Ex. No: 1 **Date:31/07/2020**

Verification of KIRCHHOFF'S LAWS using Mesh and Nodal Analysis

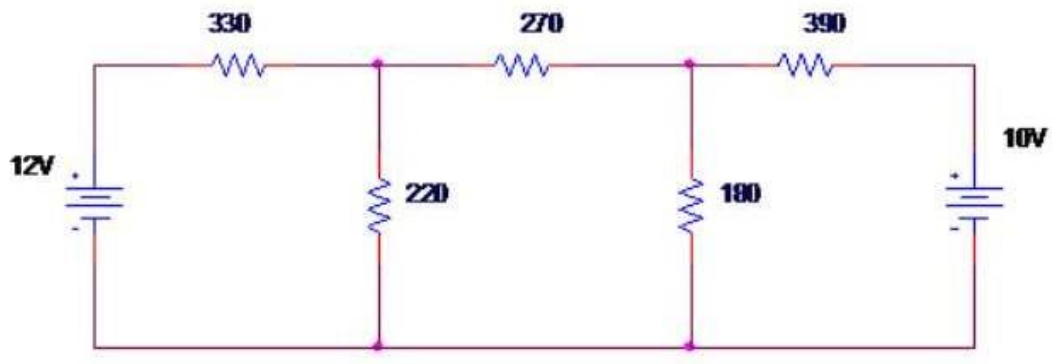
Aim:

To verify Kirchhoff's laws using Voltage nodal Analysis and Mesh current analysis and compare the output results of OrCAD software with manual calculations.

Apparatus / Tools required:

Orcad CIS lite software , Resistors ,Voltage source, wires ,Voltage & Current probe, Ground

Circuit Diagram:



Theory:

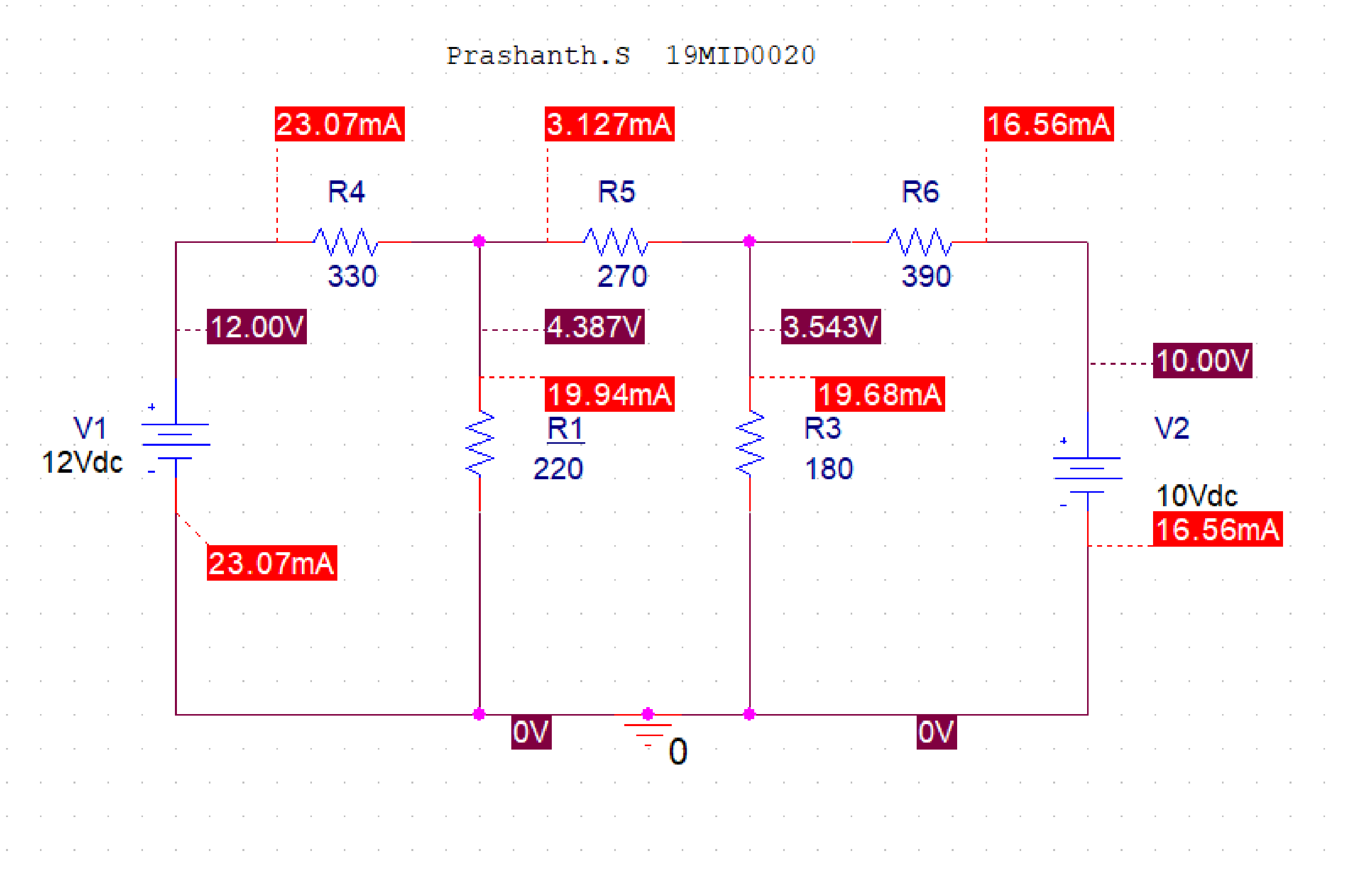
Kirchhoff's Current Law (KCL):

