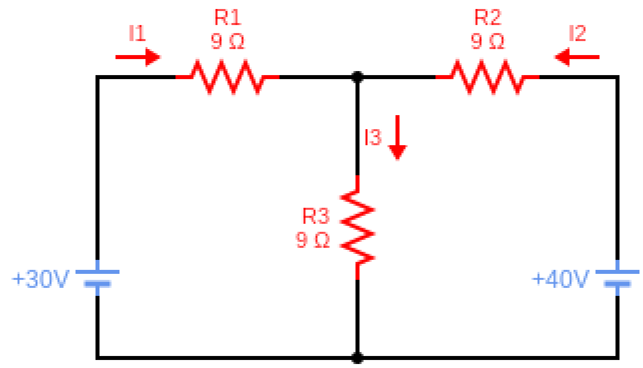
Experiment No. 03

Name of the Exp: Verification of superposition theorem.

Objective: Our objective is to find the total current through the resistors in the following circuit using superposition theorem.



Circuit Diagram 1.0

Theory: In this experiment we are verifying the superposition theory which states that "*The current through, or voltage across, any element of a network is equal to the algebraic sum of the currents or voltages produced independently by each source*".

Apparatus:

1. DC power supply
2. Resistors
3. Digital multi meter
4. Bread board
5. Connection wire

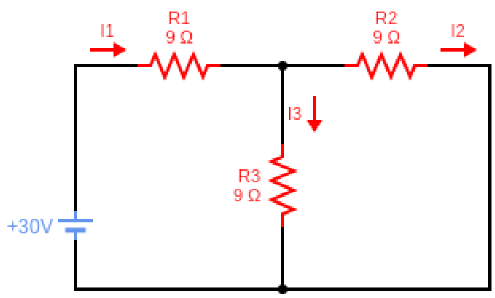
Procedure:

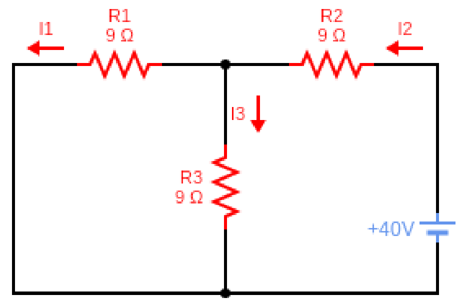
1. For the 1^{st} step of superposition theorem, we must disconnect one of the voltage sources and replace it with a short circuit.
2. Then determine the current through each resistor for the 1^{st} voltage source.
3. As for the 2^{nd} step of superposition theorem, we are going to disconnect the other voltage source from the circuit and replace it with a short circuit.
4. Then determine the current through each resistor for the 2^{nd} voltage source.

5. Now we sum up the currents for 1st & 2nd voltage source and match with the total current value that we got practically.

Circuit Diagram:

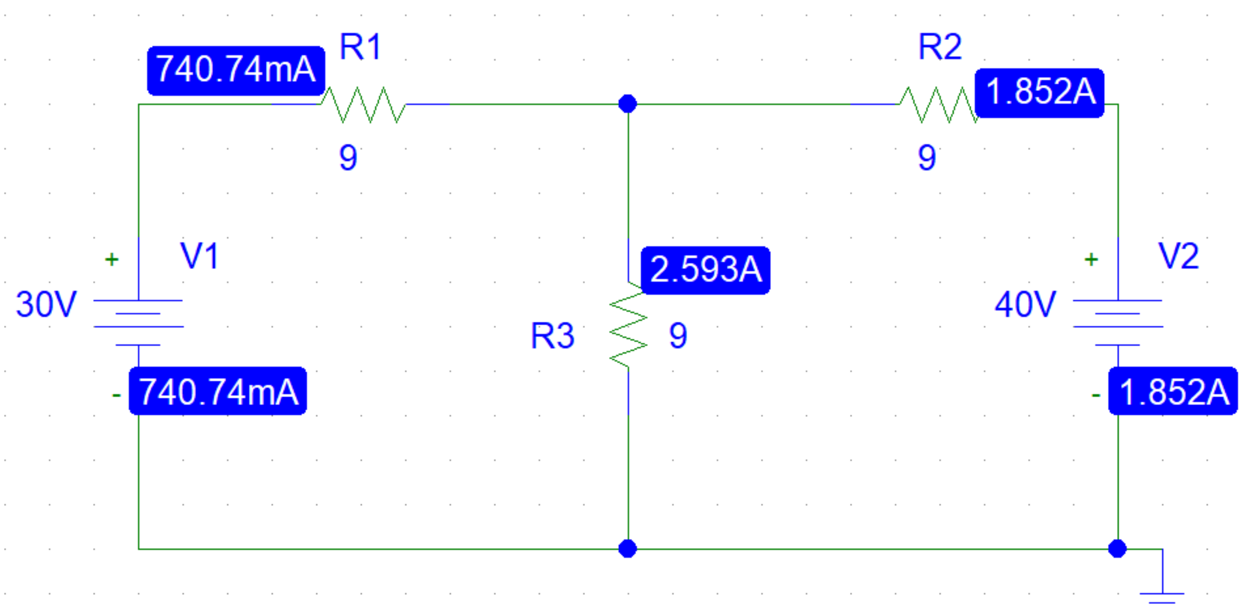
1. For theoretical calculations



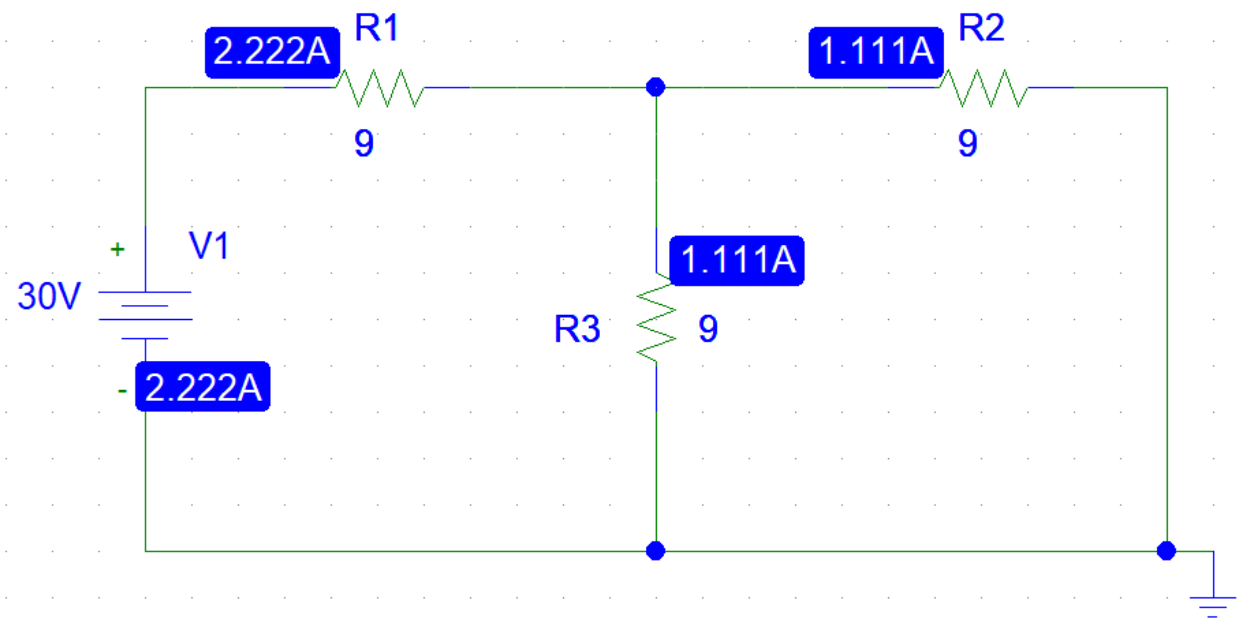


Circuit Diagram 2.0 ***Circuit Diagram 3.0***

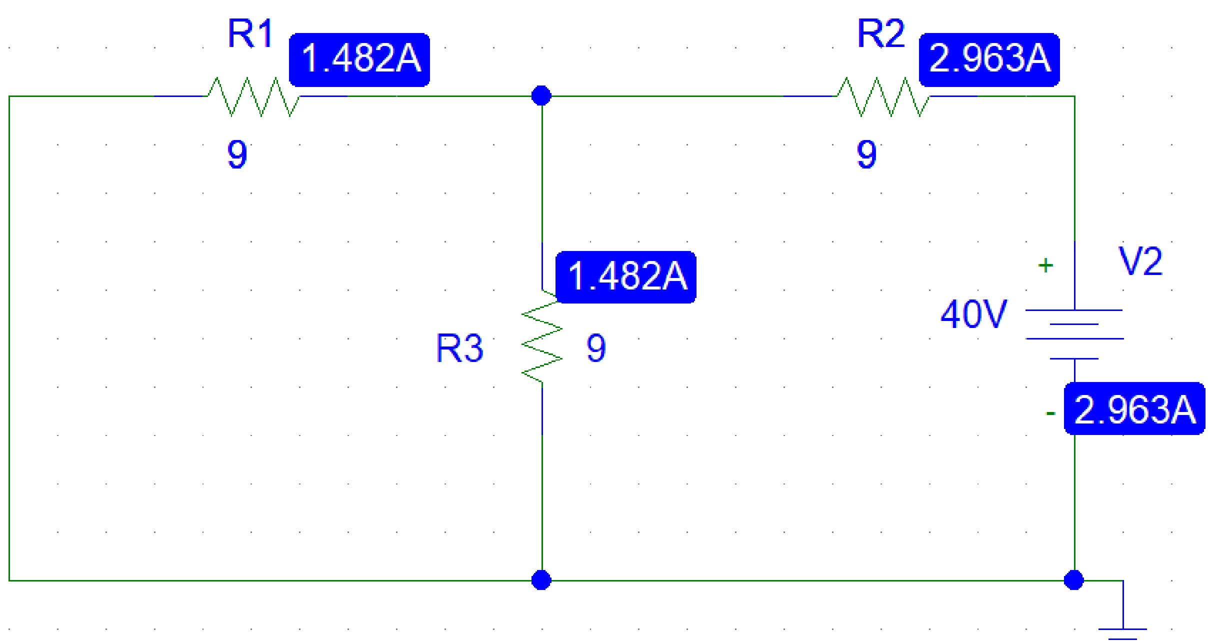
2. Measured Value



Circuit Diagram 1.1



Circuit Diagram 2.2



Circuit Diagram 3.3

<u>Model Calculation</u>: (For theoretical & measured value).

Theoretical:

Let's say, $R_1 = R_2 = R_3 = 9\Omega$, $E_1 = 30V$, $E_2 = 40V$

For E_1 in circuit diagram 2.0 we get,

$$\frac{1}{R_{(2+3)}} = \frac{1}{R_2} + \frac{1}{R_3} = \frac{1}{9} + \frac{1}{9} = \frac{2}{9} = \frac{1}{4.5}$$

$or,\ R_{(2+3)} = 4.5\Omega$ Now,

$$R_T = R_1 + R_{(2+3)} = 9 + 4.5 = 13.5$$

$$or, \quad R_{T_1} = 13.5\Omega$$

For E_1

$$I_{T_1} = \frac{E_1}{R_{T_1}} = \frac{30}{13.5} = 2.22A$$

$I_1' = I_{T_1}$ & Using current divider rule we get,

$$I_3' = \frac{I_{T_1}.R_2}{R_2 + R_3} = \frac{2.22 \times 9}{18} = 1.11A \qquad I_2' = \frac{I_{T_1}.R_3}{R_2 + R_3} = \frac{2.22 \times 9}{18} = 1.11A$$

For E_2 in circuit diagram 3.0 we get,

$$\frac{1}{R_{(1+3)}} = \frac{1}{R_1} + \frac{1}{R_3} = \frac{1}{9} + \frac{1}{9} = \frac{2}{9}$$

$or, \quad R_{(1+3)} = 4.5\Omega$ Now,

$$R_{T_2} = R_{(1+3)} + R_2 = 4.5 + 9 = 13.5\Omega$$

For E_2

$$I_{T_2} = \frac{E_2}{R_{T_2}} = \frac{40}{13.5} = 2.963A$$

$I_2'' = I_{T_2}$ & Using current divider rule we get,

$$I_3'' = \frac{I_{T_2}.R_1}{R_1 + R_3} = \frac{2.963 \times 9}{18} = 1.481A \qquad I_1'' = \frac{I_{T_2}.R_3}{R_1 + R_3} = \frac{2.963 \times 9}{18} = 1.481A$$

