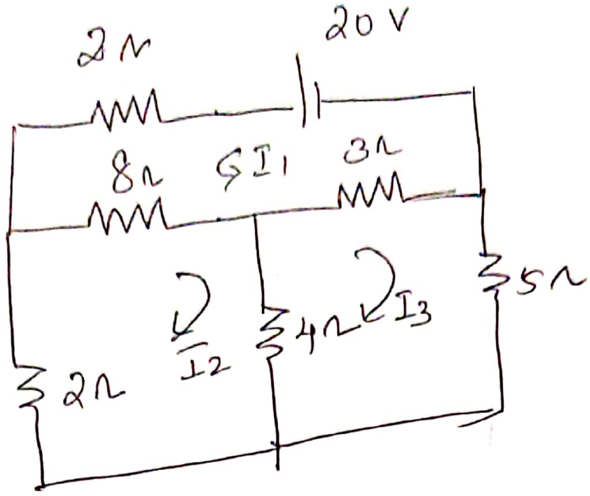
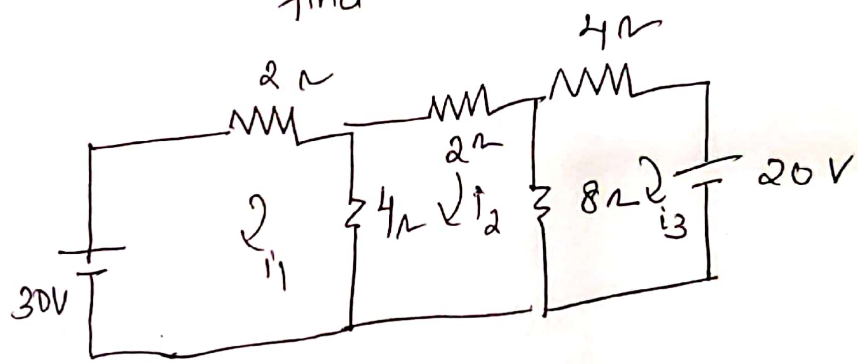
(1)



$$\begin{bmatrix} 13 & 8 & 3 \\ 8 & 14 & -4 \\ 3 & -4 & 12 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \\ I_3 \end{bmatrix} = \begin{bmatrix} 20 \\ 0 \\ 0 \end{bmatrix}$$

Find $I_{2\Omega} = I_1 = \dfrac{\Delta_1}{\Delta}$

(2)



$$P(8\Omega) = (i_8)^2 \times 8$$

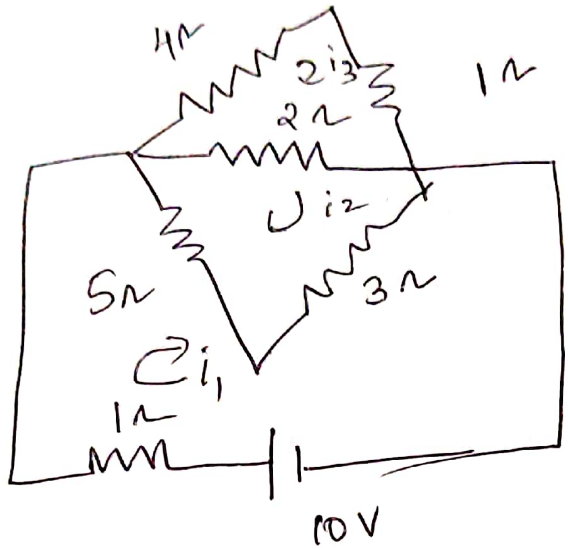
$$i_8 = i_2 - i_3$$

$$\begin{bmatrix} 6 & -4 & 0 \\ -4 & 14 & -8 \\ 0 & -8 & 12 \end{bmatrix} \begin{bmatrix} i_1 \\ i_2 \\ i_3 \end{bmatrix} = \begin{bmatrix} 30 \\ 0 \\ -20 \end{bmatrix}$$

