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Course : CSE250

section : CSE06

Lab Assignment : 04

Name of the Experiment:

Verification of Superposition Principle

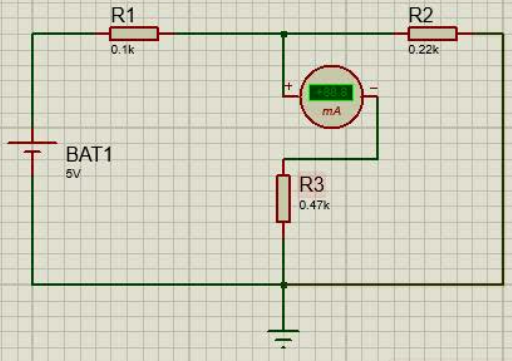
Objective: To verify experimentally the Superposition theorem which is an analytical technique of determining currents in a circuit with more than one emf source.

Apparatus:

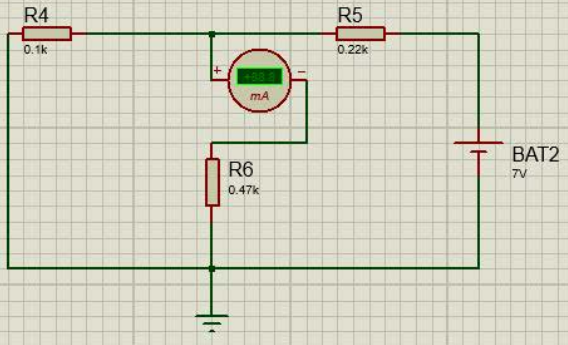
1. Two DC Power supplies
2. One multimeter

Circuit Diagram:

