# EE 101H – Electric Circuits

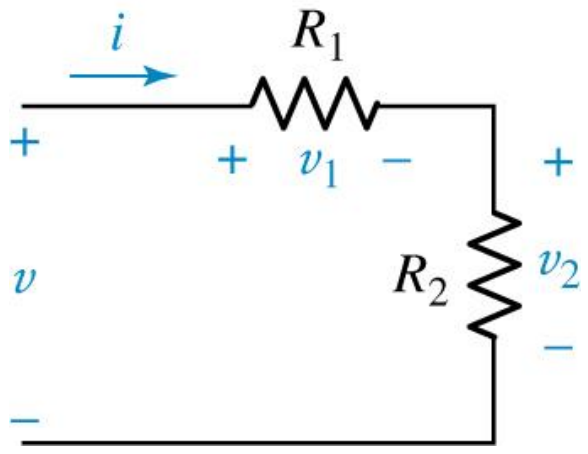
Lect-2

## Kirchoff's Voltage Law (KVL)

***KVL : The algebraic sum of the voltages around any closed path in a circuit is zero***

***Convention : The voltage across a circuit element is considered***

***+ve if we travel from lower potential to higher potential***
***-ve if we travel from higher potential to lower potential***



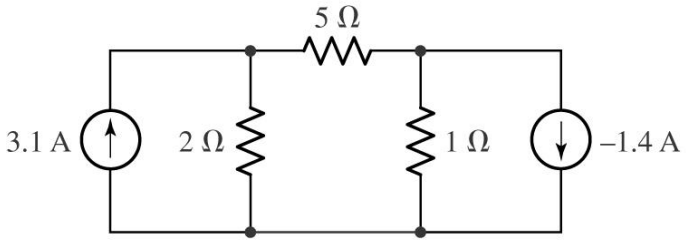

***KVL gives the equation***

$$v - v_1 - v_2 = 0$$

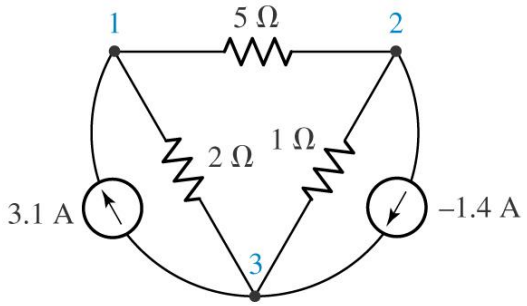
***Or,***

$$v - iR_1 - iR_2 = 0$$

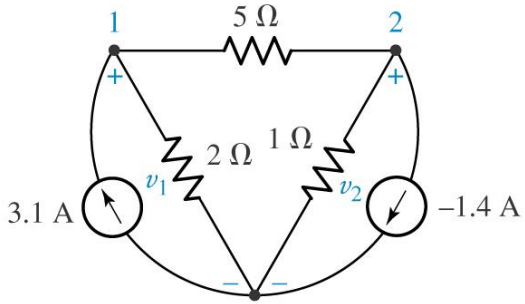
# Nodal Analysis




(a)

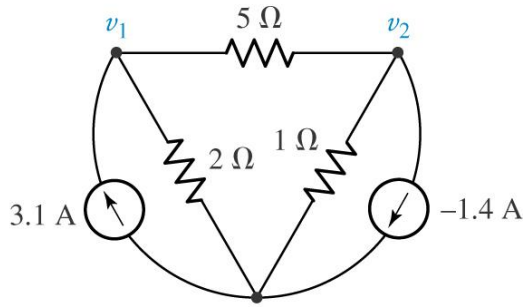



(b)




Reference node

(c)




Ref.

