Ex. No.: 2 Date: 04/10/2021

Verification of Kirchhoff's Current Law

Aim:

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

Apparatus:

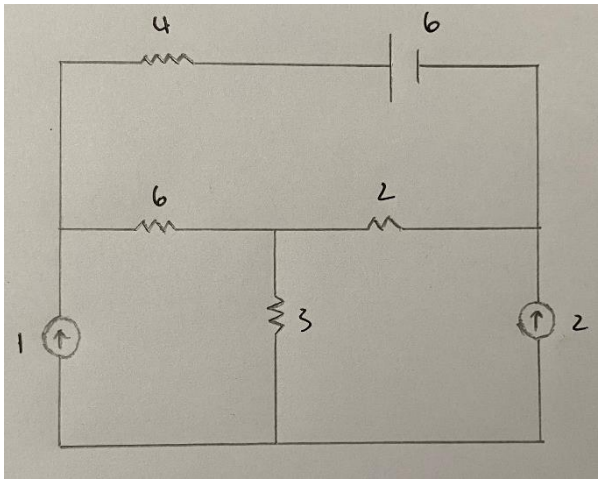
ORCAD / Capture CIS: Analog Library – R

Source Library – Vdc, Idc

Ground (GND) – 0 (zero)

Simulation Settings: Analysis Type – Bias Point

Circuit Diagram for Nodal Analysis:



Statement:

Nodal analysis finds the unknown voltage drops around a circuit between different nodes that provide a common connection for two or more circuit components.

Manual Calculations:

$$\frac{V_a - 6 - V_L}{4} + \frac{V_a - V_b}{6} - 1 = 0 \quad - (1)$$

$$\frac{V_b - V_a}{6} + \frac{V_b}{3} + \frac{V_b - V_c}{2} = 0 \quad - (2)$$

$$\frac{V_c + 6 - V_a}{4} + \frac{V_b - V_b}{2} - 2 = 0 \quad - (3)$$

(1) $6V_a - 36 - 6V_b + 4V_a - 4V_b = 24$

$\Rightarrow 10V_a - 4V_b - 6V_c = 60$

$\Rightarrow 5V_a - 2V_b - 3V_c = 30 \quad - (4)$

(2) $V_b - V_a + 2V_b + 3V_b - 3V_c = 0$

$\Rightarrow 6V_b - V_a - 3V_c = 0 \quad - (5)$

(3) $V_c + 6 - V_a + 2V_c - 2V_b - 8 = 0$

$\Rightarrow 3V_c - V_a - 2V_b = 2 \quad - (6)$

(4) + (6)

$\Rightarrow 4V_a - 4V_b = 32$

$\Rightarrow V_a - V_b = 8 \quad - (7)$

(5) + (6)

$\Rightarrow 4V_b - 2V_a = 2$

$\Rightarrow 2V_b - V_a = 1$

$\Rightarrow V_a = 2V_b - 1 \quad - (8)$

Substituting ⑧ in ⑦

$$2V_b - 1 - V_b = 8$$

$$\Rightarrow V_b = 9$$

⑧ $V_a = 2V_b - 1$

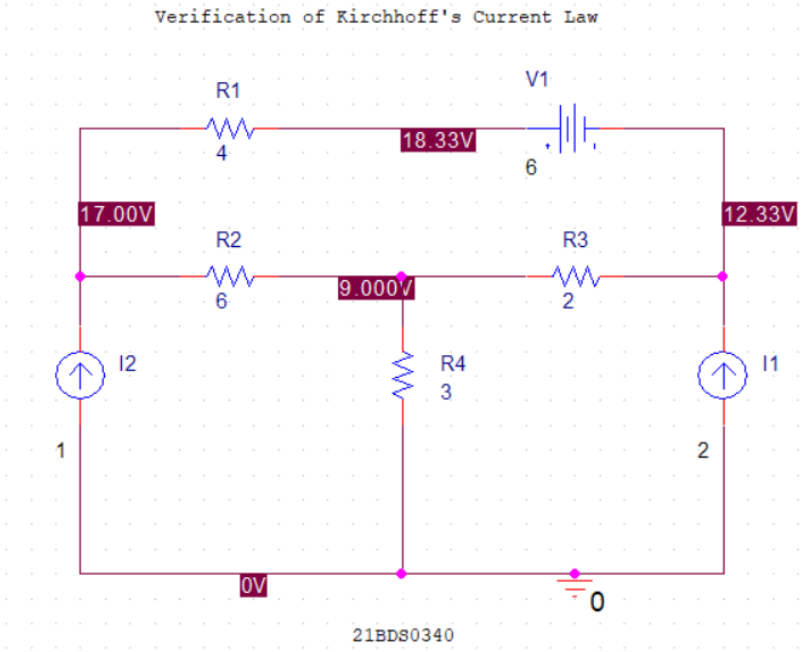
$$\Rightarrow V_a = 17$$

⑤ $6V_L - V_a = 3V_c$

$$\Rightarrow 54 - 17 = 3V_c$$

$$\Rightarrow V_c = \frac{37}{3} = 12.33$$

Simulation Circuit:



Procedure:

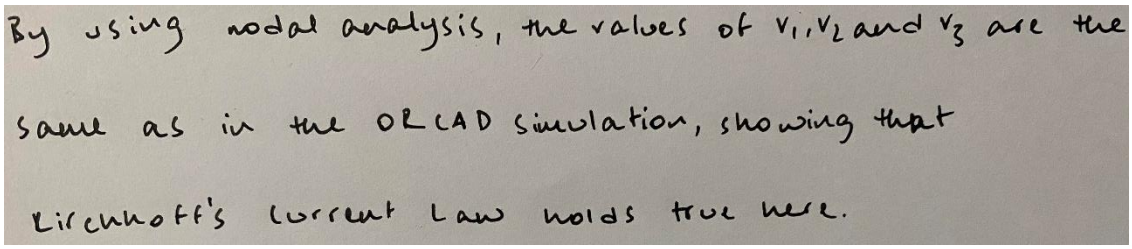
1. Press 'P' to place a part
2. Press 'R' to filter for resistor
3. Click analog resistor and place 4 of them referring to the circuit diagram.
4. Repeat step 1 again and now type 'vdc'
5. Click voltage and place one
6. Repeat step 1 again and type 'Idc'
7. Click current source and place two
8. Place a ground from the right-side selection menu.
9. Change all the values referring to the circuit diagram
10. Create a new simulation circuit named 'nodal'
11. Run the simulation to find the nodal voltages

Result:

Nodal Analysis

NOTATION	MANUAL CALCULATIONS	SIMULATED RESULT
V_1	17	17
V_2	9	9
V_3	12.33	12.33

Inference:



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