- This law states that, for any node (junction) in an electrical circuit, the sum of currents flowing into that node is equal to the sum of currents flowing out of that node; or equivalently:
- The algebraic sum of currents in a network of conductors meeting at a point is zero.

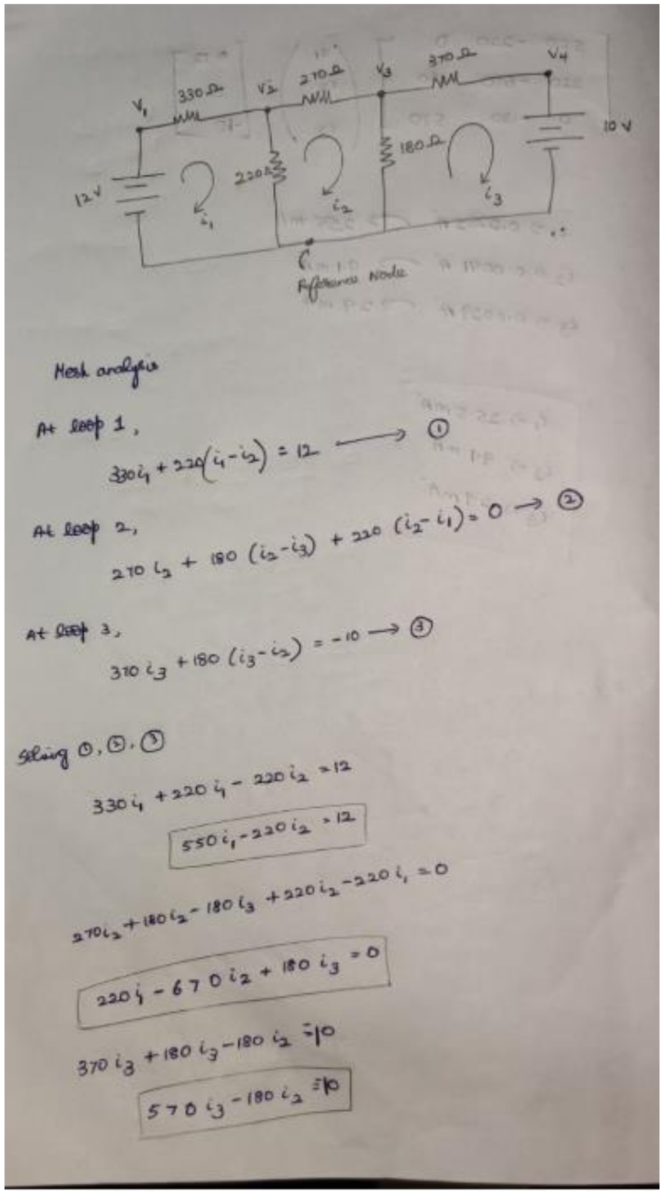
Kirchhoff's Voltage Law (KVL):

The directed sum of the potential differences (voltages) around any closed loop is zero.