(d)

**Reference Node** : The node to which the greatest number of branches is connected. Ground node is generally selected as reference node

***Find $v_1$ and $v_2$ by Nodal Analysis method***

***OR***

***Find $v_1$ and $v_2$ using KCL***

***At node 1***

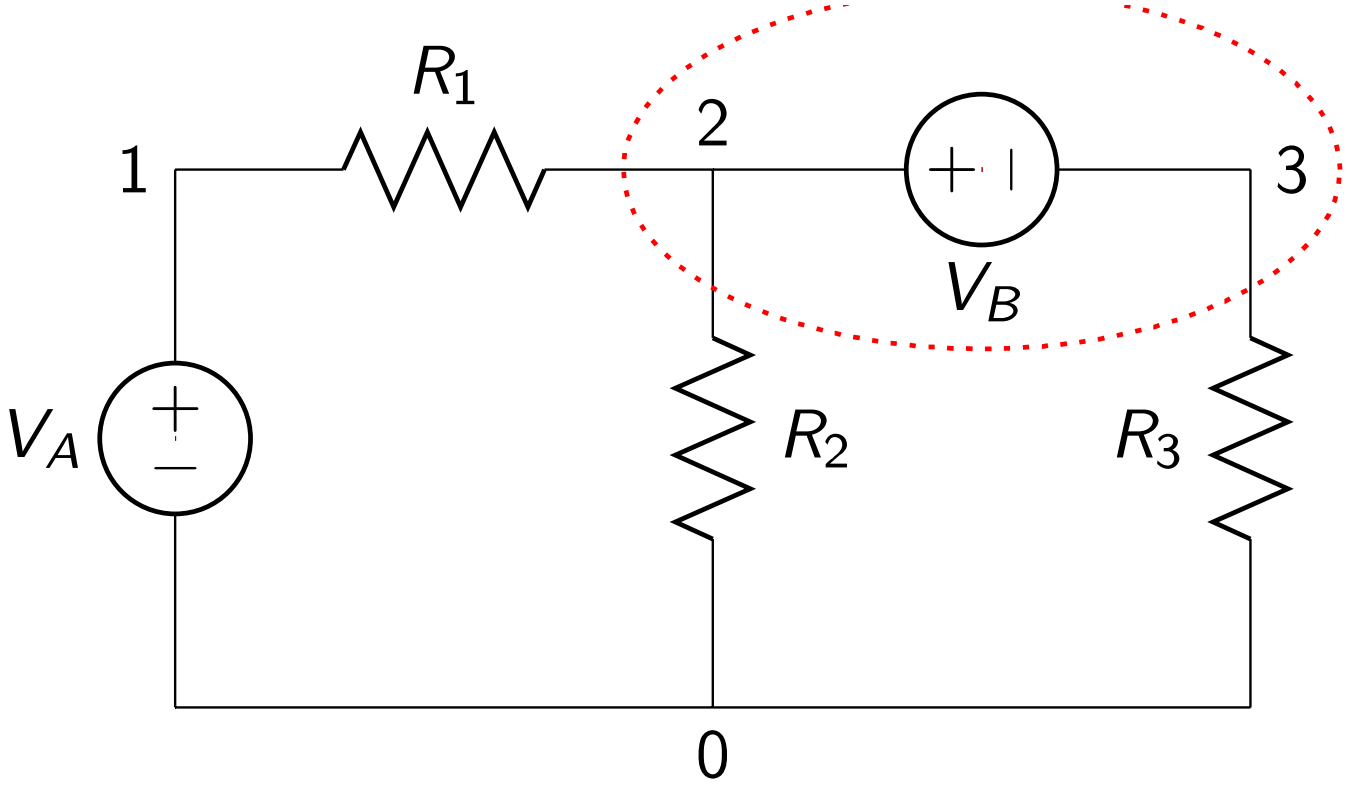
$$\frac{v_1}{2} + \frac{v_1 - v_2}{5} = 3.1$$

***At node 2***

$$\frac{v_2}{1} + \frac{v_2 - v_1}{5} + (-1.4) = 0$$

***Ans : $v_1$ = 5 V and $v_2$ = 2 V***

# *Super Node*



Voltage scource between nodes yield $V_2 - V_3 = V_B$ .....(1)

Whenever there is a voltage source (dependent or independent) between two non reference nodes, form a super node by combining them and apply KCL for the super node.

Node 2 and 3 overlap and form one node BUT super node has no voltage of its own.

