Electrical Science: 2021-22
Lecture 4
Mesh and Node Analysis

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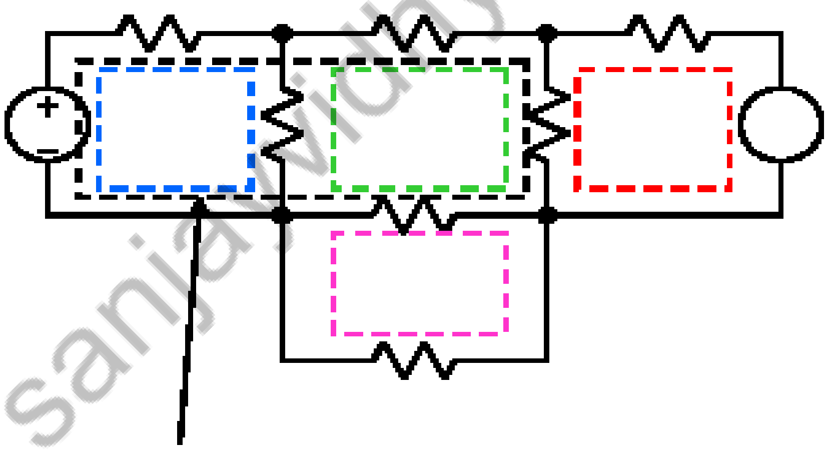
MESH ANALYSIS

- **Mesh analysis helps us to solve complex electrical networks.**

Loop: It is a closed path with no node passed more than once.

Mesh: A mesh is a loop that does not contain any other loop within it.



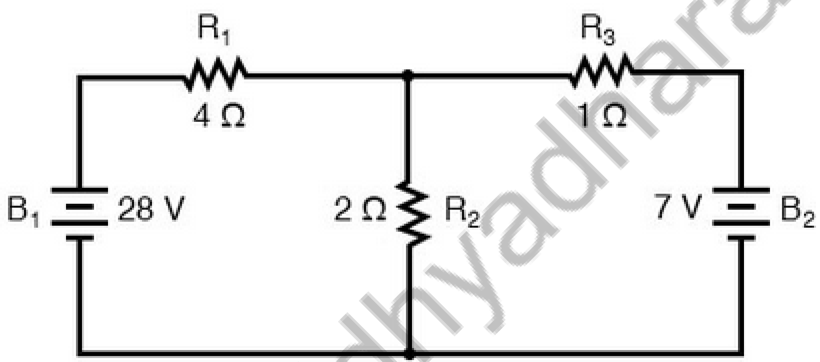
MESH ANALYSIS

➢ **Mesh analysis helps us to solve complex electrical networks.**

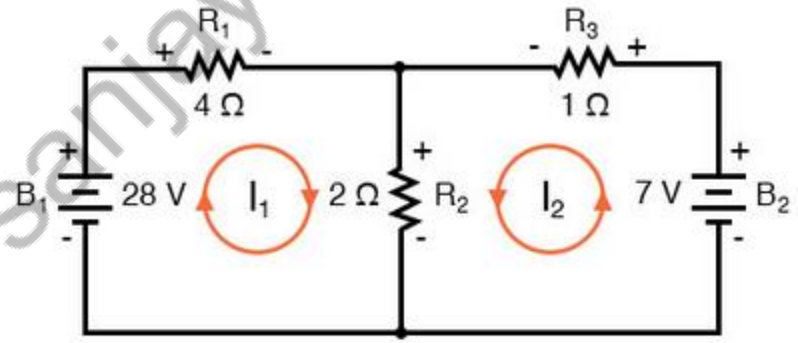
1. Identify the *m* meshes in the circuit
2. Assign a current to each mesh.
3. Assign voltages to the elements for which no voltage is designated.
4. Apply KVL to each of the *m* meshes
5. Use Ohm's law to express the voltages across resistors
6. Solve the resulting set of *m* simultaneous equations for the mesh currents

