SNS COLLEGE OF TECHNOLOGY
Coimbatore-35
An Autonomous Institution

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DEPARTMENT OF ELECTRONICS & COMMUNICATION ENGINEERING

23ECB101 – CIRCUIT ANALYSIS AND DEVICES

I YEAR/ II SEMESTER

UNIT 1 – MESH AND NODE ANALYSIS OF ELECTRIC CIRCUITS

TOPIC - Mesh Analysis

Empathy

- It is difficult to solve complex electrical networks and to determine current, voltage drop at any point of the circuit.
- In power systems, it is difficult to understand the flow of current and voltage in complex power networks.
- In control systems - analysis of feedback systems.

Define

- Build a powerful as well as a general circuit analysis method for solving the unknown currents and voltages in any complex circuit used in various applications.
- Once the loop currents are found, the problem is solved, as then any current in the circuit can be determined from the loop currents.

Ideate - Mesh Analysis

- In Mesh analysis, we will consider the currents flowing through each mesh. Hence, Mesh analysis is also called as **Mesh-current method**.
- A **branch** is a path that joins two nodes and it contains a circuit element. If a branch belongs to only one mesh, then the branch current will be equal to mesh current.

Mesh Analysis

- If a branch is common to two meshes, then the branch current will be equal to the sum (or difference) of two mesh currents, when they are in same (or opposite) direction.

Procedure of Mesh Analysis

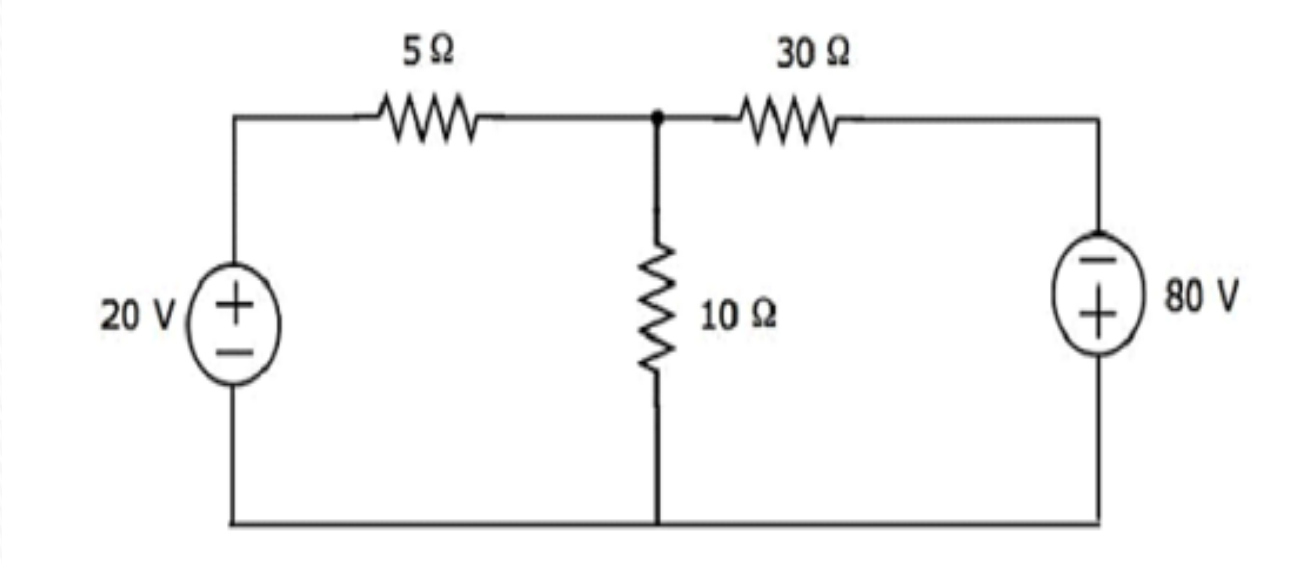
Step 1 − Identify the **meshes** and label the mesh currents in either clockwise or anti-clockwise direction.

