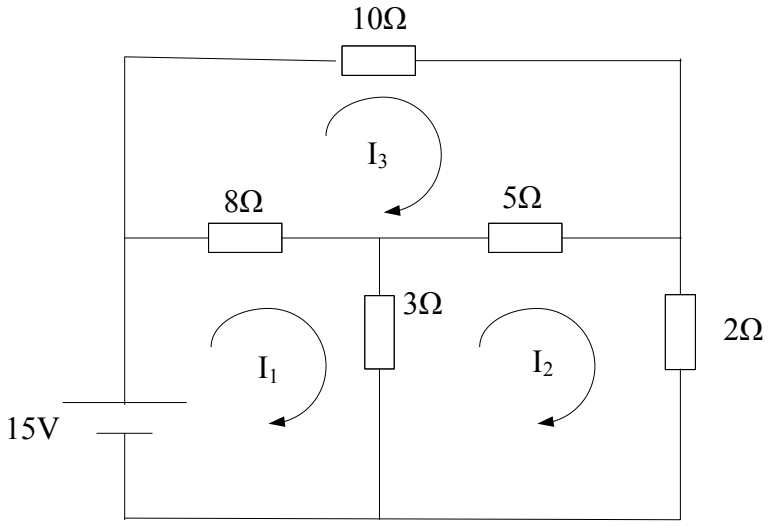
Network Solution :-

To solve a circuit is to find the current and voltage in all branches.

1) Loop (Mesh) current method :-

Example(1):- Find the current through the 10 Ω resistor of the network shown:



Solution :-

- مجموع المقاومات * تيار الـ Loop + المقاومة المشتركة * تيار الـ Loop المشترك ∓ الفولتية (حسب اتجاهها مع تيار الـ Loop) = صفر .

The loop equations are :-

Loop 1 :-

$$-(8+3)I_1 + 3I_2 + 8I_3 + 15 = 0$$

Loop 2 :-

$$-(3+5+2)I_2 + 3I_1 + 5I_3 = 0$$

Loop 3 :-

$$-(10+8+5)I_3 + 8I_1 + 5I_2 = 0$$

Rearrange the equations , then :-

$$-11I_1 + 3I_2 + 8I_3 = -15$$

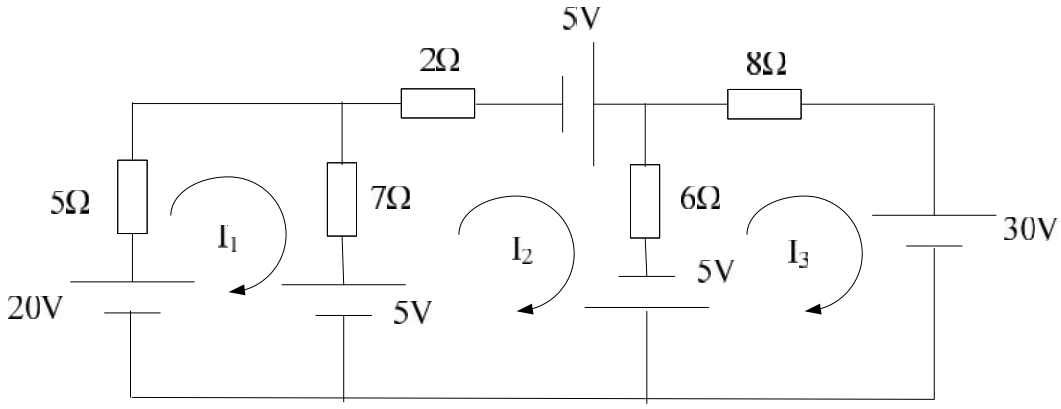
$$3I_1 - 10I_2 + 5I_3 = 0$$

$$8I_1 + 5I_2 - 23I_3 = 0$$

$$I_3 = \frac{D_3}{D} = \frac{\begin{bmatrix} -11 & 3 & -15 \\ 3 & -10 & 0 \\ 8 & 5 & 0 \end{bmatrix}}{\begin{bmatrix} -11 & 3 & 8 \\ 3 & -10 & 5 \\ 8 & 5 & -23 \end{bmatrix}} = 1.22A$$

$$\therefore I_3 = I_{10\Omega} = 1.22A$$

Example(2):- Solve following circuit diagram;



