	1.421
Theoretical				0.870	0.554	1.424	1.424

Table 2: Lab Task

Observation	R_1 (kΩ)	R_2 (kΩ)	R_3 (kΩ)	V'_2 (when only V_1 is active) (V)	V''_2 (when only V_2 is active) (V)	$V'_2 + V''_2$ (V)	V_2 (when both V_1 and V_2 is active) (V)
Experimental	1.990	2.191	3.264	2.835	-5.19	-2.355	-2.366
Theoretical				2.835	-5.19	-2.355	-2.355

Error Calculation

- $$Percentage\ of\ Error = \frac{Expected\ Value - Observed\ Value}{Expected\ Value} X\ 100\%$$

Table 3, 4: Error Calculation

Task	I_3 with both V_1 and V_2 active (mA) [Expected Value]	$I_3' + I_3''$ (mA) [Observed Value]	% Error
Circuits 1, 2 and 3	1.424	1.424	0

Task	V_2 (when both V_1 and V_2 is active) (V) [Expected Value]	$V'_2 + V''_2$ (V) [Observed Value]	% Error
Lab Task	-2.355	-2.355	0