SNS COLLEGE OF TECHNOLOGY

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COIMBATORE-35
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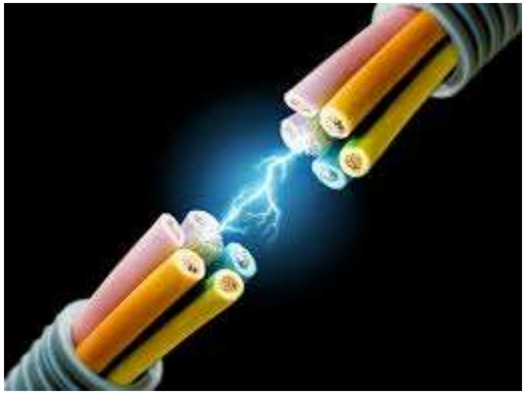
19EEB102 / ELECTRIC CIRCUIT ANALYSIS
I YEAR / II SEMESTER
UNIT-I: BASIC CIRCUIT ANALYSIS

MESH AND NODAL ANALYSIS

TOPIC OUTLINE

- KVL/KCL recap
- Mesh Analysis
  - Problems
- Nodal Analysis
  - Problems



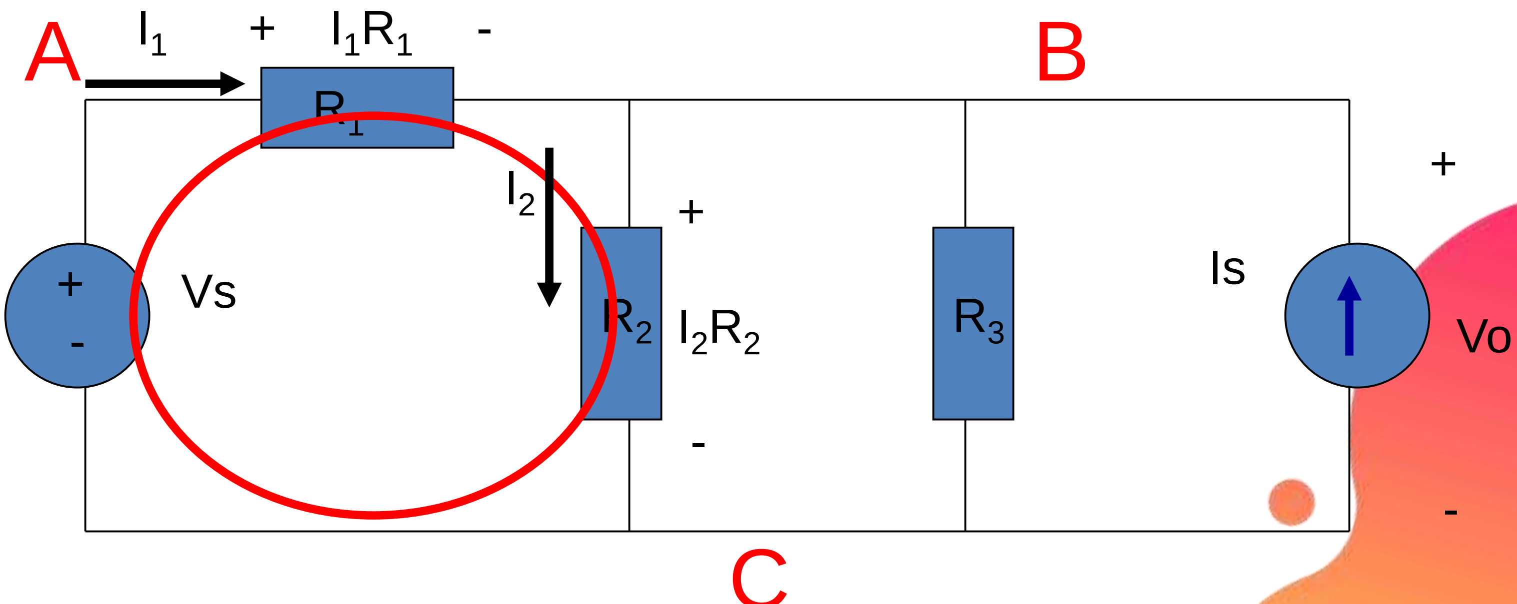
KVL -RECAP

Kirchoff's Voltage Law (KVL):

