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Batch – 2024
Application No - 158377
Subgroup – 1H3

Experiment: To study Super position's theorem.

Objective: To verify the Super position's Theorem.

Apparatus: Virtual using Tinkercad (www.tinkercad.com)

Theory: Superposition theorem states that - "In a linear, bilateral network, consisting of several sources, the resultant current in any branch is the algebraic sum of the currents caused by the separate independent sources acting alone replacing all other sources by their respective internal resistances." This theorem when used for evaluating response in a complicated network containing several sources, simplifies the analysis. The theorem is particularly used in case of network, where sources generating voltages or currents of different frequencies are acting simultaneously, considering the effect of individual source independent of others.

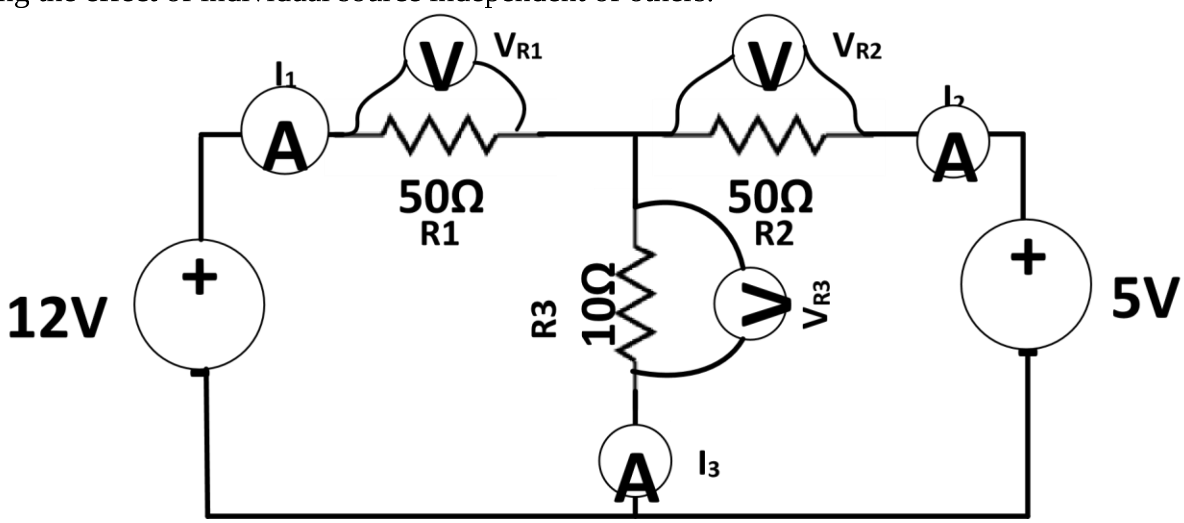


Fig. Circuit diagram for verification of Superposition theorem

Procedure:

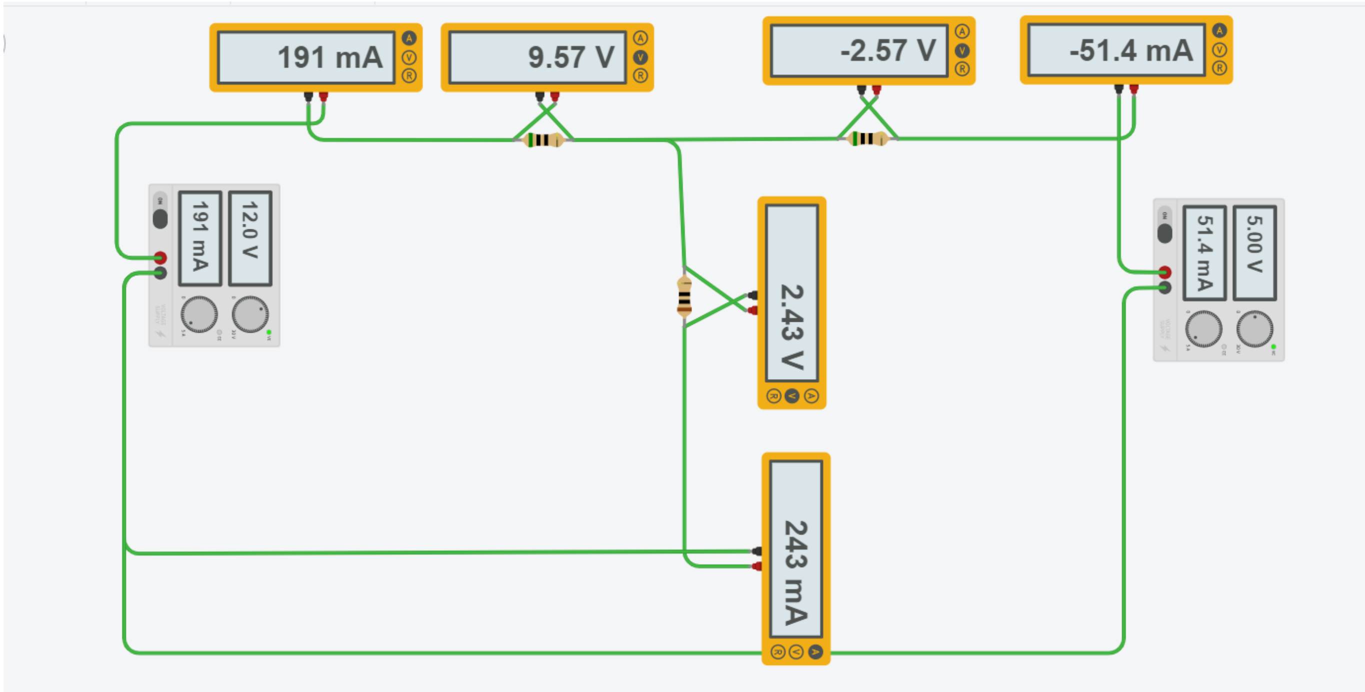
1. Connect circuit as shown in diagram on tinkercad workspace. Consider only one voltage source at a time, first 12V.

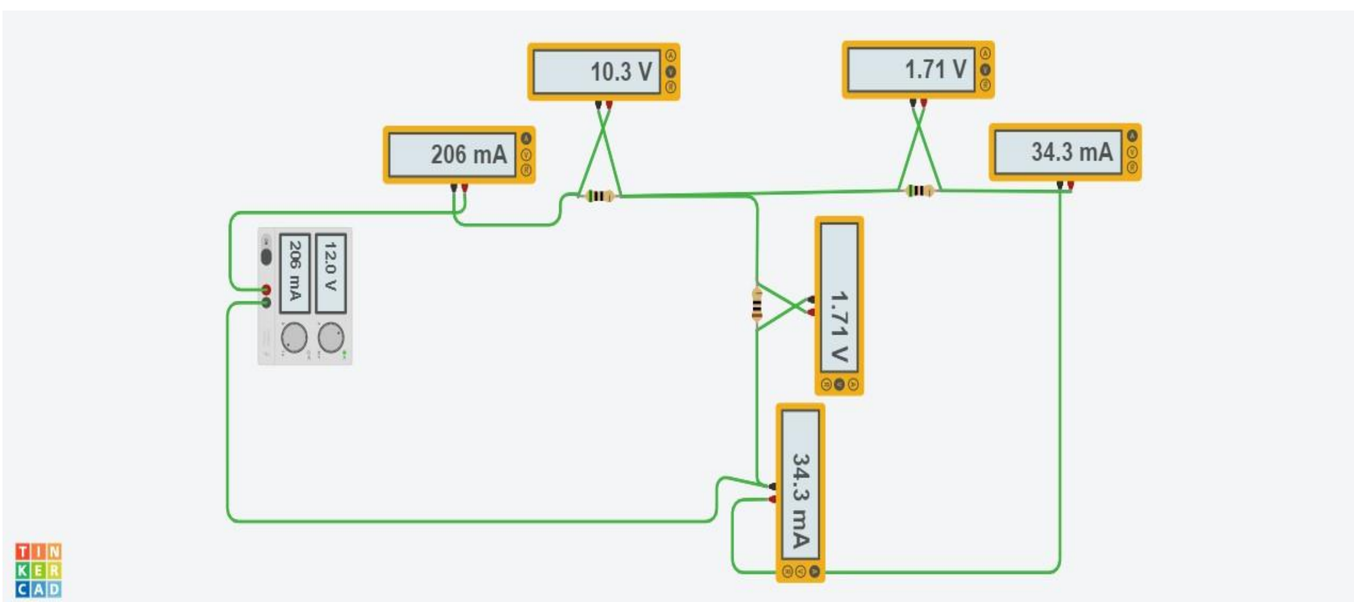
2. Start the simulation and note down I_1, I_2 & I_3 one by one by connecting current meter in series of resistances R_1, R_2 & R_3. Also note down the voltages across the resistances V_{R1}, V_{R2} and V_{R3} by connecting the multimeter in voltage mode in parallel to the resistances.
3. Now consider only 5V and note down I_1, I_2 & I_3 one by one by connecting current meter in series of resistances R_1, R_2 & R_3. Also note down the voltages across the resistances V_{R1}, V_{R2} and V_{R3} by connecting the multimeter in voltage mode in parallel to the resistances.
4. Now consider both 12V & 5V to note down I_1, I_2 & I_3 one by one by connecting current meter in series of resistances R_1, R_2 & R_3. Also note down the voltages across the resistances V_{R1}, V_{R2} and V_{R3} by connecting the multimeter in voltage mode in parallel to the resistances.
5. Now compute the same through analytical method by calculating the currents and voltages for all the modes and tabulate the results. Compute the percentage error if any.