MESH ANALYSIS

Using mesh analysis, obtain the current through the various components

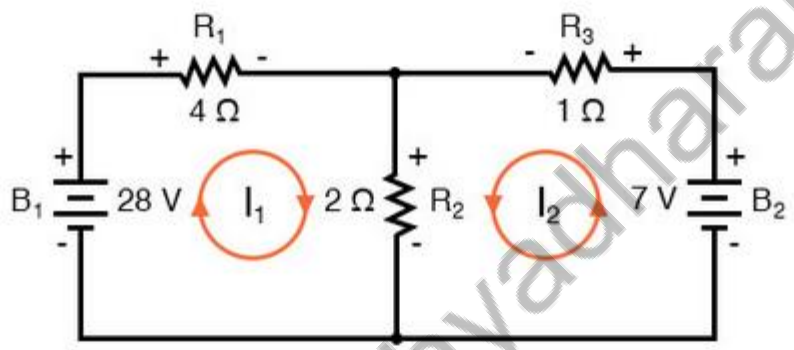


Identify Mesh



MESH ANALYSIS

Using mesh analysis, obtain the current through the various components



$28 = 4\,i_1 + 2(i_1 + i_2)$

$7 = \;i_2 + 2(i_1 + i_2)$

$28 = 6\,i_1 + 2i_2$

$7 = 2i_1 + 3i_2$

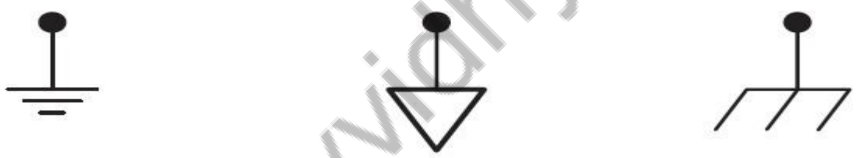
$i_1 = 5\,A$

$i_2 = -1\,A$

NODAL ANALYSIS

- **Nodal analysis helps us to solve complex electrical networks.**
  - ✓ Variables are voltage
  - ✓ Usually used if the circuit contains more no. of current sources.

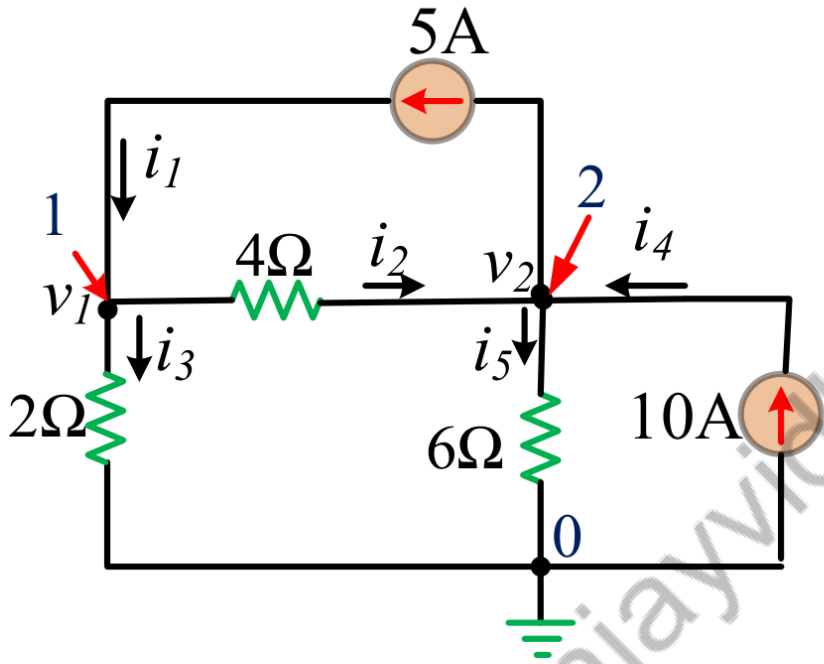
1. Choose a node and name it as a reference node. Symbol used -



2. Assign node voltages to the other nodes and currents in each branch.
3. Apply KCL to each node other than the reference and express currents in terms of node voltages.
4. Solve the resulting system of linear equations.