- The algebraic sum of voltages around each loop is zero
- Σ voltage drops - Σ voltage rises = 0
- Or Σ voltage drops = Σ voltage rises

MESH ANALYSIS

- Kirchoff's Voltage Law around 1st Loop (mesh)

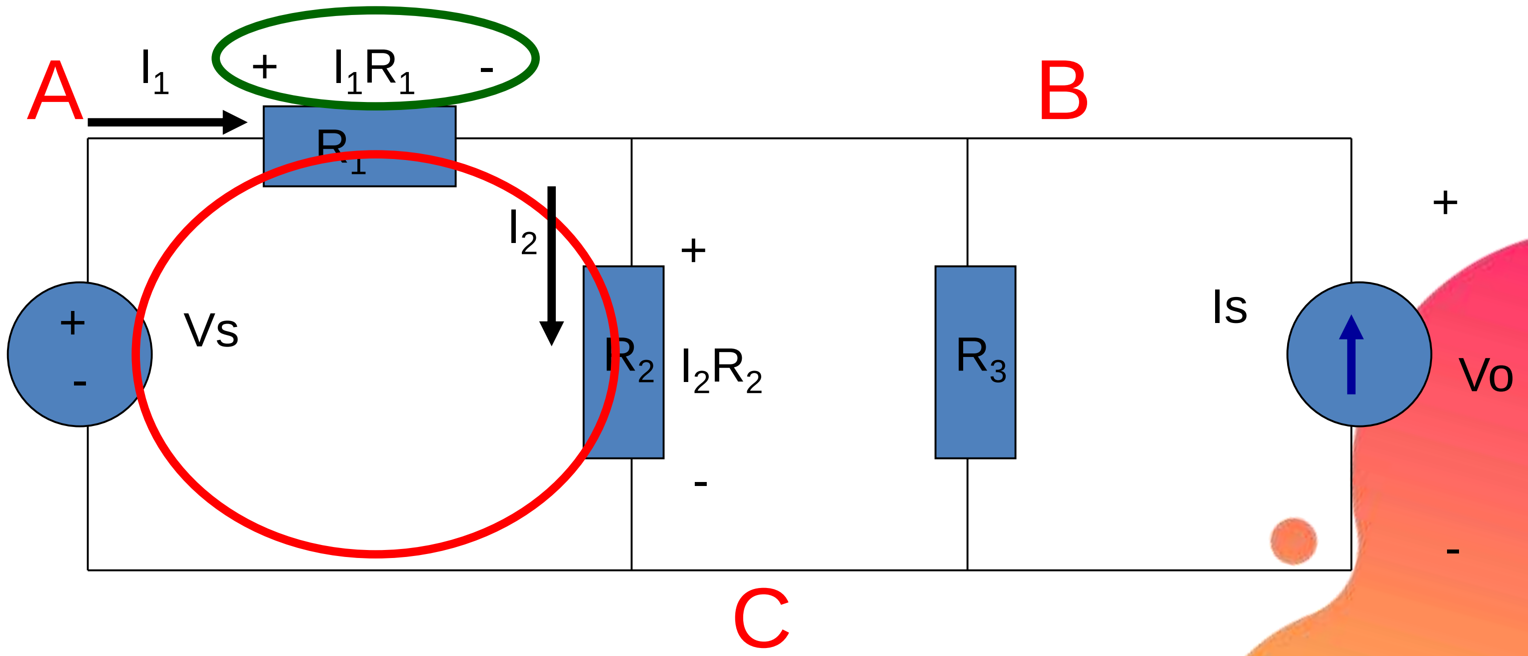


Assign current variables and directions

Use Ohm's law to assign voltages and polarities consistent with passive devices (current enters at the + side)