Applying KCL for super node,

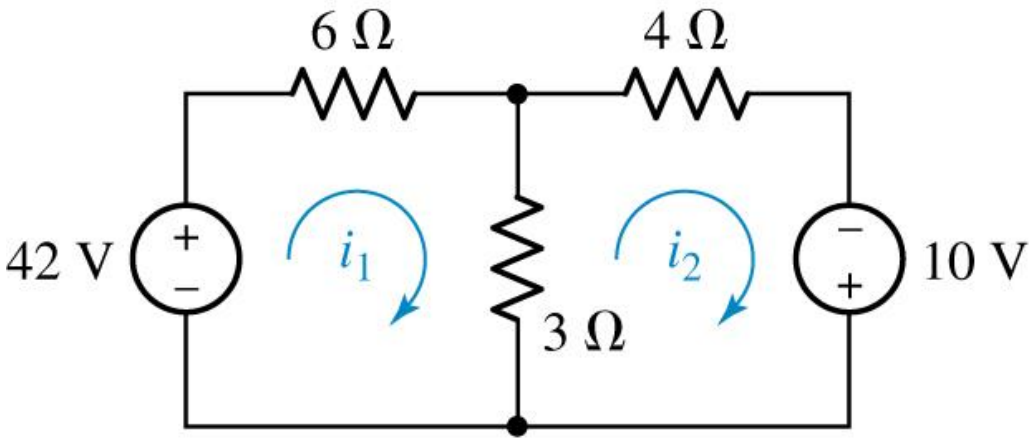
$$\frac{V_2 - V_A}{R_1} + \frac{V_2}{R_2} + \frac{V_3}{R_3} = 0 \qquad \text{.....(2)}$$

$$V_2\left(\frac{1}{R_1} + \frac{1}{R_2}\right) + V_3\frac{1}{R_3} = \frac{V_A}{R_1}$$

