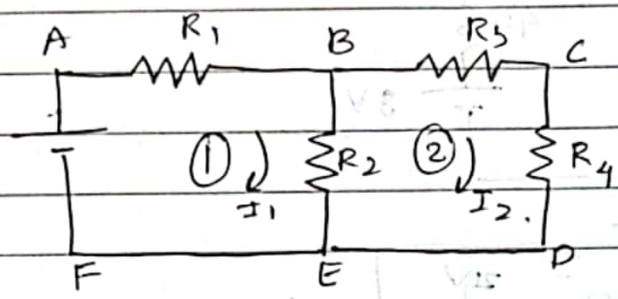
6/11

MESH CURRENT ANALYSIS

Mesh

- A closed path for the flow of current.

KVL - The algebraic sum of voltages in a mesh is 0.



ABEF, BCDE → mesh.

ABCDEF — loop (not mesh)

All meshes are loops but not all loops are meshes.

$$V - I_1 R_1 - (I_1 - I_2) R_2 = 0.$$

$$\therefore V = I_1 (R_1 + R_2) - I_2 R_2 \quad — (1)$$

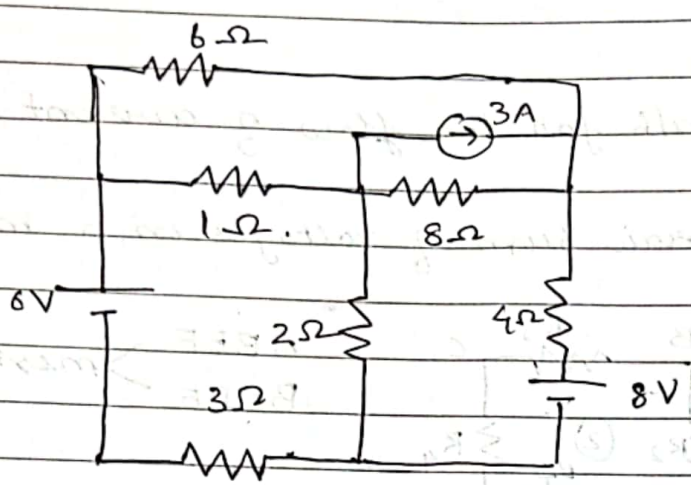
$$-I_2 R_3 - I_2 R_4 - R_2 (I_2 - I_1) = 0 \quad — (2)$$

Sign conventions for KVL - refer previous class notes.

METHOD:

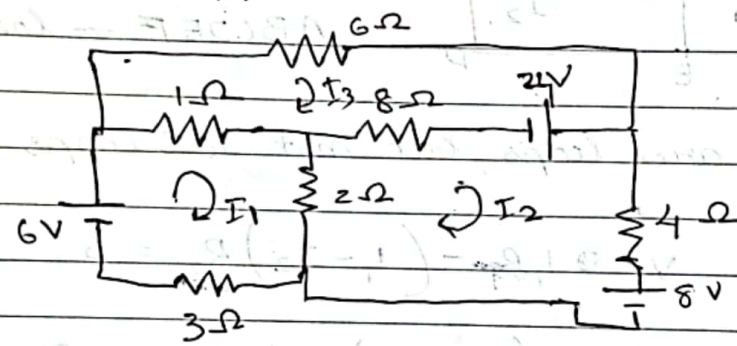
- Convert current sources to voltage source
- Mark different currents in all independent meshes
- Write KVL equation for meshes
- Solve for current.

Q. Determine power drawn by 2Ω resistor.



Q.

Ans.



Mesh 1

$$6 - 1\times(I_1 - I_3) - 2(I_1 - I_2) - 3I_1 = 0.$$

$$6I_1 - 2I_2 - I_3 = 6 \quad \text{— (1)}$$

Mesh 2

$$-8(I_2 - I_3) + 24 - 4I_2 - 8 - 2(I_2 - I_1) = 0$$

$$-2I_1 + 14I_2 - 8I_3 = 16. \quad \text{— (2)}$$

Mesh 3.

$$-6I_3 - 24 - 8(I_3 - I_2) - 1(I_3 - I_1) = 0$$

$$-I_1 - 8I_2 + 15I_3 = -24 \quad \text{— (3)}$$

Ans.

Solve ①, ② & ③.

$I_1 = 0.99\ A$

$I_2 = 0.587\ A$

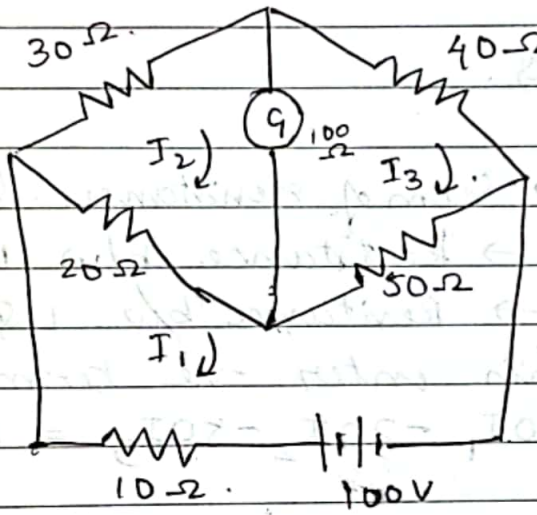
$I_3 = -1.22\ A$

$P = I^2R$

$= (0.99 - 0.587)^2 \times 2$

$= 0.324\ W$

Q. Determine the current through the Galvanometer G.



Ans. Mesh 1

$100 - 10I_1 - 20(I_1 - I_2) - 50(I_1 - I_3) = 0$

$80I_1 - 20I_2 - 50I_3 = 100$ — ①

Mesh 2

$-30I_2 - 100(I_2 - I_3) - 20(I_2 - I_1) = 0$

$150I_2 - 20I_1 - 100I_3 = 0$ — ②

Mesh 3.