MESH ANALYSIS

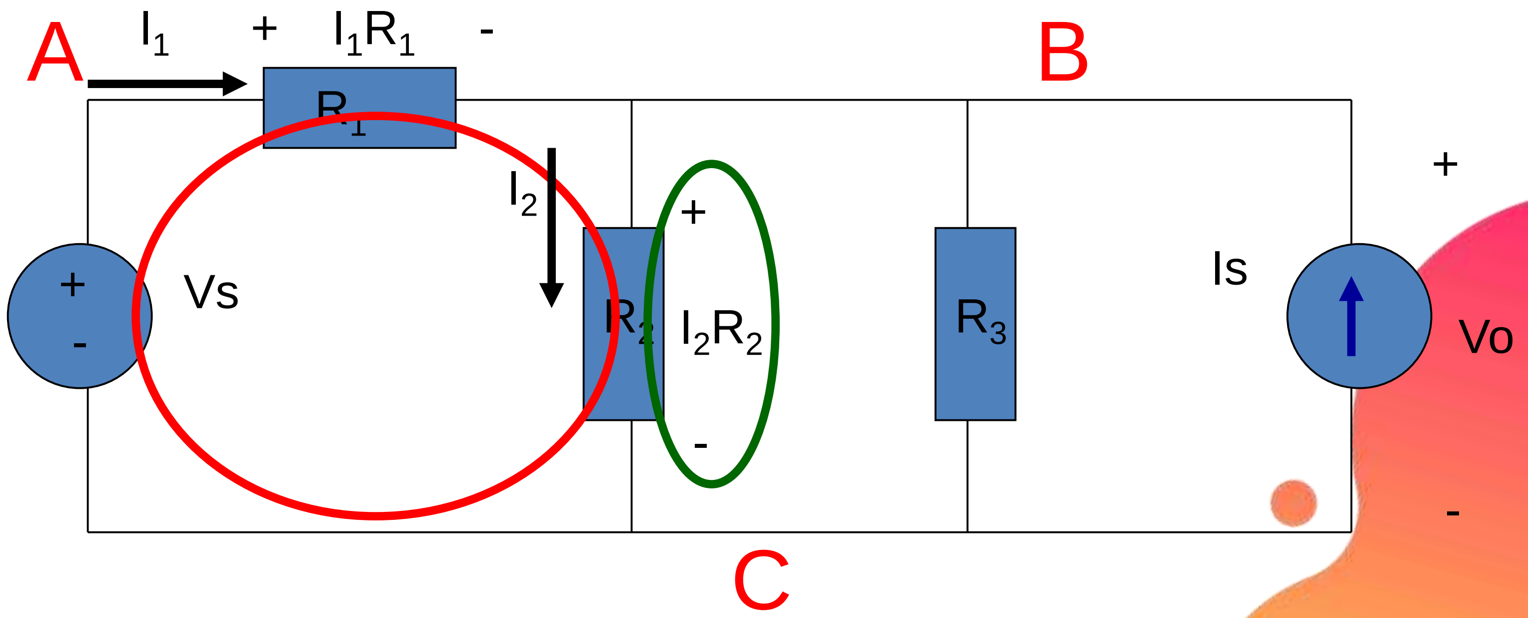
- Kirchoff's Voltage Law around 1st Loop