# *Mesh Analysis*

***A mesh is a loop which does not contain any other loops within it***

**Ex. Determine the two mesh currents, $i_1$ and $i_2$, in the circuit below.**




**Using KVL for the left-hand mesh,**

$$42 - 6\,i_1 - 3\,(i_1 - i_2) = 0$$

**Using KVL for the right-hand mesh,**

$$-4\,i_2 + 10 - 3\,(i_2 - i_1) = 0$$

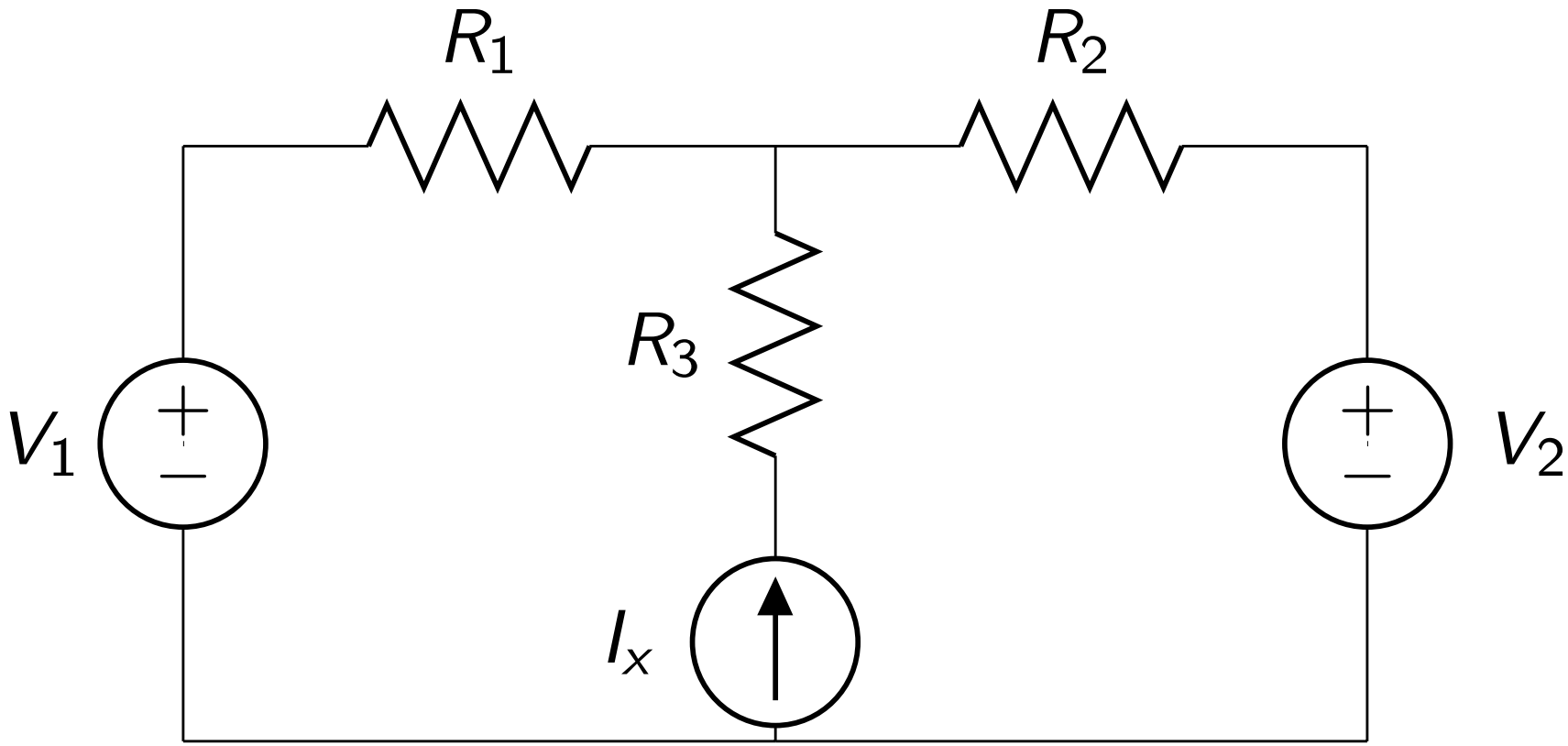
**Find (i) $i_1$ and $i_2$**

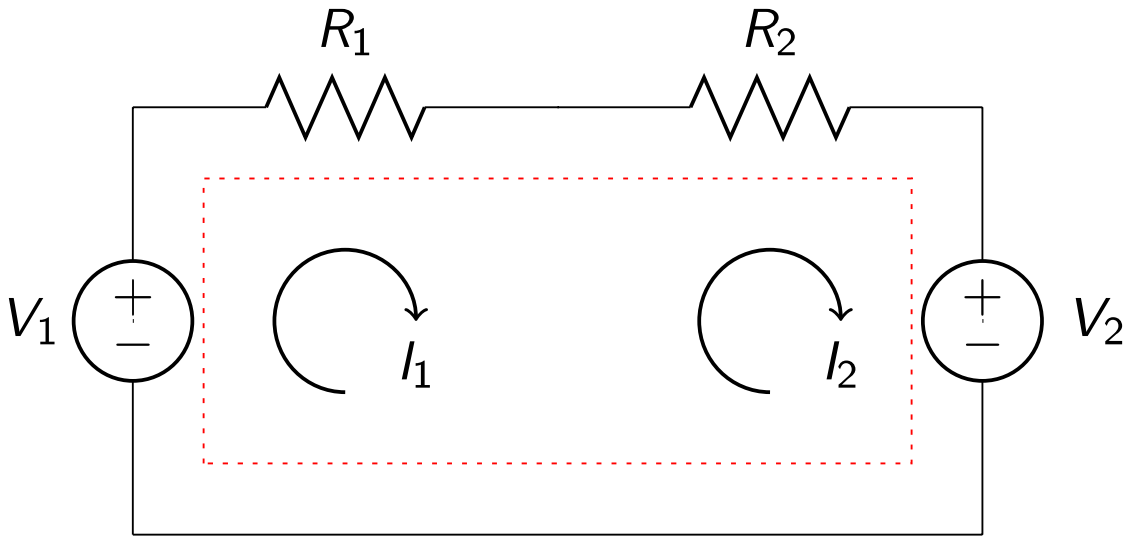
**(ii) The current flowing downward through the 3 Ω resistor**