Now according to superposition theorem, we are going to do the algebraical sum of the current for E_1 & E_2 and see if the sum matches out for total current.

Since the direction of I_1' & I_1'' is opposite so,

$I_1 = I_1' - I_1'' = 2.22 - 1.481 = 0.738A$

It means the direction of I_1 is the same direction of I_1'.

And the direction of I_2' & I_2'' is also opposite so,

$I_2 = I_2' - I_2'' = 1.11 - 2.963 = -1.853A = 1.853A$

The negative sign means the direction of I_2 is in the direction of I_2''.

The direction of I_3' & I_3'' is in the same direction so,

$I_3 = I_3' + I_3'' = 1.11 + 1.481 = 2.591A$

Since both current is in the same direction so the current I_3 will flow the same way as I_3' & I_3''.

Result: The result for theoretical (TV) and measured (MV) value is given below

For **E$_1$**

Current (A)	I_{T_1}		I_1'		I_2'		I_3'	
Values (TV)&(MV)	TV	MV	TV	MV	TV	MV	TV	MV
	2.22	2.222	2.22	2.222	1.11	1.111	1.11	1.111

For **E$_2$**

Current (A)	I_{T_2}		I_1''		I_2''		I_3''	
Values (TV)&(MV)	TV	MV	TV	MV	TV	MV	TV	MV
	2.963	2.963	1.481	1.482	2.963	2.963	1.481	1.482

For **E$_1$** & **E$_2$**

Current (A)	I_1		I_2		I_3	
Values (TV)&(MV)	TV	MV	TV	MV	TV	MV
	0.738	0.740	1.853	1.852	2.591	2.593

Conclusion: The theoretical and measured value of this circuit matches up. So, we can say the superposition theorem, was applied & verified successfully.

Precautions:

1. Check for proper connections before switching ON the power supply.
2. Take care of the reading the apparatus.
3. The terminal of the resistance should be properly connected.