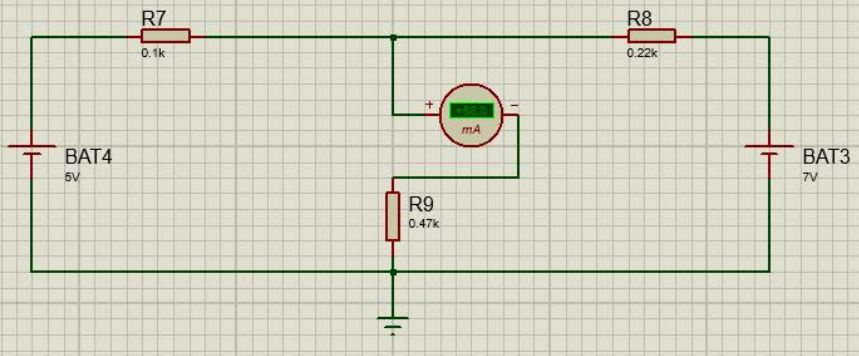
E1 is active



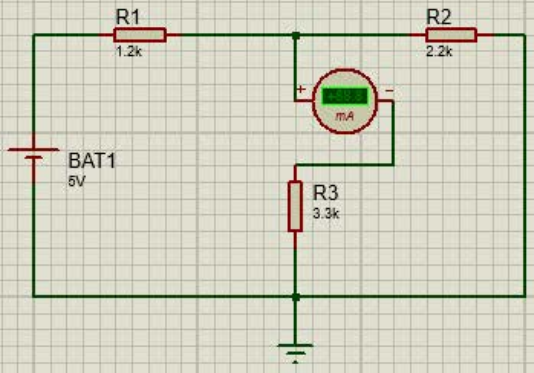
E2 is Active



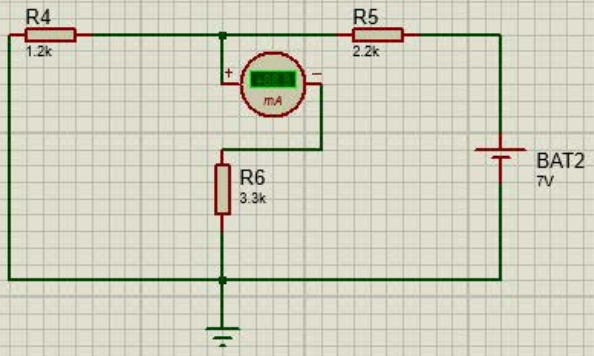
Both E1, E2 is Active



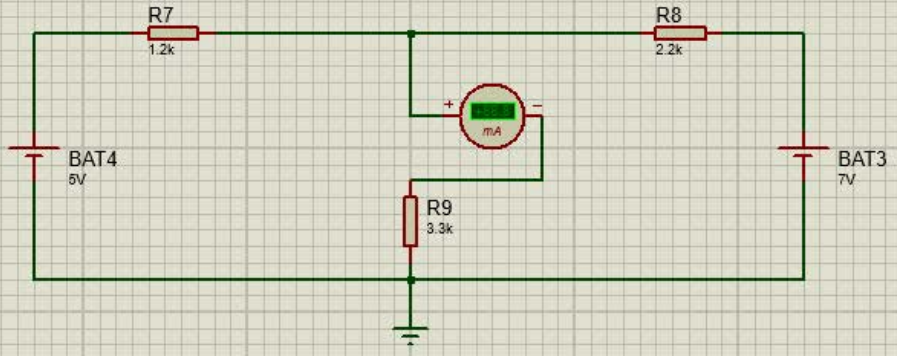
E1 is active



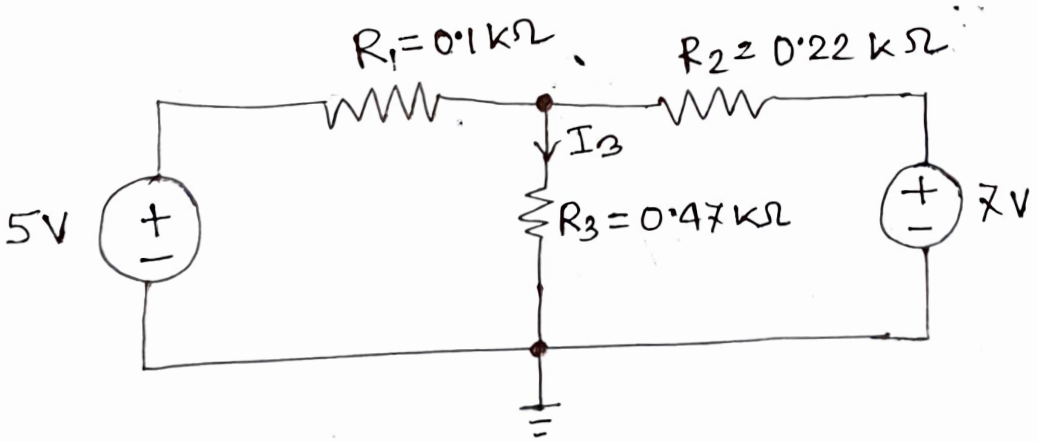
E2 is Active



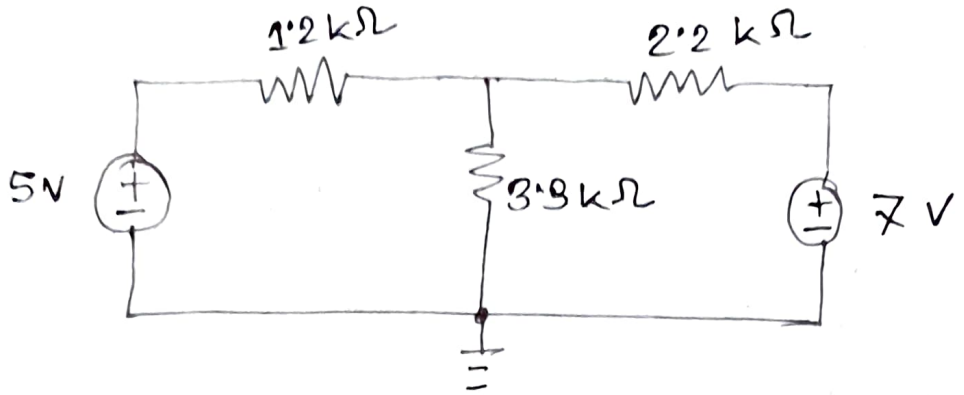
Both E1, E2 is Active



Circuit Diagram for circuit-1:



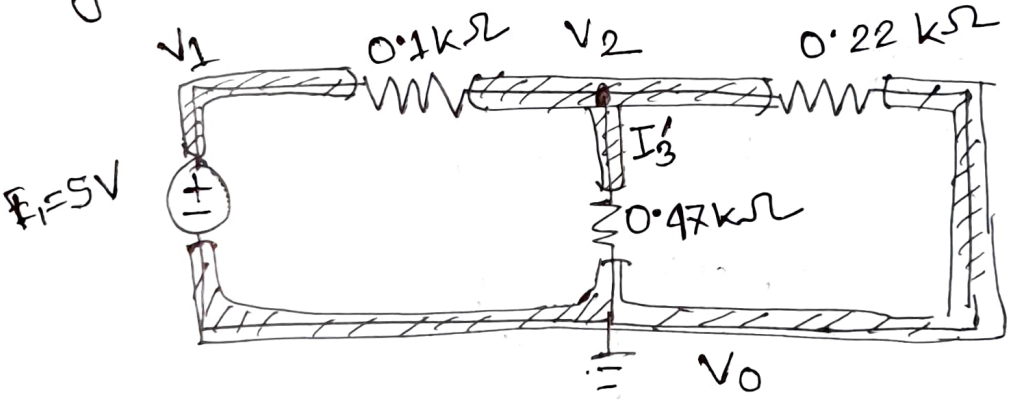
Circuit diagram for circuit-2:



Result:

For circuit-1:

Here, we take 5V or E_1 as active, so diagram is



Here

$V_1 = 5\,V$

Nodal Analysis on V_2

$$V_2\left(\frac{1}{0.1}+\frac{1}{0.47}+\frac{1}{0.22}\right)-\frac{V_1}{0.1}-\frac{V_o}{0.47}-\frac{V_o}{0.22}=0$$

$$\Rightarrow V_2\left(\frac{1}{0.1}+\frac{1}{0.47}+\frac{1}{0.22}\right)-\frac{V_1}{0.1}=0$$

$$\Rightarrow V_2\left(\frac{8620}{517}\right)-\frac{5}{0.1}=0$$

$$\Rightarrow V_2(16.6731)-50=0$$

$$\Rightarrow V_2(16.6731)=50$$

$$\Rightarrow V_2=\frac{50}{16.6731}=2.9988$$

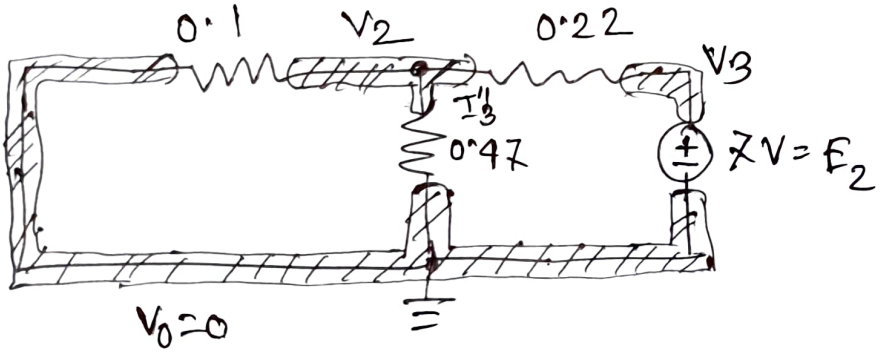
$$=\sim 3V$$

$$\therefore I_3'=\frac{3}{0.47}=6.38297$$

$$=6.383\ mA$$

Now

Taking $E_2=7V$ as active, so circuit diagram is.