Starting at node A, add the 1st voltage drop: $+ I_1R_1$

MESH ANALYSIS

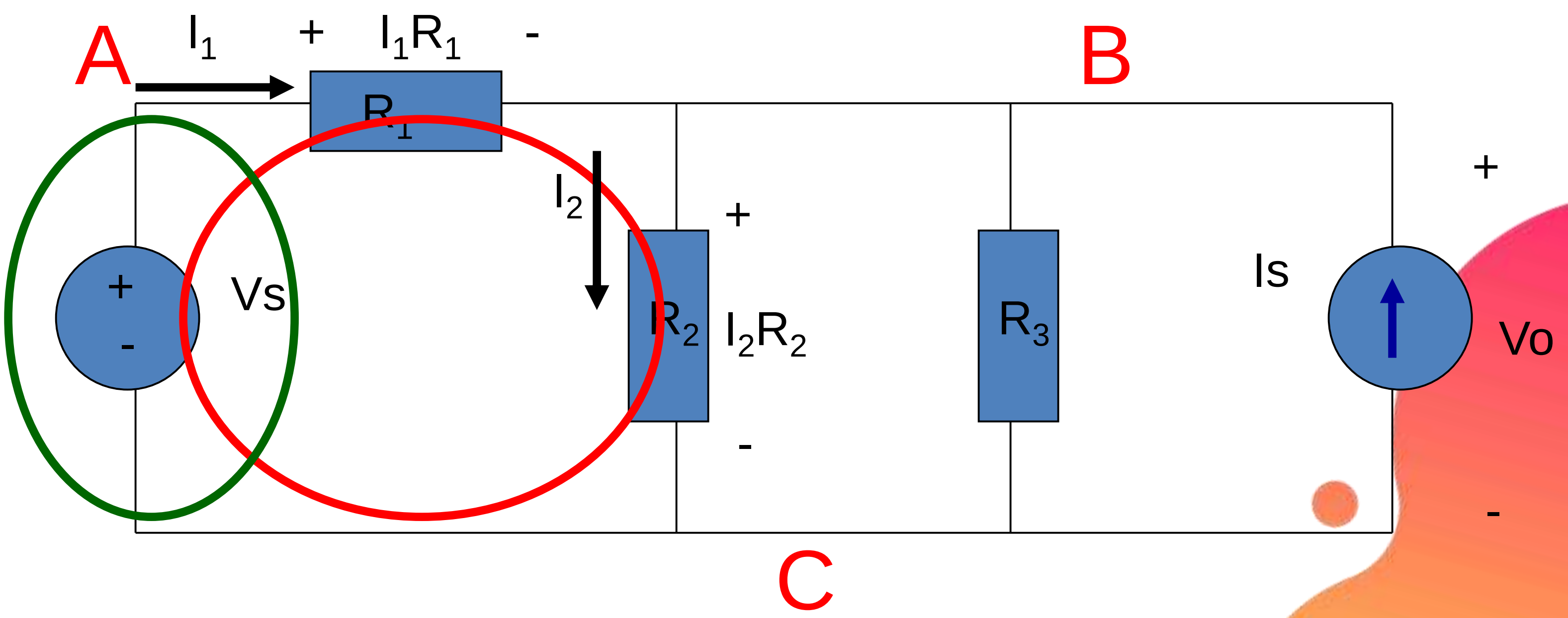
- Kirchoff's Voltage Law around 1st Loop



Add the voltage drop from B to C through R_2: $+ I_1R_1 + I_2R_2$

MESH ANALYSIS

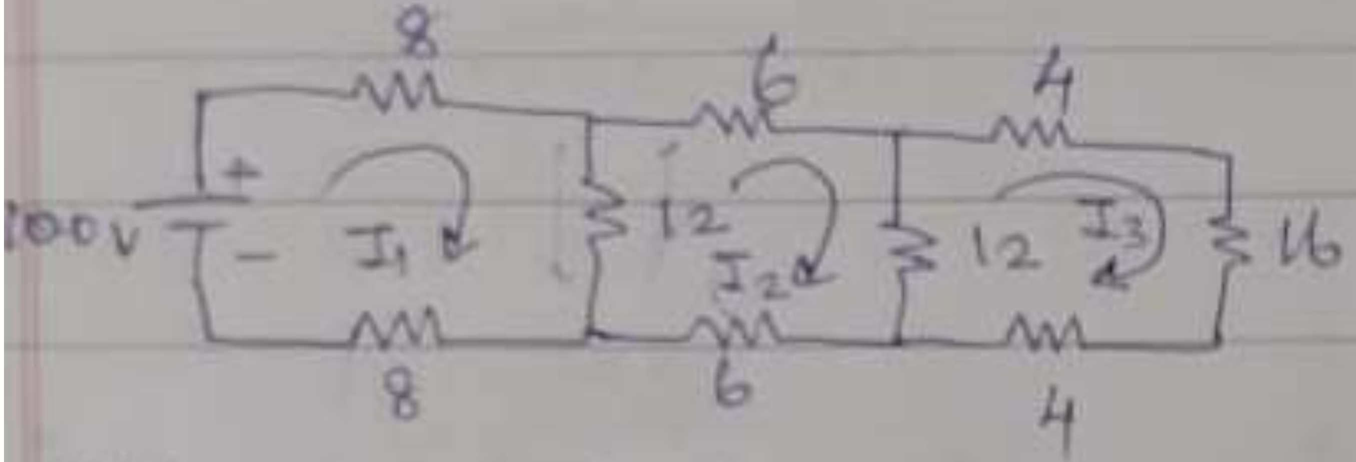
- Kirchoff's Voltage Law around 1st Loop (mesh)