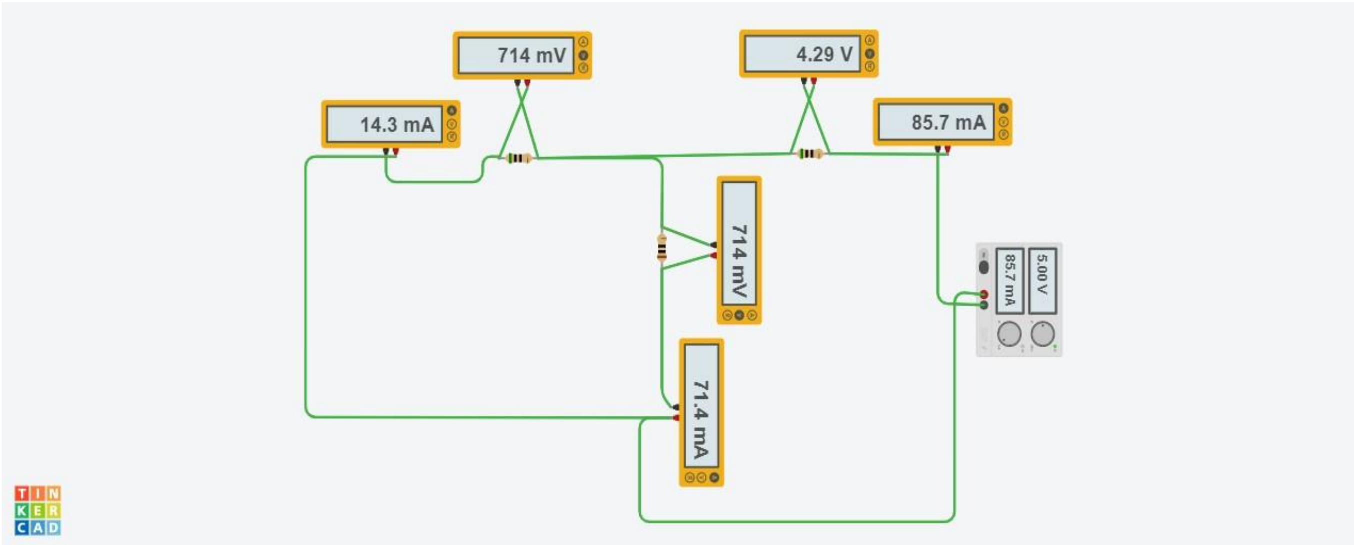
Observation Table: -

CURRENT & VOLTAGE	**EXPERIMENTAL**			**Theory**			**%Error**
	I/P DC VOLTAGE						
	12V	**5V**	**(12V+5V)**	**12V**	**5V**	**(12V+5V)**	
I_1	206mA	14.3mA	191mA	206mA	14.3mA	191mA	0%
I_2	34.3mA	85.7mA	51.4mA	34.4mA	85.7mA	51.4mA	0%
I3	34.3mA	71.4mA	243mA	34.3mA	71.4mA	243mA	0%
V_{R1}	10.3V	0.714V	9.57V	10.3V	0.714V	9.57V	0%
V_{R2}	1.71V	0.0857V	2.57V	1.71V	0.0857V	2.57V	0%
V_{R3}	1.71V	0.714V	2.43V	1.71V	0.714V	2.43V	0%