Node names have no connection with C-1

Here, $V_3 = 7\ V$

Nodal Analysis on V_2

$$V_2\left(\frac{1}{0.1} + \frac{1}{0.22} + \frac{1}{0.47}\right) - \frac{V_3}{0.22} = 0$$

$$\Rightarrow V_2(16.6731) = 31.8181$$

$$\Rightarrow V_2 = \frac{31.8181}{16.6731}$$

$$= 1.9083\ V \quad \text{(can consider as 2V?)}$$

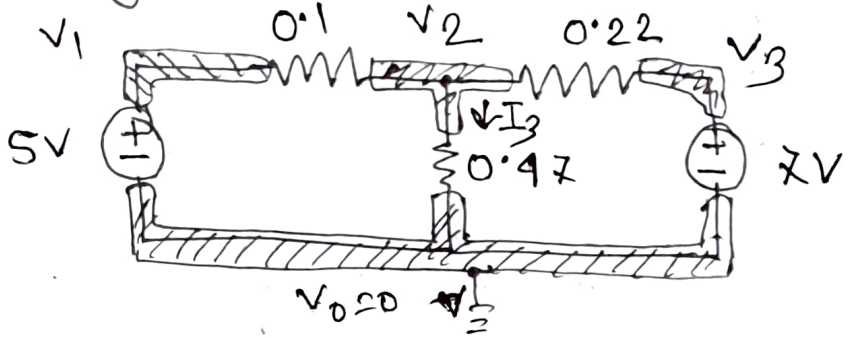
$$\therefore I_3 = \frac{1.9083}{0.47}$$

$$= 4.060\ mA$$

Now when everything is active:

$V_1 = 5V$

$V_3 = 7V$



$V_2 =$

$$V_2(16.6731) - \frac{V_1}{0.1} - \frac{V_3}{0.22} = 0$$

$$\Rightarrow V_2(16.6731) - \frac{5}{0.1} - \frac{7}{0.22} = 0$$

$$\Rightarrow V_2(16.6731) = 81.8181$$

$$\Rightarrow V_2 = \frac{81.8181}{16.6731}$$

$$= 4.9071\ V$$

$$\therefore I_3 = \frac{4.9071}{0.47}$$

$$= 10.44\ mA$$

Now $I_3' = 6.383\ mA$

$I_3'' = 4.060\ mA$

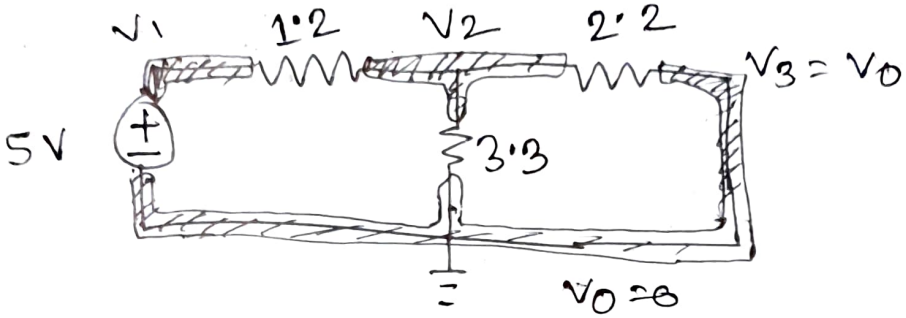
$I_3 = 10.44\ mA$

$\therefore I_3' + I_3'' = I_3$ [Theoretically proven]

Now

For Circuit-2:

Taking $E_1 = 5V$ as active



Here

$$V_1 = 5V$$

$$V_2\left(\frac{1}{1\cdot2} + \frac{1}{3\cdot3} + \frac{1}{2\cdot2}\right) - \frac{V_1}{1\cdot2} = 0$$

$$\Rightarrow V_2\,(1.5909) - \frac{5}{1\cdot2} = 0$$

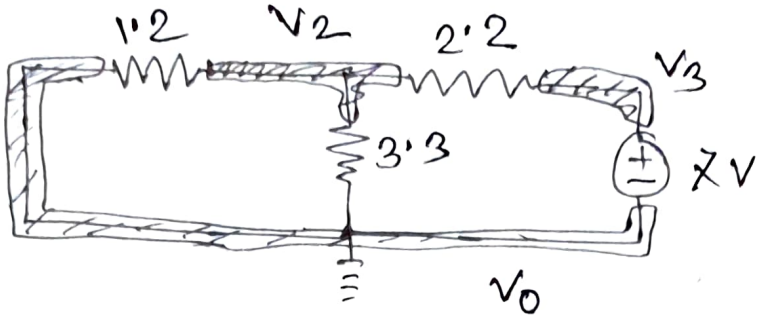
$$\Rightarrow V_2 = \frac{4.1667}{1.59} = 2.62\ V$$

$$\therefore I_3' = \frac{2.62}{3.3}$$

$$= 0.7939$$

$$= 0.794\ mA$$

Taking $E_2 = 7V$ as active



Here, $V_3 = 7V$

$$\Rightarrow V_2(1{\cdot}59) - \frac{V_3}{2{\cdot}2} = 0$$

$$\Rightarrow V_2(1{\cdot}59) - \frac{7}{2{\cdot}2} = 0$$

$$\Rightarrow V_2 = \frac{3{\cdot}1818}{1{\cdot}59}$$

$$= 2{\cdot}0011$$

$$= 2V$$

$$\therefore I_3'' = \frac{2}{3{\cdot}3}$$

$$= 0{\cdot}6060$$

$$= 0{\cdot}606 \text{ mA}$$

When E_1, E_2 both active

$V_1 = 5V$

$V_2 = 7V$

$$V_2(1.59) - \frac{V_1}{1.2} - \frac{V_2}{2.2} = 0$$

$$\Rightarrow V_2(1.59) - \frac{5}{1.2} - \frac{7}{2.2} = 0$$

$$\Rightarrow V_2(1.59) = 7.3849 \; 7.3484$$

$$\Rightarrow V_2 = \frac{7.38484}{1.59}$$

$$V_2 = 4.6216 \; V$$

$$\therefore I_3 = \frac{4.6216}{3.3} = 1.400 = 1.4 \; mA$$

$\therefore I_3 = 1.4mA$

$I_3' = 0.794mA$

$I_3'' = 0.606$

$\therefore I_3 = I_3' + I_3''$ (Theoretically Proven)

Data Table:

Data Table for circuit-1:

Observation	R_1 (kΩ)	R_2 (kΩ)	R_3 (kΩ)	I_3' (mA) (E_1 Active)	I_3'' (mA) (E_2 Active)	$I_3' + I_3''$ (mA)	I_3 (mA) (E_1, E_2 Active)
Simulation	0·1	0·22	0·47	6·38	4·06	10·44	10·4
Theoretical	0·1	0·22	0·47	6·383	4·060	10·44	10·44

Data Table for circuit-2:

Observation	R_1 (kΩ)	R_2 (kΩ)	R_3 (kΩ)	I_3' (mA) (E_1 Active)	I_3'' (mA) (E_2 Active)	$I_3' + I_3''$ (mA)	I_3 (mA) (Both Active)
Simulation	1·2	2·2	3·3	0·79	0·61	1·4	1·40
Theoretical	1·2	2·2	3·3	0·794	0·606	1·4	1·4

Discussion: We have proven the Super-position theorem, both theoretically and simulation. Both cases the found and calculated values matched exactly though there might be some decimal point mismatch due to hand calculation.