Subtract the voltage rise from C to A through Vs: $+ I_1R_1 + I_2R_2 – Vs = 0$

Notice that the sign of each term matches the polarity encountered 1st

EXAMPLE 1



Writing KVL for Loop 1:

$$100 = 8I_1 + 12(I_1 - I_2) + 8I_1$$

$$100 = 28I_1 - 12I_2 \quad \text{—— (1)}$$

EXAMPLE 1

Writing KVL for loop 2:

$$0 = 12(I_2 - I_1) + 6I_2 + 12(I_2 - I_3) + 6I_2$$

$$0 = -12I_1 + 36I_2 - 12I_3 \quad \text{——} \; (2)$$

Writing KVL for loop 3:

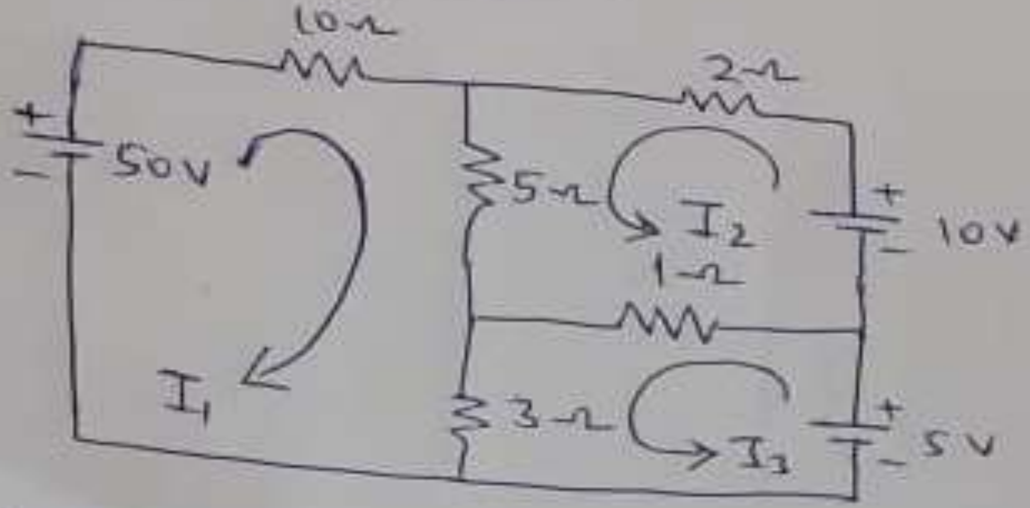
$$0 = -12I_2 + 36I_3 \quad \text{——} \; (3)$$

$$\begin{bmatrix} 28 & -12 & 0 \\ -12 & 36 & -12 \\ 0 & -12 & 36 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \\ I_3 \end{bmatrix} = \begin{bmatrix} 100 \\ 0 \\ 6 \end{bmatrix}$$

EXAMPLE 2

MESH ANALYSIS

(2)



Loop 1

$50 = 18I_1 - 5I_2 - 3I_3$ — (1)