$-40I_3 - 50(I_3 - I_1) - 100(I_3 - I_2) = 0$

$-50I_1 - 100I_2 + 190I_3 = 0$ — ③

$I_1 = 2.278\ V$ $I_1 = 1.678\ A$ | $2.23\ A = I_1$

$I_2 = 0.262\ A$ | $1.06\ A = I_2$

$I_3 = 0.589\ A$ | $1.14\ A = I_3$

$I_1 = I_3 - I_2 = 1.14 - 1.06$

$= 0.08\ A$ (upward).

Ans.

HOW TO WRITE THE EQUATIONS USING INSPECTION

Refer video:

In previous Q.

Mesh 1

For I_1 → Sum of resistances. $(80 \times I_1)$

$(-ve)\ I_2$ b. → Resistance b/w 1 & 2 i.e 20

$(-ve)\ I_3$ → Resistance b/w 1 & 3 i.e 50.

~~If~~ This enter -ve terminal of 100V

$\therefore 80I_1 - 20I_2 - 50I_3 = 100.$

Mesh 2

For I_2 → sum of resistances (150)

$(-ve)\ I_3$ ~~&~~ → ~~on~~ b/w 2 & 3 (100)

$(-ve)\ I_1$ → b/w 2 & 1 (20)

Mesh 3

For I_3 → sum of resistances (190.)

and so on....

Q. D

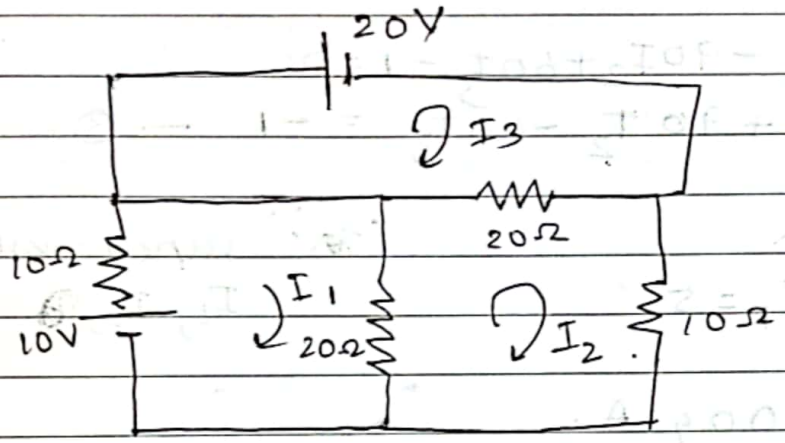
Q. F

so

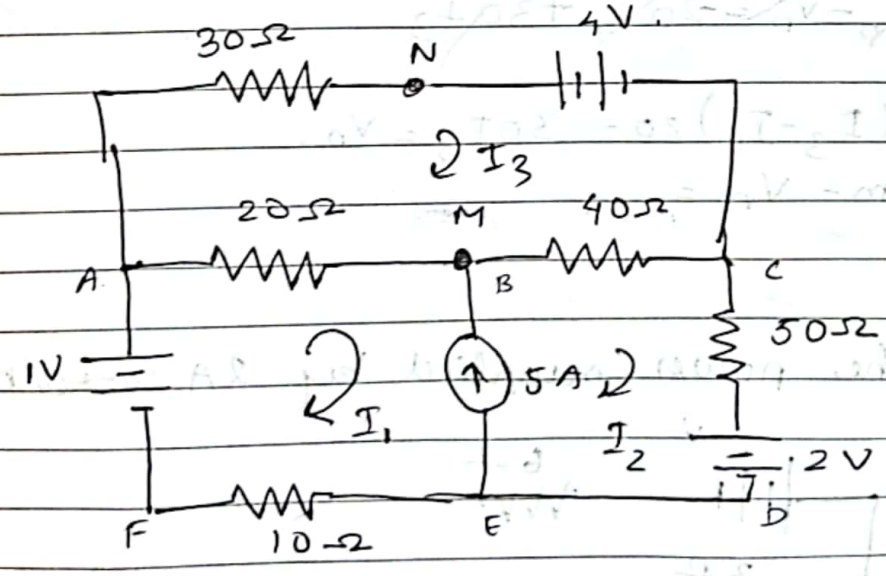
Q. Draw the mesh.

$$\begin{bmatrix} 30 & -20 & 0 \\ -20 & 50 & -20 \\ 0 & -20 & 20 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \\ I_3 \end{bmatrix} = \begin{bmatrix} 10 \\ 0 \\ -20 \end{bmatrix}$$

Ans.



Q. Find the power supplied by the 5A current source. Also determine the voltage b/w pts M & N.



→ Super Mesh (due to the ideal current source)

Mesh 3

$-30I_3 - 4 - 40(I_3 - I_2) - 20(I_3 - I_1) = 0$

$-20I_1 - 40I_2 + 90I_3 = -4$ — (1).

Mesh 1

$1 - 20(I_1 - I_3) - 40(I_2 - I_3) - 50I_2 - 2 - 10I_1 = 0$

$-30I_1 - 90I_2 + 60I_3 - 1 = 0$

$30I_1 + 90I_2 - 60I_3 = -1$ — (2).

Mesh 2

$I_2 - I_1 = 5$

(∵ super mesh I_1, I_2, I_3 are +ve)

$I_1 = -4.004$ A.

$I_2 = +0.9958$ A

$I_3 = -0.491$ A

$V_m + 20I_1 + 30I_3 = V_n$.

$V_m - V_n = -20I_1 + 30I_3$

$V_m - (I_3 - I_1)20 - 30I_3 = V_n$.

$V_m - V_n =$

Final V_{th}