NODAL ANALYSIS

Calculate Node Voltages in the given circuit.



KCL at Node 1:

$$i_1 = i_2 + i_3$$

KCL at Node 2:

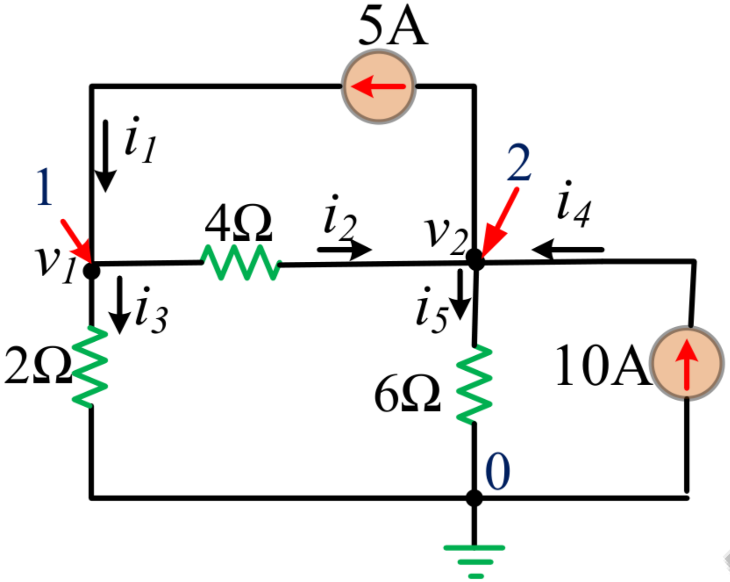
$$i_2 + i_4 = i_1 + i_5$$

Ohm's Law to KCL equation at Node 1:

$$i_1 = i_2 + i_3 \Rightarrow 5 = \frac{v_1 - v_2}{4} + \frac{v_1 - 0}{2} \Rightarrow 3v_1 - v_2 = 20 \qquad ...(1)$$

NODAL ANALYSIS

Calculate Node Voltages in the given circuit.



KCL at Node 1:

$$i_1 = i_2 + i_3$$

KCL at Node 2:

$$i_2 + i_4 = i_1 + i_5$$

$$3v_1 - v_2 = 20 \quad ...(1)$$

Now, Ohm's Law to KCL equation at Node 2:

$$i_2 + i_4 = i_1 + i_5 \Rightarrow \frac{v_1 - v_2}{4} + 10 = 5 + \frac{v_2 - 0}{6}$$