EXAMPLE 2

Loop 2:

$$10 = 2I_2 + 5(I_2 + I_1) + 1(I_1 - I_2)$$

$$10 = 5I_1 + 8I_2 - I_3 \quad \text{--- (2)}$$

Loop 3:

$$3I_1 - I_2 + 4I_3 = 5 \quad \text{--- (3)}$$

$$I_1 = 3.3\ A$$

$$I_2 = -0.9\ A$$

$$I_3 = 1.47\ A$$

EXAMPLE 2
(Matrix method-solving)

$$50 = 18 I_1 - 5 I_2 - 2 I_3 \quad \text{--- (1)}$$
$$10 = 5 I_1 + 8 I_2 - I_3 \quad \text{--- (2)}$$
$$5 = 3 I_1 - I_2 + 4 I_3 \quad \text{--- (3)}$$

$$\begin{bmatrix} 18 & -5 & -3 \\ 5 & 8 & -1 \\ 3 & -1 & +4 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \\ I_3 \end{bmatrix} = \begin{bmatrix} 50 \\ 10 \\ 5 \end{bmatrix}$$

$$\Delta = 18(32 - (+1)) + (-5)(20 - (-3)) + ((-5) - 24)\cdot(-3)$$

$$\Delta = \ //$$

$$\Delta I_1 = \begin{bmatrix} 50 & -5 & -3 \\ 10 & 8 & -1 \\ 5 & -1 & +4 \end{bmatrix} = \ //$$

$$\Delta I_2 = \ // \qquad \Delta I_3 = \ //$$

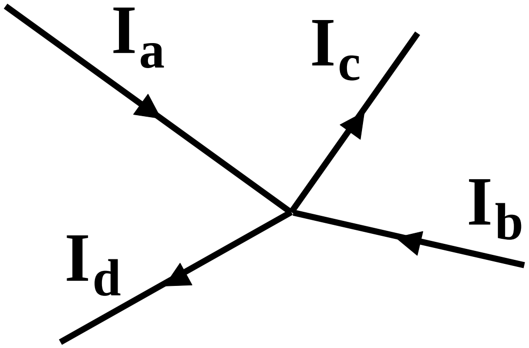
$$I_1 = \frac{\Delta I_1}{\Delta} = \ // \qquad I_2 = \frac{\Delta I_2}{\Delta} = \ //$$

$$I_3 = \frac{\Delta I_3}{\Delta} = \ //$$

KCL - RECAP

- Kirchoff's Current Law (KCL) :