Solution :-

$-I_1 (5+7) + 7I_2 + 20 – 5 = 0$

$-I_2 (7+2+6) + 7I_1 + 6I_3 + 5 + 5 + 5 = 0$

$-I_3 (6+8) + 6I_2 – 5 – 30 = 0$

Rearrange;

$-12I_1 + 7I_2 + 0 = -15$ ---------- (1)

$7I_1 - 15I_2 + 6I_3 = -15$ ---------- (2)

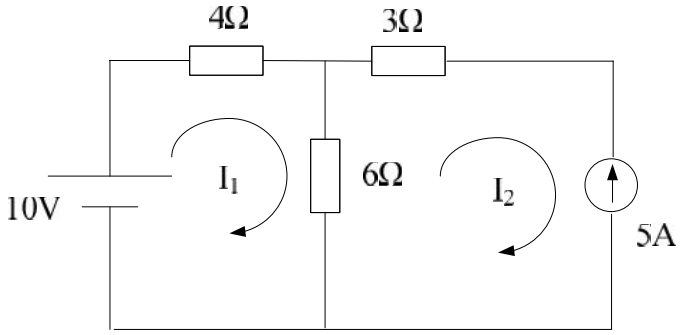
$0 + 6I_2 - 14I_3 = 35$ ---------- (3)

$$I_1 = \frac{D_1}{D} = \frac{\begin{bmatrix} -15 & 7 & 0 \\ -15 & -15 & 6 \\ 35 & 6 & -14 \end{bmatrix}}{\begin{bmatrix} -12 & 7 & 0 \\ 7 & -15 & 6 \\ 0 & 6 & -14 \end{bmatrix}} = \frac{2610}{1402} = 1.862A$$

$$I_2 = \frac{D_2}{D} = \frac{\begin{bmatrix} -12 & -15 & 0 \\ 7 & -15 & 6 \\ 0 & 35 & -14 \end{bmatrix}}{1402} = \frac{1470}{1402} = 1.049A$$

$$I_3 = \frac{D_3}{D} = \frac{\begin{bmatrix} -12 & 7 & -15 \\ 7 & -15 & -15 \\ 0 & 6 & 35 \end{bmatrix}}{1402} = \frac{-2875}{1402} = -2.05A$$

Example(3):- Find the current in the 10V source , for the following network;



