

Ex. No.: 1

Date: 27/09/2021

Verification of Kirchhoff's Voltage Law

Aim:

To verify Kirchhoff's law using mesh analysis with manual calculations and an ORCAD simulation

Apparatus:

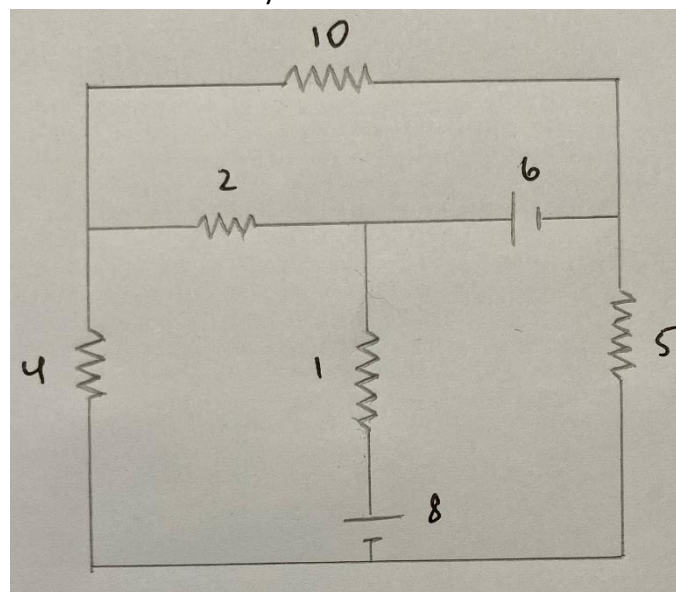
ORCAD / Capture CIS: Analog Library – R

Source Library – Vdc

Ground (GND) – 0 (zero)

Simulation Settings: Analysis Type – Bias Point

Circuit Diagram for Mesh Analysis:



Statement:

Mesh analysis is a technique to find the currents circulating around a loop or mesh within any closed circuit.

Manual Calculations:

Top loop \rightarrow clockwise current i_1

Bottom left loop \rightarrow Anti-clockwise i_2

Bottom right loop \rightarrow clockwise i_3

Top Loop

$$-10i_1 + 6 - 2(i_1 + i_2) = 0$$

$$\Rightarrow 12i_1 + 2i_2 = 6$$

$$\Rightarrow i_2 = 3 - 6i_1 \quad \text{--- ①}$$

Bottom left loop

$$8 - 1(i_2 + i_3) - 2(i_2 + i_1) - 4i_2 = 0$$

$$\Rightarrow 7i_2 + 2i_1 + i_3 = 8$$

Substituting ①:

$$21 - 42i_1 + 2i_1 + i_3 = 8$$

$$\Rightarrow i_3 = 40i_1 - 13 \quad \text{--- ②}$$

Bottom right loop

$$8 - 1(i_3 + i_2) - 6 - 5i_3 = 0$$

$$\Rightarrow 6i_3 + i_2 = 2$$

Substituting ① and ②:

$$240i_1 - 78 + 3 - 6i_1 = 2$$

$$\Rightarrow 234i_1 = 77$$

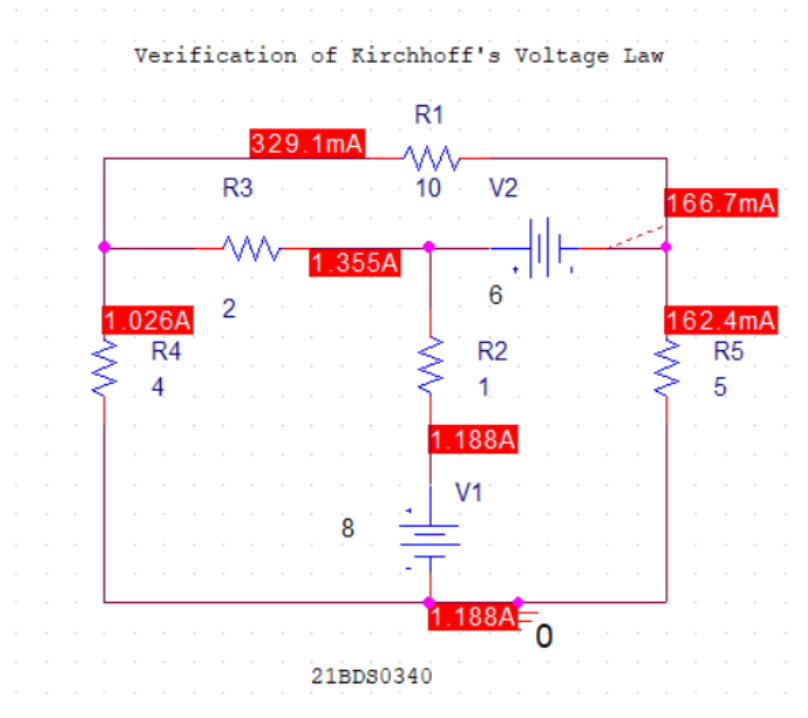
$$\Rightarrow i_1 = 0.329$$

$$\therefore i_1 = 0.329$$

$$i_2 = 1.026 \text{ (from ①)}$$

$$i_3 = 0.162 \text{ (from ②)}$$

Simulation Circuit:



Procedure:

1. Press 'P' to place a part
2. Press 'R' to filter for resistor
3. Click analog resistor and place 5 of them referring to the circuit diagram.
4. Repeat step 1 again and now type 'Vdc'
5. Click voltage and place one.
6. Place a ground from the right side selection menu
7. Create a new simulation called 'mesh'
8. Run the simulation to find mesh currents.

Result:

Mesh Analysis

NOTATION	MANUAL CALCULATIONS	SIMULATED RESULT
I_1	0.329	0.3291
I_2	1.026	1.026
I_3	0.162	0.1624

Inference:

By using mesh analysis, the values of I_1 , I_2 , I_3 are the same as in the ORCAD simulation, showing that Kirchhoff's Voltage Law holds true here.