Procedure of Mesh Analysis

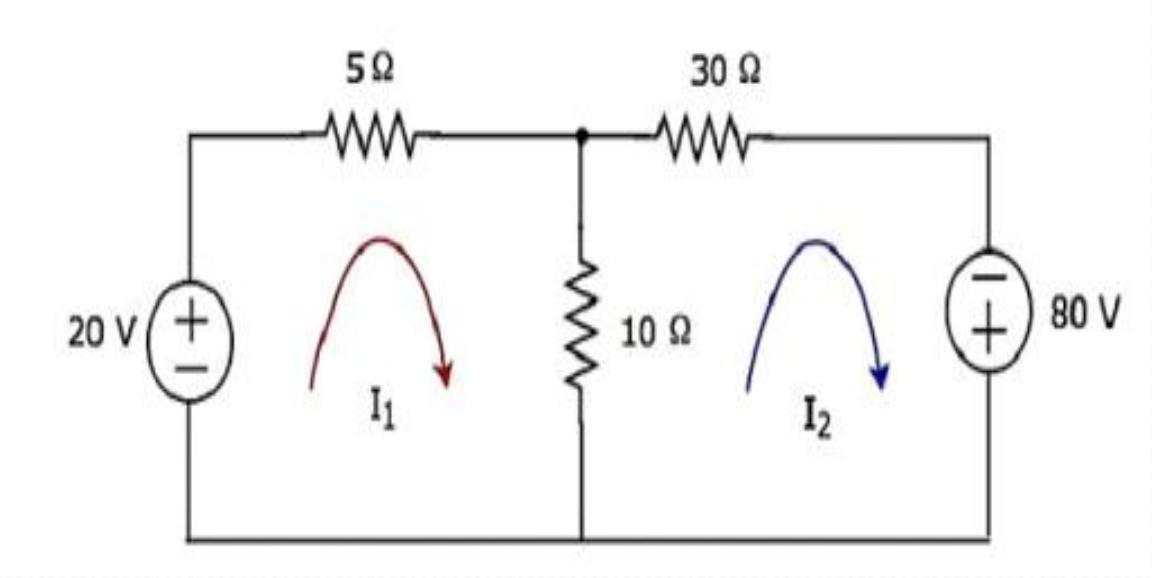
- **Step 2** − Observe the amount of current that flows through each element in terms of mesh currents.
- **Step 3** − Write **mesh equations** to all meshes. Mesh equation is obtained by applying KVL first and then Ohm's law.
- **Step 4** − Solve the mesh equations obtained in Step 3 in order to get the **mesh currents**.

Solution - Example

- Find the voltage across 30 Ω resistor using **Mesh analysis**.



Step 1 – There are two meshes in the above circuit. The **mesh currents** I_1 and I_2 are considered in clockwise direction. These mesh currents are shown in the following figure.



- **Step 2** − The mesh current I_1 flows through 20 V voltage source and 5 Ω resistor. Similarly, the mesh current I_2 flows through 30 Ω resistor and -80 V voltage source. But, the difference of two mesh currents, I_1 and I_2, flows through 10 Ω resistor, since it is the common branch of two meshes.
- **Step 3** − In this case, we will get **two mesh equations** since there are two meshes in the given circuit. When we write the mesh equations, assume the mesh current of that particular mesh as greater than all other mesh currents of the circuit.

The **mesh equation** of first mesh is

$$20 - 5I_1 - 10(I_1 - I_2) = 0$$

$$\Rightarrow 20 - 15I_1 + 10I_2 = 0$$

$$\Rightarrow 10I_2 = 15I_1 - 20$$

Divide the above equation with 5.

$$2I_2 = 3I_1 - 4$$

Multiply the above equation with 2.

$$4I_2 = 6I_1 - 8 \qquad \textbf{Equation 1}$$

The **mesh equation** of second mesh is

$$-10(I_2 - I_1) - 30I_2 + 80 = 0$$

Divide the above equation with 10.

$$-(I_2 - I_1) - 3I_2 + 8 = 0$$

$$\Rightarrow -4I_2 + I_1 + 8 = 0$$

$$4I_2 = I_1 + 8 \qquad \textbf{Equation 2}$$

Step 4 − Finding mesh currents I_1 and I_2 by solving Equation 1 and Equation 2. The left-hand side terms of Equation 1 and Equation 2 are the same. Hence, equate the right-hand side terms of Equation 1 and Equation 2 in order find the value of I_1.

$$6I_1 - 8 = I_1 + 8$$

$$\Rightarrow 5I_1 = 16$$

$$\Rightarrow I_1 = \frac{16}{5}A$$

Substitute I_1 value in Equation 2.

$$4I_2 = \frac{16}{5} + 8$$

$$\Rightarrow 4I_2 = \frac{56}{5}$$

$$\Rightarrow I_2 = \frac{14}{5}A$$

- **Step 5** − The current flowing through 30 Ω resistor is nothing but the mesh current I_2 and it is equal to 14/5 A. Now, we can find the voltage across 30 Ω resistor by using Ohm's law.

$$V_{30\Omega} = I_2 R$$

Substitute the values of I_2 and R in the above equation.

$$V_{30\Omega} = (\frac{14}{5})30$$

$$\Rightarrow V_{30\Omega} = 84V$$

Therefore, the voltage across 30 Ω resistor of the given circuit is **84 V**.

Assessment

1. Mesh analysis employs the method of _____
a) KVL
b) KCL
c) Both KVL and KCL
d) Neither KVL nor KCL

2. Mesh analysis is generally used to determine _____
a) Voltage
b) Current
c) Resistance
d) Power

3. Mesh analysis can be used for _____
a) Planar circuits
b) Non-planar circuits
c) Both planar and non-planar circuits
d) Neither planar nor non-planar circuits

THANK YOU