Practical Circuit and output for Mesh Analysis:



Manual Calculation:



Mesh analysis

At loop 1,

$$330 i_1 + 220(i_1 - i_2) = 12 \longrightarrow ①$$

At loop 2,

$$270 i_2 + 180(i_2 - i_3) + 220(i_2 - i_1) = 0 \longrightarrow ②$$

At loop 3,

$$370 i_3 + 180(i_3 - i_2) = -10 \longrightarrow ③$$

Solving ①, ②, ③

$$330 i_1 + 220 i_1 - 220 i_2 = 12$$

$$\boxed{550 i_1 - 220 i_2 = 12}$$

$$270 i_2 + 180 i_2 - 180 i_3 + 220 i_2 - 220 i_1 = 0$$

$$\boxed{220 i_1 - 670 i_2 + 180 i_3 = 0}$$

$$370 i_3 + 180 i_3 - 180 i_2 = -10$$

$$\boxed{570 i_3 - 180 i_2 = -10}$$

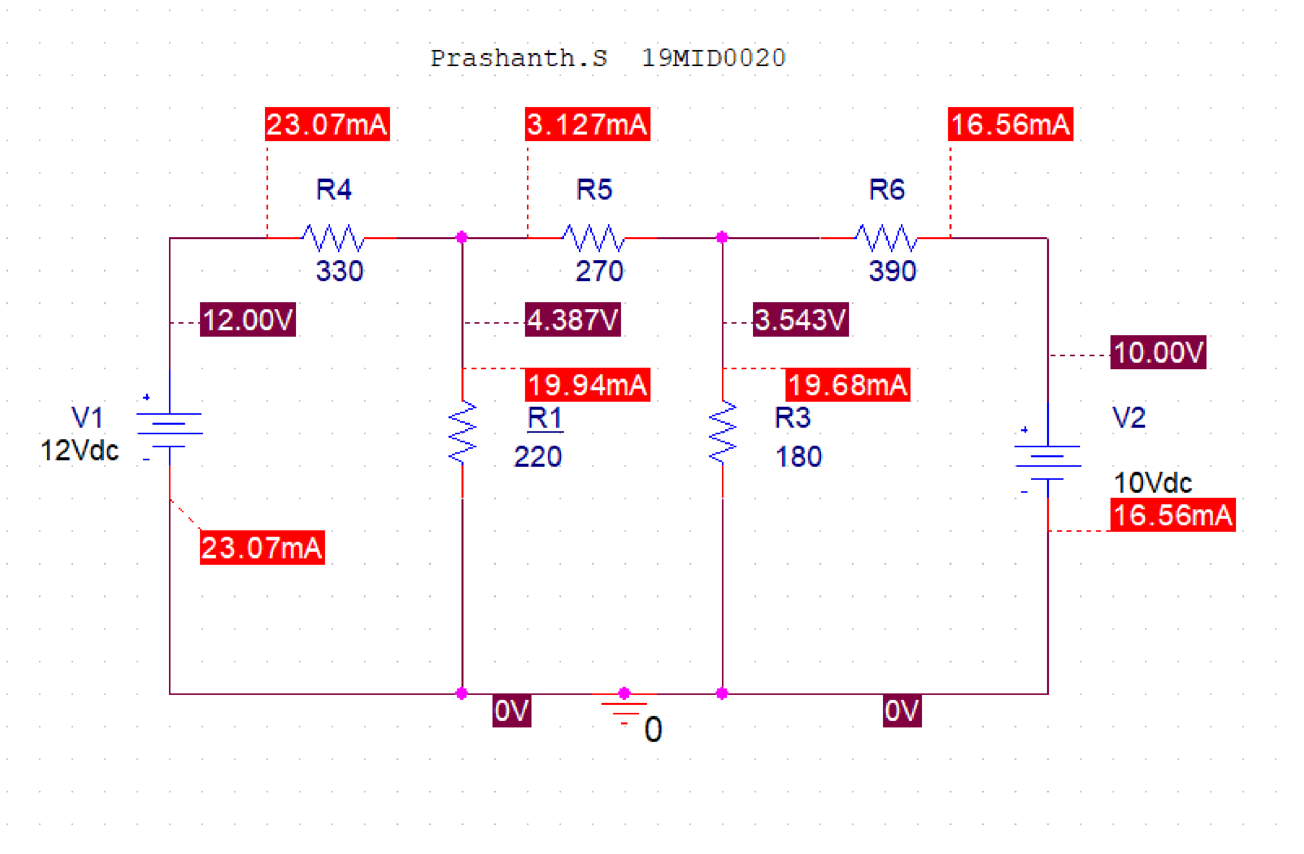
By solving these,

$$i_1 = 23.0689\ mA$$

$$i_2 = 3.1268\ mA$$

$$i_3 = -16.5564\ mA$$

Practical Circuit and output for Node Analysis:



Manual Calculation:

At node 1,

$V_1 \Rightarrow 12V$

At node 4,

$V_4 \Rightarrow 10V$

At node 2,

$$\frac{V_2 - V_1}{R_4} + \frac{V_2 - V_3}{R_5} + \frac{V_2 - 0}{R_1} \Rightarrow 0$$

$$\frac{V_2 - 12}{330} + \frac{V_2 - V_3}{270} + \frac{V_2}{220} \Rightarrow 0$$

$$\frac{V_2}{330} - \frac{12}{330} + \frac{V_2}{270} - \frac{V_3}{270} + \frac{V_2}{220} \Rightarrow 0$$

$$0.00303 V_2 - 0.0363 + 0.003703 V_2 - 0.003703 V_3 + 0.00454 V_2 \Rightarrow 0$$

$$- 0.011273 V_2$$

$$0.003703 V_3 - 0.002193 V_2 + 0.0363 \Rightarrow 0$$

$$\boxed{0.3703 V_3 - 1.1273 V_2 + 3.63 \Rightarrow 0} \rightarrow (1)$$

At node 3,

$$\frac{V_3 - V_2}{270} + \frac{V_3 - V_4}{390} + \frac{V_3 - 0}{180} \Rightarrow 0$$

$$\frac{V_3 - V_2}{270} + \frac{V_3 - 10}{390} + \frac{V_3}{180} \Rightarrow 0$$

$$1.1818 V_3 - 0.37037 V_2 - 2.56 = 0 \rightarrow (2)$$

$$(1) \Rightarrow 1.128 V_2 - 0.3703 V_3 = 3.636$$

$$(2) \Rightarrow -0.37037 V_2 + 1.1818 V_3 = 2.56$$

By solving the above eqn,

$$V_2 = 4.385730 V$$

$$V_3 = 3.540652 V$$

$$V_1 = 12 V$$

$$V_4 = 10 V$$

Procedure :

1. USING OrCAD PSPICE

- Open OrCAD Capture CIS
- Create a new project (File→ New→ project)
- Enter the name of the project
- Select "Analog Or Mixed-AD"
- Click OK button
- Create a Blank Project as given below
- Design the circuit
- Open PSpice in the top menu , select Create Netlist
- Open PSpice in the top menu , select New Simulation profile and create it.
- Simulation Profile settings:
  - Analysis type – Bias point
  - Options – General
- Click “Run Pspice”

2. . MANUAL CALCULATION

NODE VOLTAGE ANALYSIS:

- Mark the nodes in the circuit
- Draw the direction of currents from all the nodes in way that no current is entering the node (all currents are leaving the node)
- Apply Kirchhoff’s current law
- Simply and solve the obtained Equations

MESH CURRENT ANALYSIS:

- Draw the meshes (Always clockwise)
- The value of current is chosen in such a manner that it is equal to the current flowing in the direction of loop minus the current flowing in opposite direction
- Apply Kirchhoff’s voltage law
- Simplify and solve the equation

Result:

NODE VOLTAGE ANALYSIS:

	Manual Calculation	Practical Output
V_1	**12V**	**12V**
V_2	**4.385730V**	**4.387V**
V_3	**3.540652V**	**3.543V**
V_4	**10V**	**10V**

MESH CURRENT ANALYSIS:

	Manual Calculation(Mesh Current)	Practical Output
I_1	**23.0689mA**	**23.07mA**
I_2	**3.1268mA**	**3.127mA**
I_3	**-16.5564mA (flows in opposite direction)**	**16.56mA**

Inference:

The values obtained through Practical output and Manual Calculations are approximately equal.

Reg. No:19MID0020 **Name: Prashanth.S** **Date:31/07/2020**