Circuit diagram on Tinkercad:

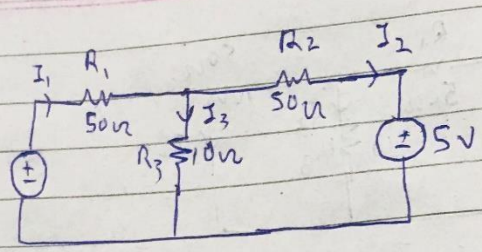

191 mA
9.57 V
-2.57 V
-51.4 mA
191 mA
12.0 V
2.43 V
51.4 mA
5.00 V
243 mA


10.3 V
1.71 V
206 mA
34.3 mA
206 mA
12.0 V
1.71 V
34.3 mA
TIN
KER
CAD



Calculations:

For 12V+5V:



$I_1 + I_2 = I_3$

Nodal analysis

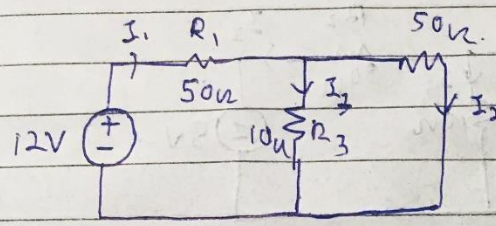
$(12 - V_a)/50 + (5 - V_a)/50 = V_a/10$

$12 - V_a + 5 - V_a = 5V_A \qquad 7V_a = 17 \qquad V_a = \underline{2.43\,V}$

$V_1 = 12 - 2.43 = 9.57V$
$V_2 = 5 - 2.43 = 2.57V$
$V_3 = 2.43 - 0 = 2.43V$

$I_1 = 9.75/50 = 0.1914A$
$I_2 = 2.57/50 = 0.0514A$
$I_3 = 2.43/10 = 0.243A$

For 12V



$R_2 - R_3$ are parallel

$$R_{\parallel} = \frac{10 \times 50}{10 + 50} = 8.3\Omega$$

$R_{\parallel}$ series with R_1

$$R_{eq} = 50 + 8.3 = \underline{58.3\Omega}$$

Using Now $I_1 = \dfrac{12}{58.3} = \underline{0.206\,A}$

$$I_3 = (50/60) \times 0.206 = \underline{0.172A}$$

$$I_2 = I_1 - I_3 = \underline{0.034\,A}$$

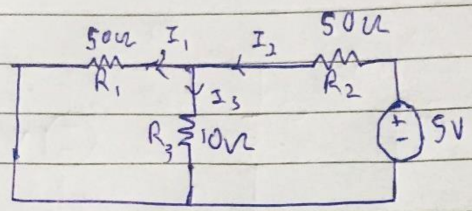
Now voltage across all the resistors

$$V_1 = 50 \times 0.206 = \underline{10.3V}$$

$$V_2 = 50 \times 0.034 = \underline{1.7V}$$

$$V_3 = 10 \times 0.172 = \underline{1.72V}$$

for 5V



$$R_{11} = \frac{R_1 R_3}{R_1 + R_3} = \frac{10 \times 50}{10+50} = 8.3\Omega$$

$$R_{eq} = R_{11} + R_2 = 50 + 8.3 = \underline{58.3\Omega}$$

$$I_2 = \frac{5}{58.3} = \underline{0.0852A}$$

Using current distribution law

$$I_3 = (50/60) \times 0.0857 = \underline{0.0714A}$$

$$I_1 = I_2 - I_3 = \underline{0.143A}$$

Now voltage across all resistor.

$$V_1 = I_1 R_1 = 50 \times 0.0143 = \underline{0.715V}$$

$$V_2 = I_2 R_2 = 50 \times 0.0857 = \underline{4.285V}$$

$$V_3 = I_3 R_3 = 10 \times 0.0714 = \underline{0.714V}$$

Conclusion:

The branch current is the algebraic sum of currents due to individual voltage source when all other voltage sources are short circuited; hence superposition theorem has been verified.