$$\Rightarrow -3v_1 + 5v_2 = 60 \quad ...(2)$$

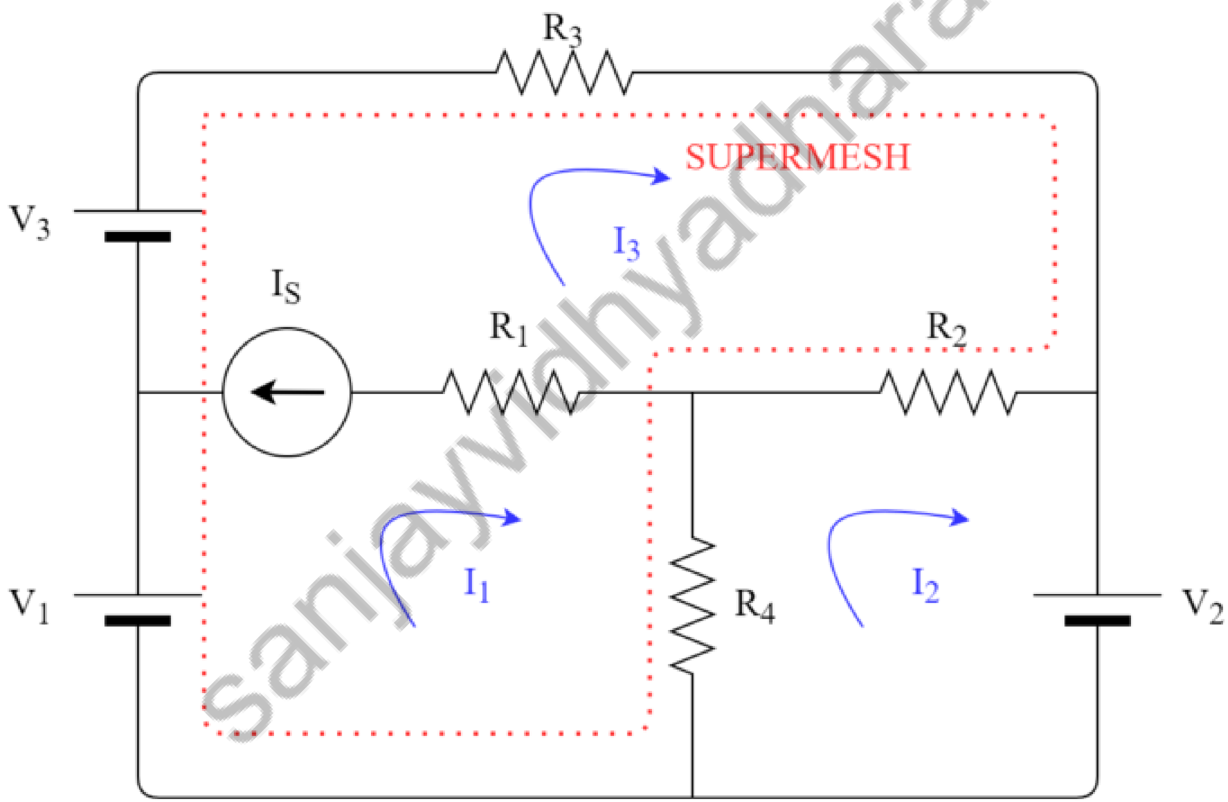
1

On solving (1) and (2) we get,

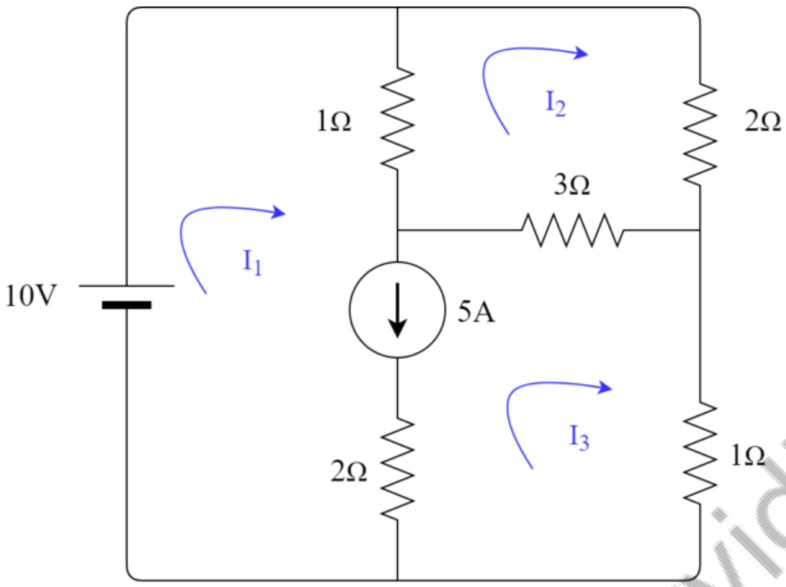
$$v_1 = 13.33\,\text{V} \; and \; v_2 = 20\,\text{V}$$

SUPER MESH CONCEPT

When a current source (dependent/independent) occurs between two meshes we apply super mesh concept to solve the circuit.