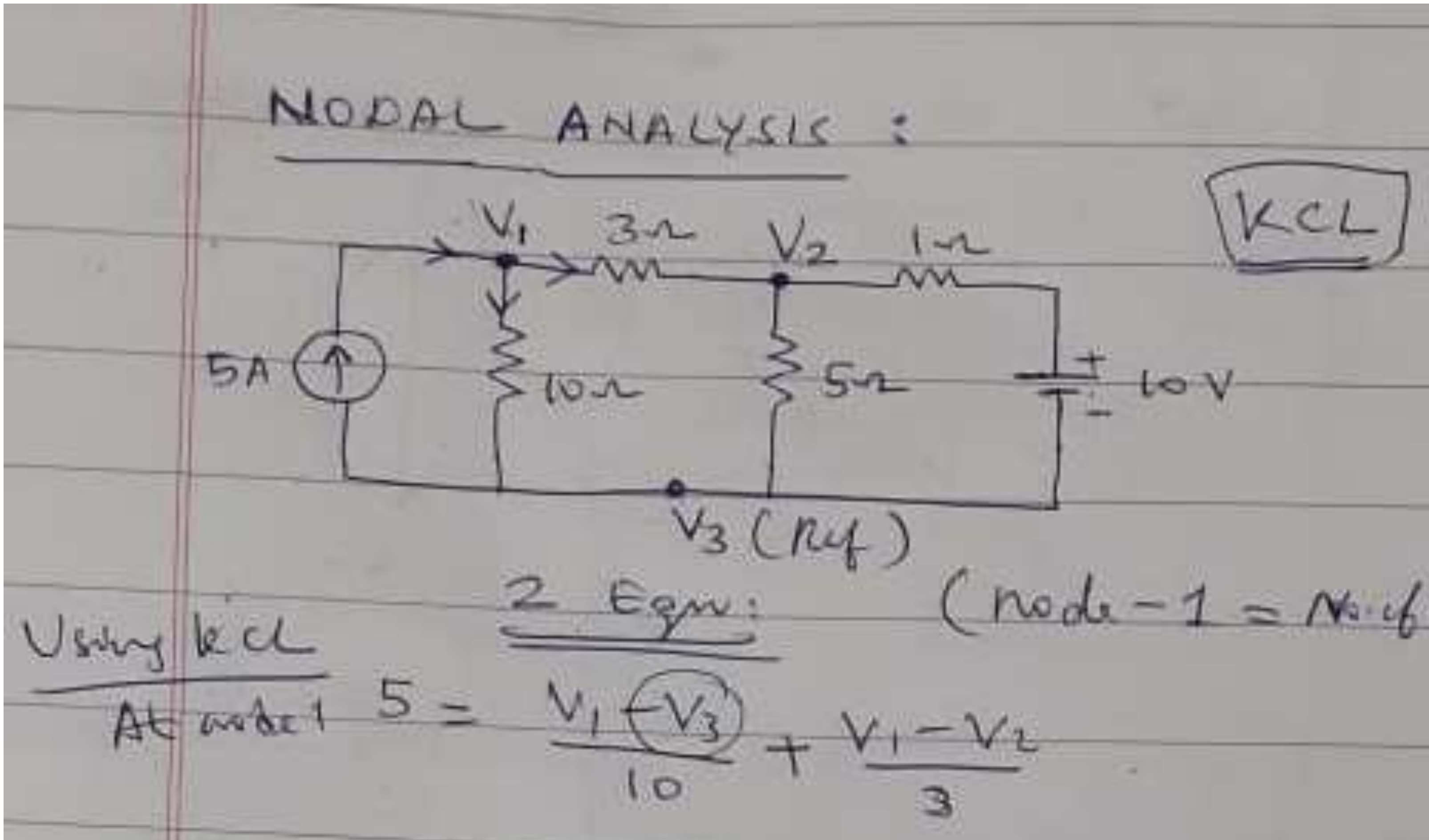
The sum of the current entering a node (junction point) equal to the sum of the currents leaving.



$$I_a + I_b = I_c + I_d$$

I_a, I_b, I_c, and I_d can each be either a positi or negative number.

NODAL ANALYSIS



NODAL ANALYSIS

$$5 = \frac{V_1}{10} + \frac{V_1 - V_2}{3} \quad \text{--- (1)}$$

Using KCL

At node 2

$$0 = \frac{V_2 - V_1}{3} + \frac{V_2 - V_3}{5} + \frac{V_2 - 10}{1}$$

$$0 = \frac{V_2 - V_1}{3} + \frac{V_2}{5} + \frac{V_2 - 10}{1} \quad \text{--- (2)}$$

NODAL ANALYSIS

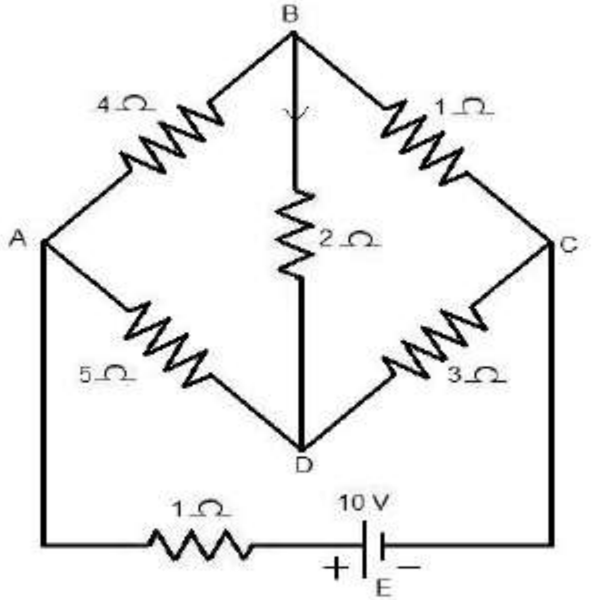
$$5 = \frac{V_1}{10} + \frac{V_1}{3} - \frac{V_2}{3} \quad \text{— (1)}$$

