LAB SESSION 05

IMPLEMENTATION OF NODAL AND MESH ANALYSIS

Objectives

To practically verify the technique of Nodal Analysis

To practically verify the technique of Loop and Mesh Analysis

Equipment Required

1. RESISTORS

2. DMM

3. DC Power supply

Theory

Nodal Analysis

1. Note all connected wire segments in the circuit. These are the *nodes* of nodal analysis.
2. Select one node as the ground reference. The choice does not affect the result and is just a matter of convention. Choosing the node with the most connections can simplify the analysis.
3. Assign a variable ($V1, V_2$....) for each node whose voltage is unknown. If the voltage is already known, it is not necessary to assign a variable.
4. For each unknown voltage, form an equation based on Kirchhoff's current law. Basically, add together all currents leaving from the node and mark the sum equal to zero. Finding the current between two nodes is nothing more than "the node you're on, minus the node you're going to, divided by the resistance between the two nodes."
5. If there are voltage sources between two unknown voltages, join the two nodes as a super node. The currents of the two nodes are combined in a single equation, and a new equation for the voltages is formed.
6. Solve the system of simultaneous equations for each unknown voltage.

Circuit Diagram

Let us have to solve the circuit shown in Figure 5.1 .

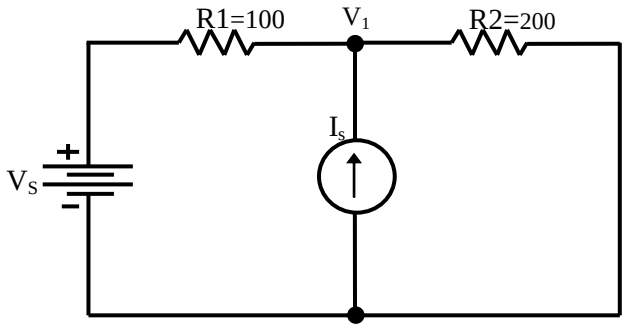

Figure 5.1 (Circuit)

V_s = 5V, I_s = 20mA, R_1 = 100Ω, R_2 = 200 Ω

Let us apply KCL at the middle node V1. (The sum of the currents entering a node is equal to the sum of the currents leaving the node.)

$$I_1 + I_2 = I_s$$

$$\frac{V_1 - V_S}{R_1} + \frac{V_1}{R_2} - I_S = 0$$

This equation can be solved in respect to V_1:

$$V_1 = \frac{\left(\frac{V_s}{R_1} + I_s\right)}{\left(\frac{1}{R_1} + \frac{1}{R_2}\right)}$$

Finally, the unknown voltage can be solved by substituting numerical values for the symbols. Any unknown currents are easy to calculate after all the voltages in the circuit are known.

$$V_1 = \frac{\left(\frac{5V}{100\Omega} + 20mA\right)}{\left(\frac{1}{100\Omega} + \frac{1}{200\Omega}\right)} \approx 4.667\ \text{V}$$

And from V_1, we can find all the voltages and the currents.

Results

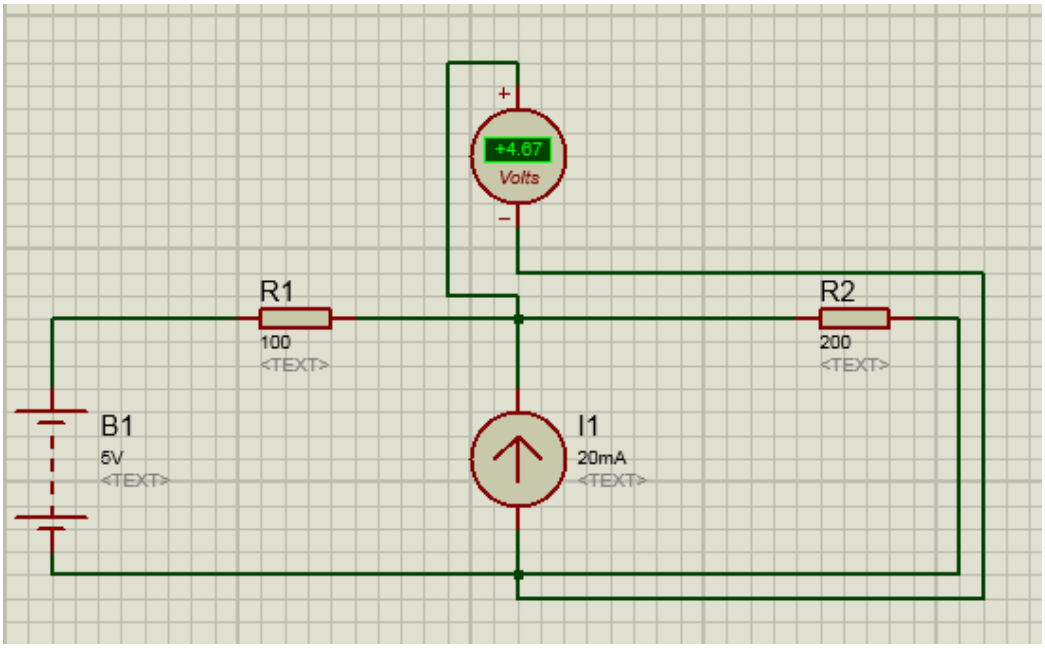

Figure 5.2 (Simulation Result of Circuit 5.1)