SUPER MESH CONCEPT



First, the KVL equation for mesh II is

$$1 \times (I_2 - I_1) + 2I_2 + 3(I_2 - I_3) = 0$$
$$or, -I_1 + 6I_2 - 3I_3 = 0 \ldots (i)$$

Now, the current of the common boundary of meshes I and III is given by

$$I_1 - I_3 = 5 \ldots (ii)$$

Then, applying KVL for supermesh I and II we have

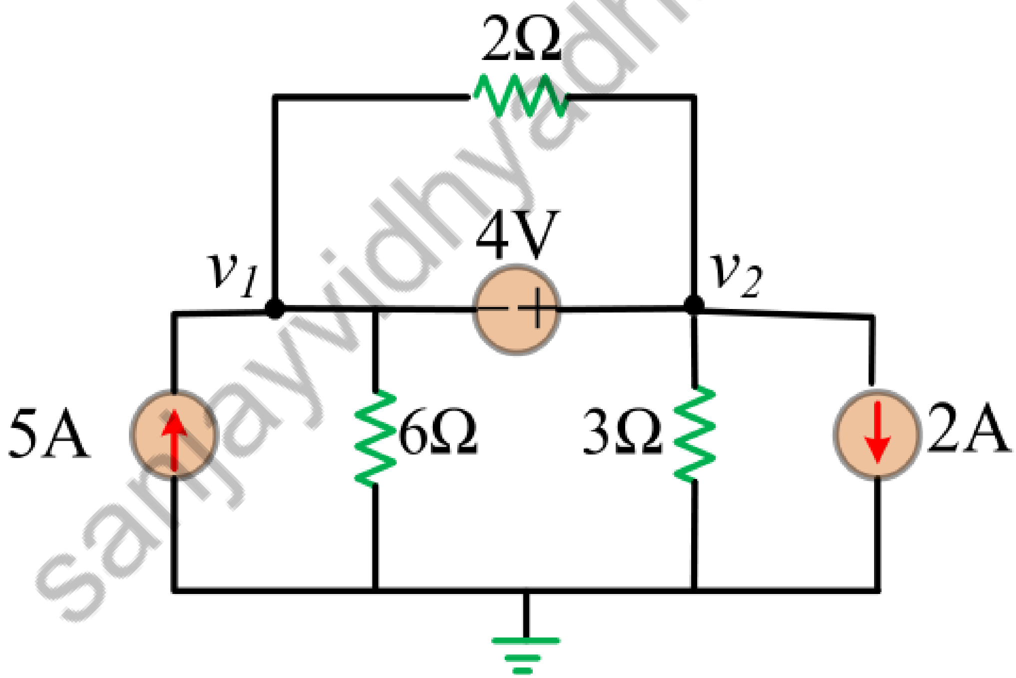
$$1 \times (I_1 - I_2) + 3(I_3 - I_2) + 1 \times I_3 = 10$$
$$or, I_1 - 4I_2 + 4I_3 = 10 \ldots (iii)$$

Finally, solving equations (i), (ii), and (iii) we have

$$I_1 = \frac{60}{7} Amps$$
$$I_2 = \frac{45}{14} Amps$$
$$I_3 = \frac{25}{7} Amps$$