**Ans : (i) $i_1 = 6A$ and $i_2 = 4A$**

**(ii) The current flowing downward through the 3 Ω resistor = $i_1 - i_2 = 6A - 4A = 2A$**

# *Super Mesh*






By applying KVL for super mesh,

$$-V_1 + I_1R_1 + I_2R_2 + V_2 = 0$$

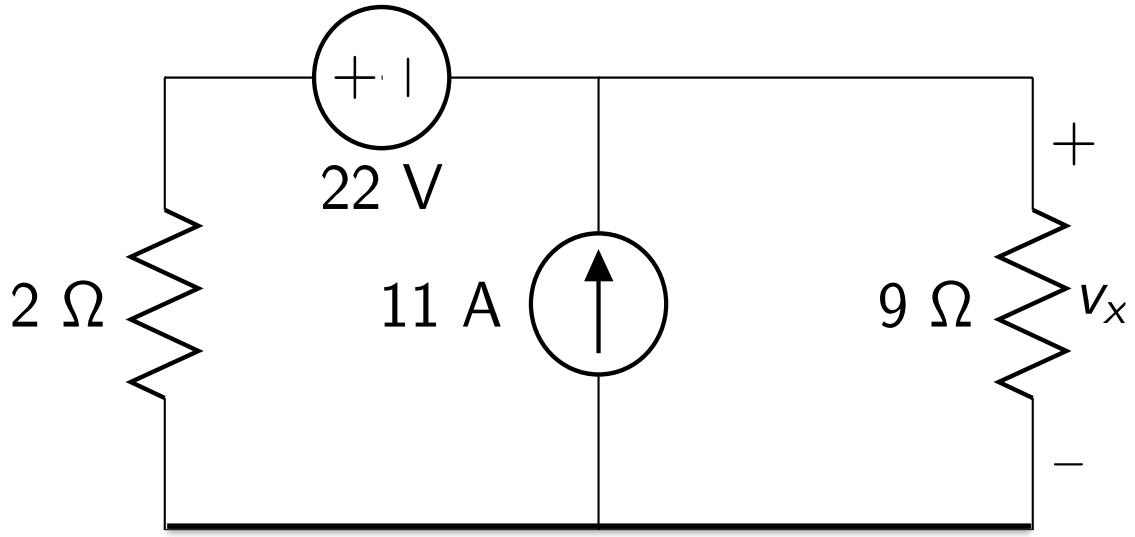
$$I_1R_1 + I_2R_2 = V_1 - V_2$$

Again, $I_2 - I_1 = I_x$

Whenever there is a current source (dependent or independent) between two meshes, form a super mesh by excluding the current source and any elements connected in series.

- Super mesh requires the application of both KVL and KCL
- Super mesh has no current of its own.