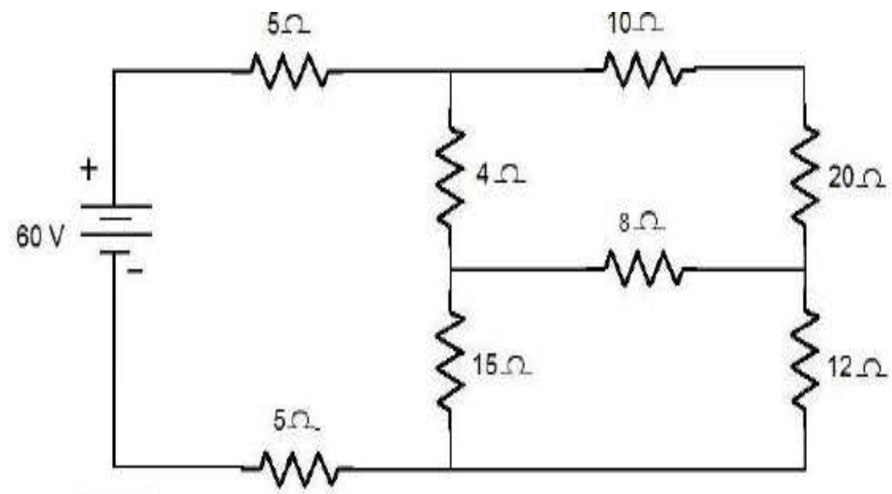
S2

$$0 = \frac{V_2}{3} - \frac{V_1}{3} + \frac{V_2}{5} + \frac{V_2}{1} - 10$$

Solving equations, the nodal voltages are:
V1 = 19.85 volts, V2 = 10.9 volts

ANALYSIS-PROBLEMS

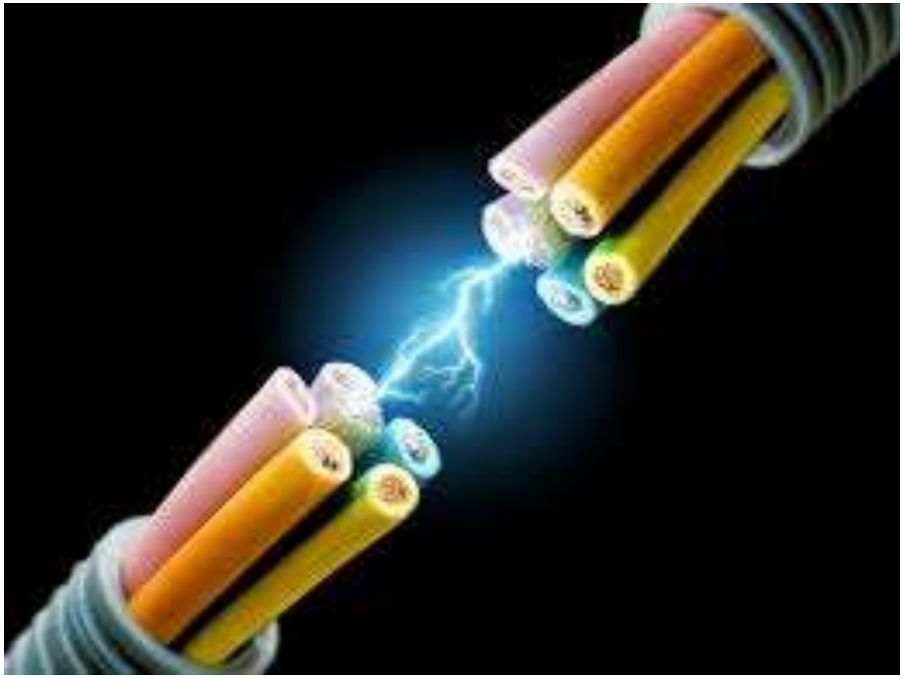




Ex 4: Find the mesh currents in the circuit shown above (left)

Ex 5: Find the nodal voltages in the circuit shown above (right)

RECAP....



...THANK YOU