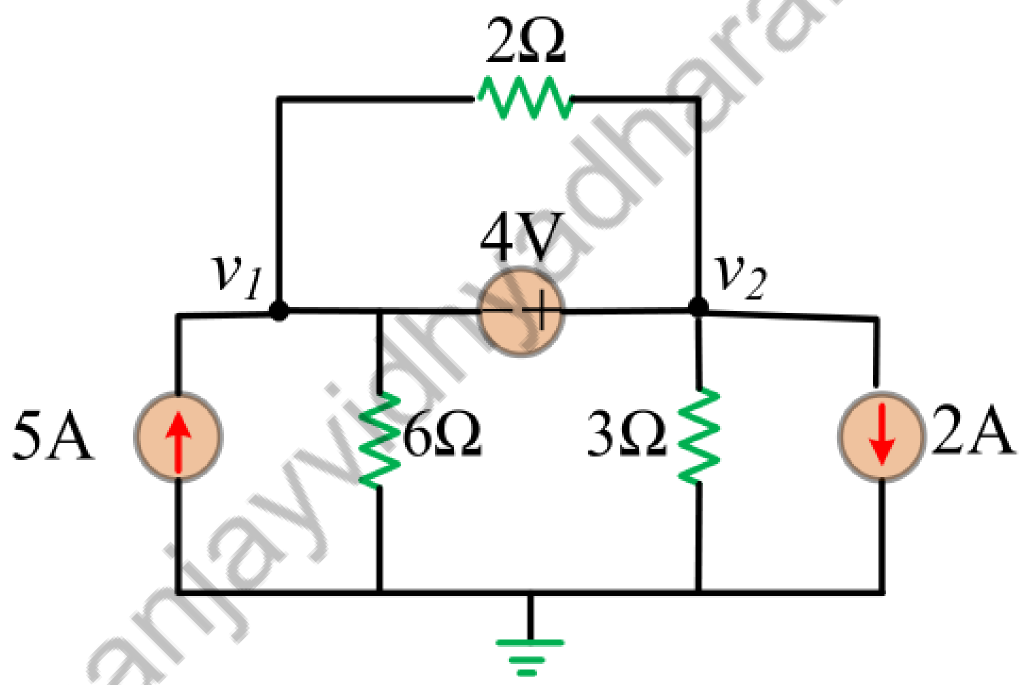
SUPER NODE CONCEPT

when a dependent or an independent voltage source is connected between two non-reference nodes, then these nodes can be combined to form a generalised node which is known as Super Node.



SUPER NODE CONCEPT

Calculate Node Voltages in the given circuit.



$v_2 - v_1 = 4V$

(always, whatever may be the value of resistor in parallel). So 2Ω resistor is irrelevant for applying KCL to the super-node.

SUPER NODE CONCEPT

Calculate Node Voltages in the given circuit.

CONTD.

KCL in terms of nodes voltages:

$$5 = \frac{v_1 - 0}{6} + \frac{v_2 - 0}{3} + 2$$

$$\Rightarrow 30 = v_1 + 2v_2 + 12$$

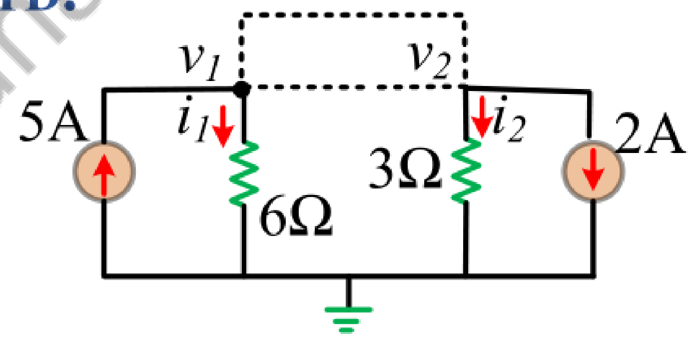
$$\Rightarrow v_1 + 2v_2 = 18 \qquad (1)$$

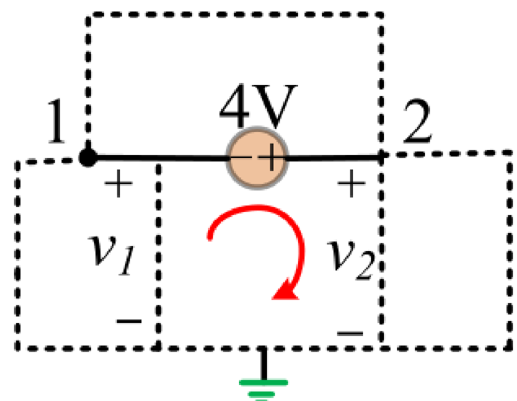
$$v_1 + 4 - v_2 = 0$$

$$\Rightarrow v_2 = v_1 + 4 \qquad (2)$$

On solving (1) and (2) we get,

$$v_1 = 3.33 \text{ V and } v_2 = 7.33 \text{ V}$$





Thank you