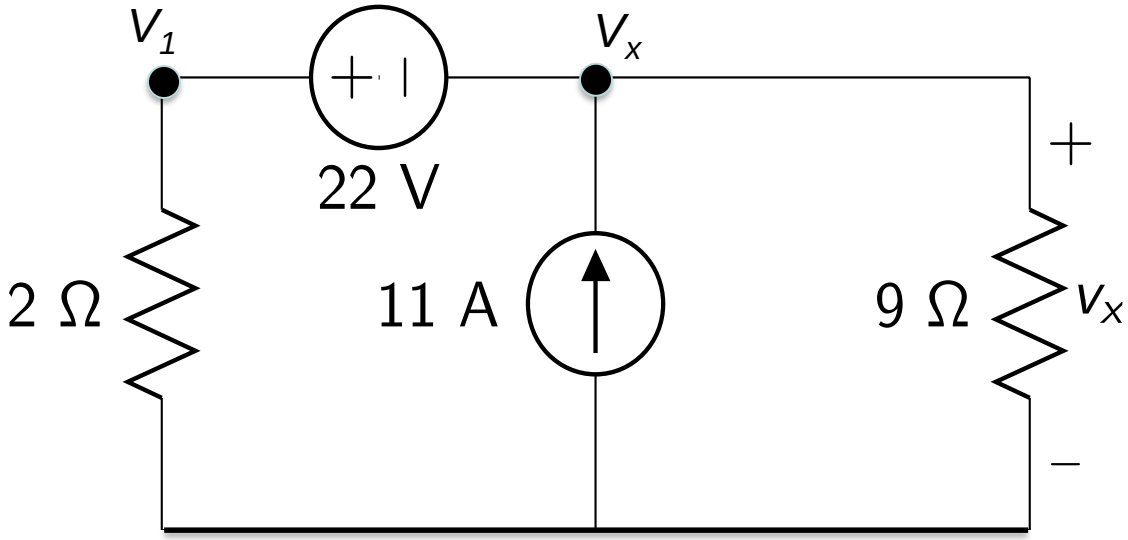
# Estimate $V_x$




*(a) By Nodal Analysis and Supernode*

*(b) By Mesh Analysis and Supermesh*

*(a) By Nodal Analysis and Supernode*



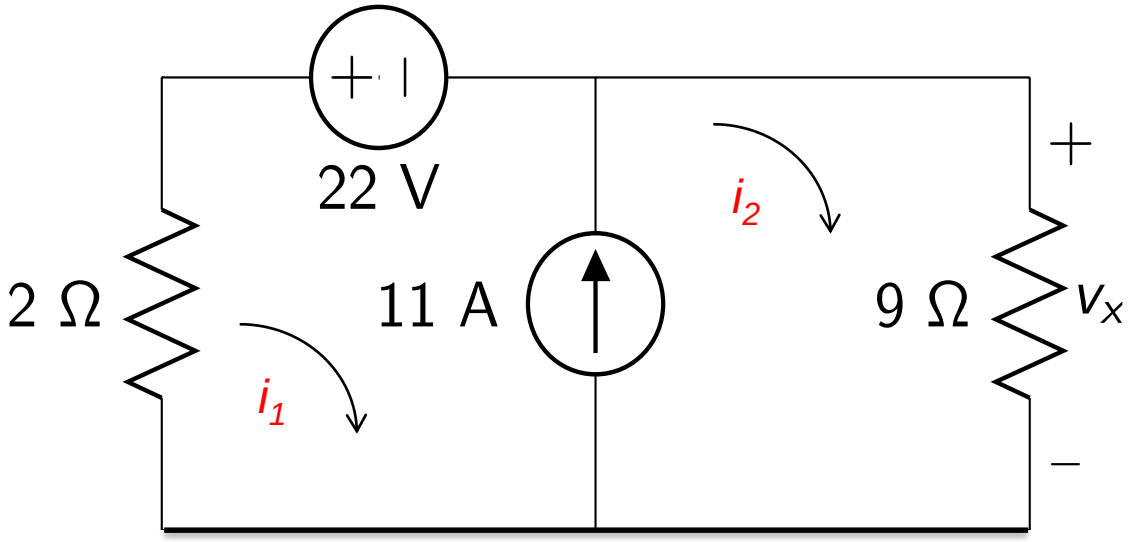

*Forming ONE supernode made up of nodes having voltages $V_1$ and $V_x$ and then following the steps given in Slide 5, we get the nodal equations*

$$V_1 - V_X = 22 \qquad (1)$$

$$\frac{-V_1}{2} + 11 - \frac{V_X}{9} = 0 \qquad (2)$$

*Solving (1) and (2) we get $V_x = 0$ V*

*(b) By Mesh Analysis and Supermesh*




*Forming ONE supermesh made up of meshes having currents $i_1$ and $i_2$ and then following the steps given in Slide 8, we get the mesh equation*

$$2i_1 + 22 + 9i_2 = 0 \qquad (1)$$

$$i_2 - i_1 = 11 \qquad (2)$$

*Solving (1) and (2) we get $i_2 = 0$ and therefore $9\,i_2 = V_x = 0$ V*

*--The End --*