Solution :-

$I_2 = -5$ A

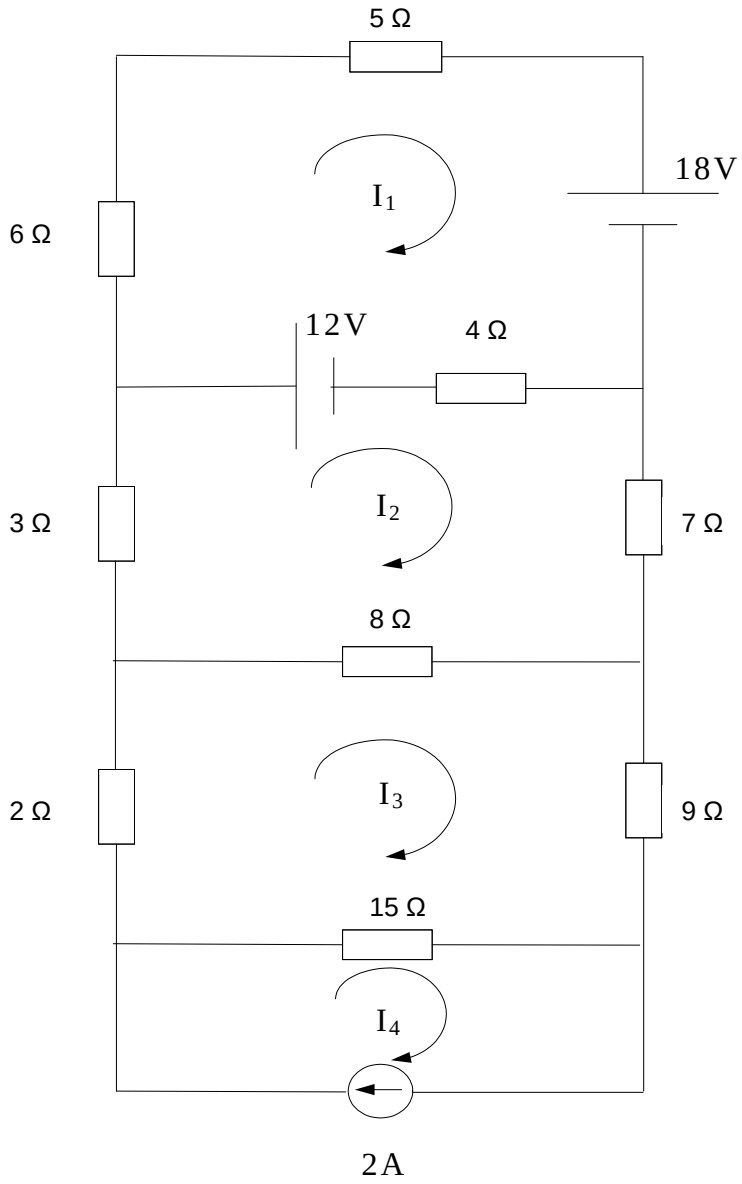
Hence , we need only one equation to solve this circuit

$-I_1 (4+6) + 6 * (-5) + 10 = 0$

$-10I_1 - 20 = 0 \Rightarrow -10I_1 = 20$

$$\therefore I_1 = \frac{20}{-10} = -2A$$

Example(4):- Solve the following circuit diagram, also find the voltage across 15 Ω resistance?



Solution:-

$I_4 = 2$ A

$-I_1 (4+6+5) + 4I_2 + 12 - 18 = 0$

$-I_2 (8+3+4+7) + 4I_1 + 8I_3 - 12 = 0$

$-I_3 (15+2+8+9) + 8I_2 + 15 * 2 = 0$

Rearrange:-

$-15I_1 + 4I_2 + 0 = 6$ ---------- (1)

$4I_1 - 22I_2 + 8I_3 = 12$ ---------- (2)

$0 + 8I_2 - 34I_3 = -30$ ---------- (3)

$$I_1 = \frac{D_1}{D}$$

$$I_2 = \frac{D_2}{D}$$

$$I_3 = \frac{D_3}{D}$$

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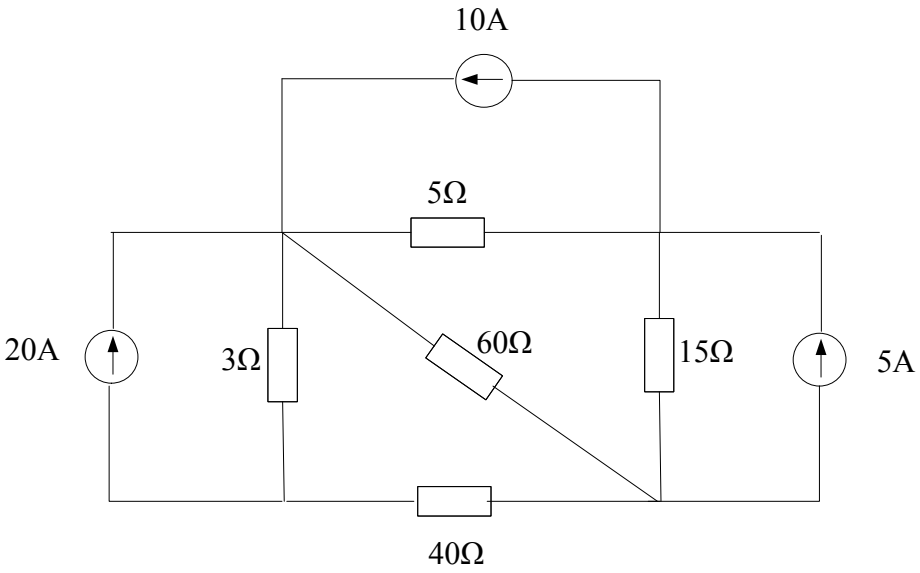
$V_{15} = I_{15} * R_{15}$