Calculation Table 5.1

Voltage Source	Current Source	Value of R_1	Value of R_2	Measured V_1 Voltage
5 V	20 mA	100	200	4.67

Task 1

Nodal Analysis

Calculate the node voltages in the circuit shown in Figure below

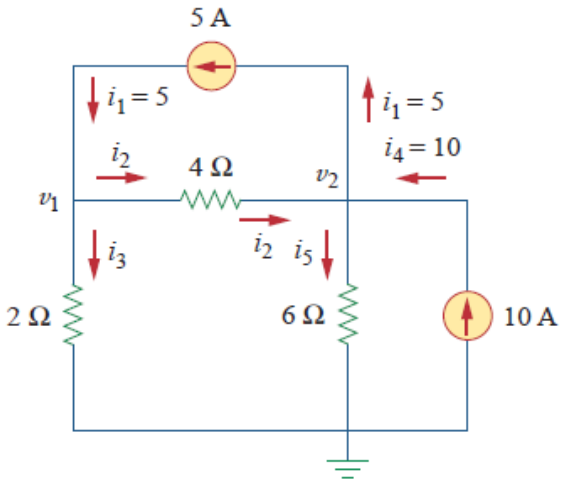

Figure 5.3 (Circuit for Nodal Analysis)

In the above circuit, there are three nodes v_1, v_2 and GND.

Practically connect this circuit on the breadboard/ Proteus and measure all node voltages V_1 & V_2 with respect to gnd.

V1 = _____ V2 = _____

Now theoretically calculate node voltages using nodal analysis, use accurate values of all resistors (measure them from DMM) in analysis. Show your calculations below.

State the reason for the difference in practical and theoretical results

MESH ANALYSIS

Theory of Mesh Analysis

A closed path of circuit components that does not pass through the same node twice is called a loop. Mesh is a loop which does not have sub-loops. Mesh analysis is used as a tool when we require loop currents rather than node voltages as in nodal analysis. Mesh analysis is an extension of Kirchhoff`s Voltage Law (KVL) which states that '***In a closed loop, sum of all voltages is zero'.***

The best network analysis method to use depends not only on the network to be analyzed but also on the information required. However, it is wise to pick the method that result in smallest set of equation.

Circuit For Analysis

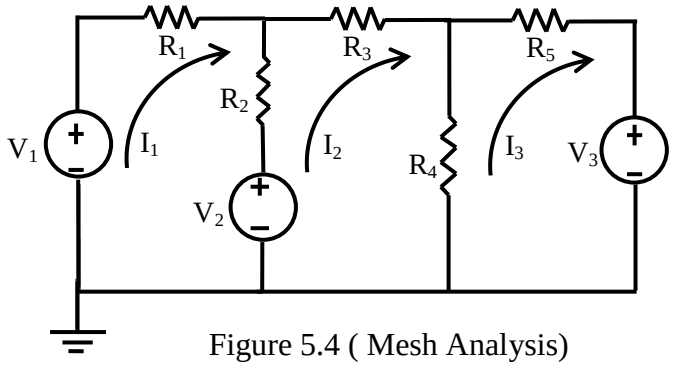

Figure 5.4 (Mesh Analysis)

Mesh equations for the circuit of Fig.5.4 can be written as under,

$$-V_1 + I_1R_1 + (I_1 - I_2)R_2 + 5 = 0$$

$$-V_2 + (I_2 - I_1)R_2 + I_2R_3 + (I_2 - I_3)R_4 = 0$$

$$(I_3 - I_2)R_4 + I_3R_5 - V_3 = 0$$

TASK 2. Loop and Mesh Analysis

For the circuit in Fig. 5.5, find the branch currents I_1, I2 and I3 using mesh analysis.

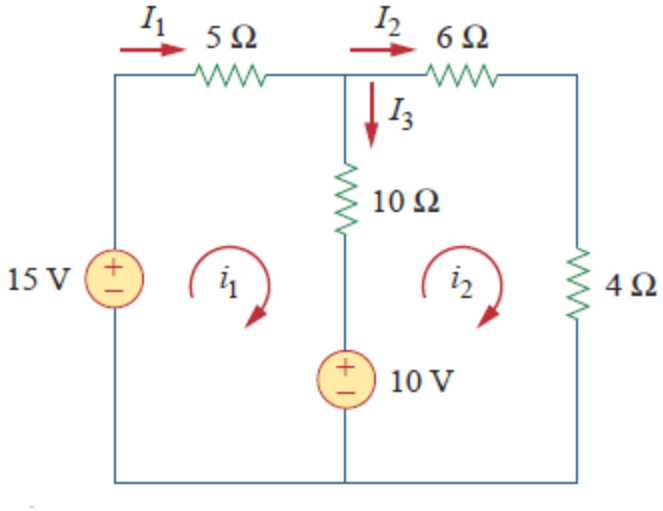

Figure 5.5 (Mesh Analysis)

Measurements:

I_1 = _____ I_2 = _____

Now theoretically calculate these mesh currents using either loop or mesh analysis, use accurate values of all resistors. Show your calculations below:

DISCUSSION AND CONCLUSION:

Evaluation Chart

	Total Marks	Obtained Marks
Participation in the Lab	3	
Accuracy of Results Obtained	4	
Viva	3	
Total	10	

Comments from Lab Instructor:

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_____

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_____ _____

Date Instructor's Signature