Ex. No.: 1

Date: 25/7/2019

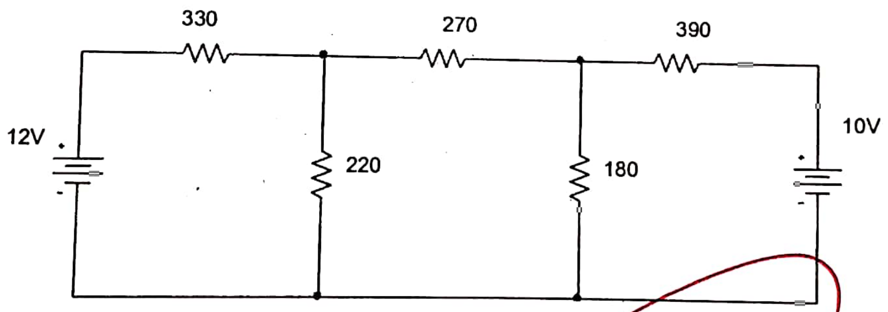
Verification of KIRCHHOFF'S LAWS
(Mesh and Nodal Analysis)

Aim: To verify the Kirchoff's Current Law & Voltage Law for the given network theoretically and experimentally.

Apparatus/Tool required:

Sl. No.	Components Name	Range	Quantity
1	Resister	330Ω, 270Ω, 390Ω, 220Ω, 180Ω	Each 1 No.
2	Ammeter	0-50mA (DC)	1 No.
3	Voltmeter	0-30V (DC)	1 No.
4	RPS	0-32 V (DC)	1 No.
5	Connecting Wires	-	Few
6	Bread Board	-	1 No.

Circuit Diagram:



Theory:

Kirchhoff's Current Law (KCL): The algebraic sum of the current at any junction is zero.

$\Sigma i = 0$

Kirchhoff's Voltage Law (KVL): The algebraic sum of the voltage is zero at any closed loop.

$\Sigma V = 0$

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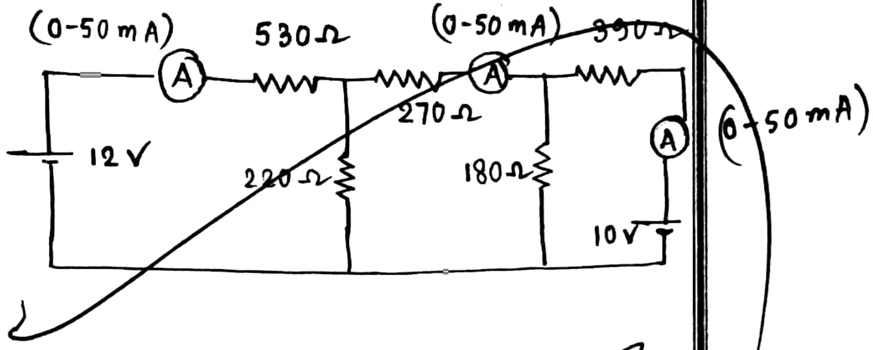
Practical Circuit and output:

Mesh Analysis:



$i_1 = 23.0$ mA

$i_2 = 3.0$ mA

$i_3 = 16.5$ mA

$i_1 - i_2 = i_4 = 18.0$ mA

$i_2 - i_3 = i_5 = -11.5$ mA

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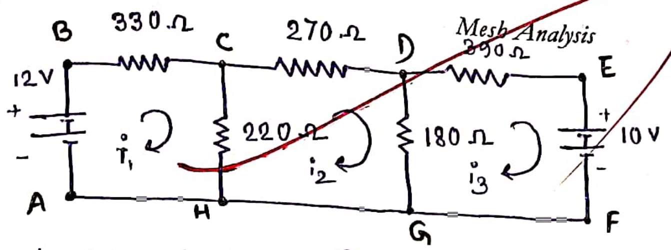
Manual Calculations:



Loops : ABCHA — (I), CDHC — (II), DEFGD — (III)

(I) ABCHA

$$12 - 330\, i_1 - 220(i_1 - i_2) = 0$$

$$\Rightarrow 12 - 550\, i_1 + 220\, i_2 = 0$$

$$\boxed{550\, i_1 - 220\, i_2 = 12} \quad \text{— (1)}$$

(II) CDHC

$$-270\, i_2 - 180(i_2 - i_3) - 220(i_2 - i_1) = 0$$

$$\Rightarrow -270\, i_2 - 180\, i_2 + 180\, i_3 - 220\, i_2 + 220\, i_1 = 0$$

$$\therefore \boxed{220\, i_1 - 670\, i_2 + 180\, i_3 = 0} \quad \text{— (2)}$$

(III) DEFGD

$$-390\, i_3 - 10 - 180(i_3 - i_2) = 0$$

$$\Rightarrow -390\, i_3 - 10 - 180\, i_3 + 180\, i_2 = 0$$

$$\therefore \boxed{180\, i_2 - 570\, i_3 = 10} \quad \text{— (3)}$$

By solving (1), (2), (3) we get :

$$i_1 = 23.06 \text{ mA} = 23.06 \times 10^{-3} \text{ A}$$

$$i_2 = 3.12 \text{ mA}$$

$$i_3 = -16.56 \text{ mA}$$

$$\therefore\ i_1 - i_2 = (23.06 - 3.12) \text{ mA} = 19.94 \text{ mA}$$

$$i_2 - i_3 = (3.12 - (-16.56)) \text{ mA} = 19.68 \text{ mA}$$

KCL proof :-

At point c :

$$i_1 = i_2 + i_4$$

$$23.06 = 19.94 + 3.12$$

$$23.06 = 23.06$$

$$LHS = RHS$$

At point d :