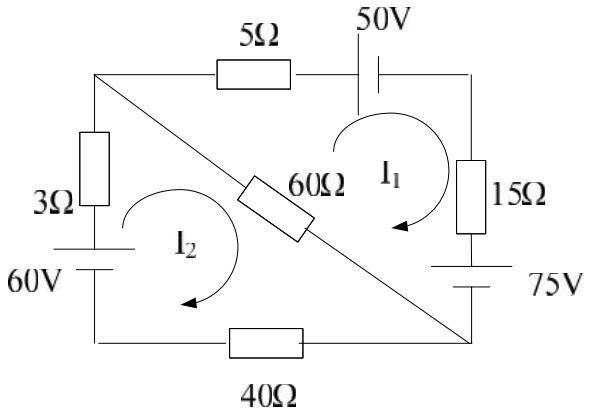
$= (I_3 – I_4) * 15$

$= (I_3 – 2) * 15$

Example(5):- Solve the following circuit diagram .



Solution:- The above diagram can be reduced to the following diagram;



$-I_1 (5+15+60) + 60I_2 - 50 - 75 = 0$

$-I_2 (3+60+40) + 60I_1 + 60 = 0$

Rearrange:-

$-80I_1 + 60I_2 = 125$ ---------- (1)

$60I_1 - 103I_2 = -60$ ---------- (2)

$I_1 = \frac{D_1}{D}$

$I_2 = \frac{D_2}{D}$

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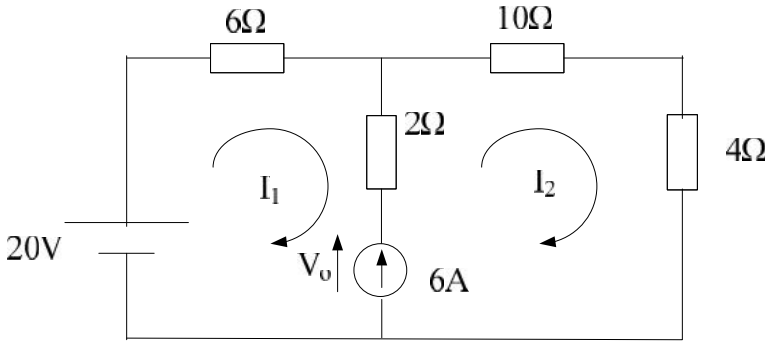
Example(6):- Solve the following circuit diagram:



Solution:-

$-(6+2)I_1 + 2I_2 +20 - V_o = 0$ ---------- (1)

$-(10+2+4)I_2 + 2I_1 + V_o = 0$ ---------- (2)

$I_2 - I_1 = 6$ ---------- (3)

Add eq. 1 & eq. 2

$-8I_1 + 2I_2 +20 -16 I_2 + 2I_1 = 0$ ---------- (1)

$-6I_1 - 14I_2 = -20$ ---------- (2)

From eq. 3

$I_1 – I_2 = -6$

$$I_1 = \frac{D_1}{D} = \frac{\begin{bmatrix} -20 & -14 \\ -6 & -1 \end{bmatrix}}{\begin{bmatrix} -6 & -14 \\ 1 & -1 \end{bmatrix}} = \frac{20-84}{6+14} = -3.2A$$

$$I_2 = \frac{D_2}{D} = \frac{\begin{bmatrix} -6 & -20 \\ 1 & -6 \end{bmatrix}}{20} = \frac{36+20}{20} = 2.8A$$