$$i_3 + i_2 = i_5$$

$$13.56 + 3.12 = 19.68$$

$$19.68 = 19.68$$

$$LHS = RHS$$

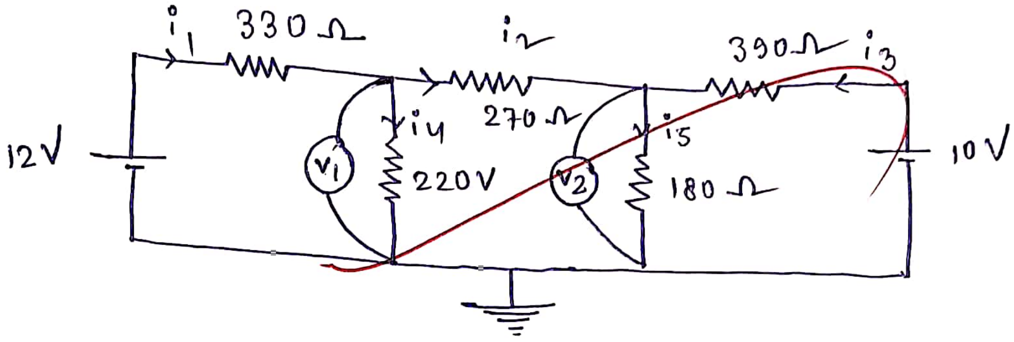
KVL proof :-

Substituting the values of current in equation 1 we get :-

$$\left(550 \times 23.06 \times 10^{-3}\right) - \left(220 \times 3.12 \times 10^{-3}\right) = 12$$

Practical Circuit and output:

Node Analysis:



$V_1 = 4.2$ V

$V_2 = 3.5$ V

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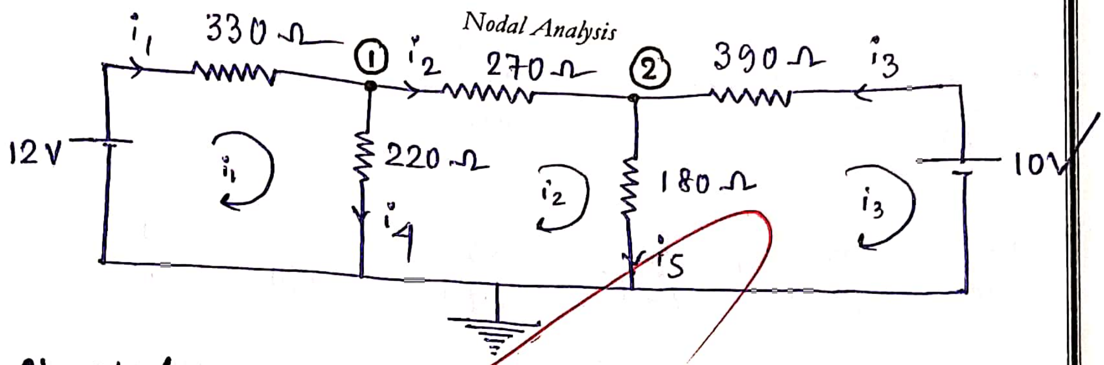
Manual Calculations:

Nodal Analysis



At node 1 :

$$i_2 + i_4 = i_1 \quad \text{——— (1)}$$

$$i_1 = \frac{12 - V_1}{330} \quad \text{——— 2}$$

$$i_2 = \frac{V_1 - V_2}{270} \quad \text{——— 3}$$

$$i_4 = \frac{V_1 - 0}{220} \quad \text{——— 4}$$

$$\frac{12 - V_1}{330} = \frac{V_1 - V_2}{270} + \frac{V_1 - 0}{220}$$

$$\frac{12 \cancel{- V_1}}{330} - \frac{V_1}{330} - \frac{V_1}{270} + \frac{V_2}{270} - \frac{V_1}{220} = 0$$

$$\frac{12}{330} - V_1\left(\frac{1}{330} + \frac{1}{270} + \frac{1}{220}\right) + \frac{V_2}{270} = 0$$

$$-0.01127\, V_1 + 0.0037\, V_2 = -0.0364 \quad \text{——— 5}$$

At node 2 :

$$i_3 + i_2 = i_5 \quad \text{——— 6}$$

$$i_3 = \frac{10 - V_2}{390} \quad \text{——— 7}$$

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$$i_2 = \frac{V_1 - V_2}{270} \quad \text{——— } 8$$

$$i_5 = \frac{V_2 - 0}{180} \quad \text{——— } 9$$

$$\frac{10 - V_2}{390} + \frac{V_1 - V_2}{270} = \frac{V_2}{180}$$

$$\Rightarrow \frac{10}{390} - \frac{V_2}{390} + \frac{V_1}{270} - \frac{V_2}{270} - \frac{V_2}{180} = 0$$

$$\Rightarrow \frac{V_1}{270} - V_2\left(\frac{1}{390} + \frac{1}{270} + \frac{1}{180}\right) = \frac{-10}{390}$$

$$0.0037\, V_1 - 0.0118\, V_2 = -0.0256 \quad \text{——— } 10$$

By solving 5 & 10, we get:

$V_1 = 4.4\ V$

$V_2 = 3.6\ V$

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Procedure:

The Kirchoff's current & voltage law have been verified for the given network theoretically & experimentally & the following results are tabulated :

Result:

Mesh Analysis:

Manual Calculations

$i_1 = 23.06$

$i_2 = 3.12$

$i_3 = 16.56$

Practical output

$i_1 = 23.0$ mA

$i_2 = 5.0$ mA

$i_3 = 16.5$ mA

Node Voltage Analysis:

Manual Calculations

$V_1 = 4.4$

$V_2 = 3.6$

Practical output

$V_1 = 4.2$

$V_2 = 3.5$

25/7/19

Inference:

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