$$i_2 = \frac{\Delta_2}{\Delta}$$

$$i_3 = \frac{\Delta_3}{\Delta}$$

4



$V_{2\Omega} = ?$

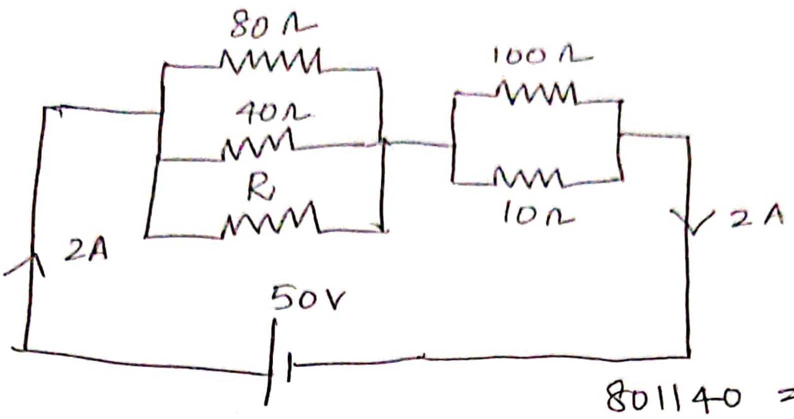
$$V_{2\Omega} = i_{2\Omega} \times 2$$

$$\begin{pmatrix} 10 & -8 & 0 \\ -8 & 10 & -2 \\ 0 & -2 & 7 \end{pmatrix} \begin{pmatrix} i_1 \\ i_2 \\ i_3 \end{pmatrix} = \begin{bmatrix} 10 \\ 0 \\ 0 \end{bmatrix}$$

$$i_{2\Omega} = i_2 \sim i_3$$

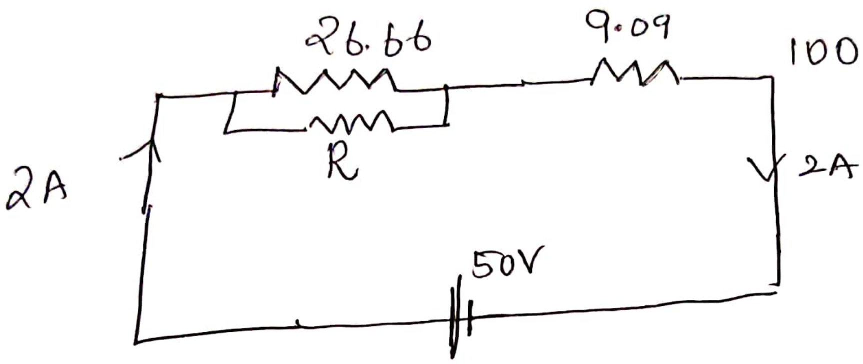
$$i_2 = \frac{\Delta_2}{\Delta} \qquad i_3 = \frac{\Delta_3}{\Delta}$$

3. Design the value of R.

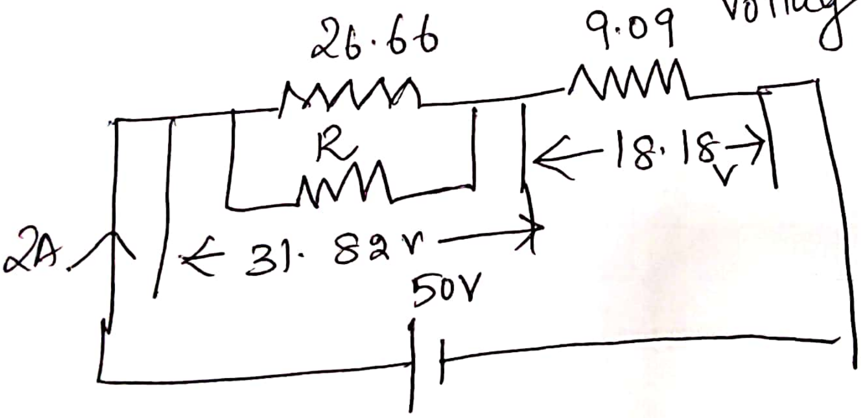


$80 \parallel 40 = \frac{80 \times 40}{80+40} = 26.66$

$100 \parallel 10 = \frac{100 \times 10}{100+10} = 9.09$



Voltage across 9.09



$V = IR$

$= 2 \times 9.09$

18.18

$50 - 18.18$

$= 31.82$

$I_{26.66} = \frac{V}{R} = \frac{31.82}{26.66} = 1.19$

$I_R = 2 - 1.19$

$= 0.81$

$R = \frac{V}{I} = \frac{31.82}{0.81} = 39.28$

$\boxed{R = 39.28}$

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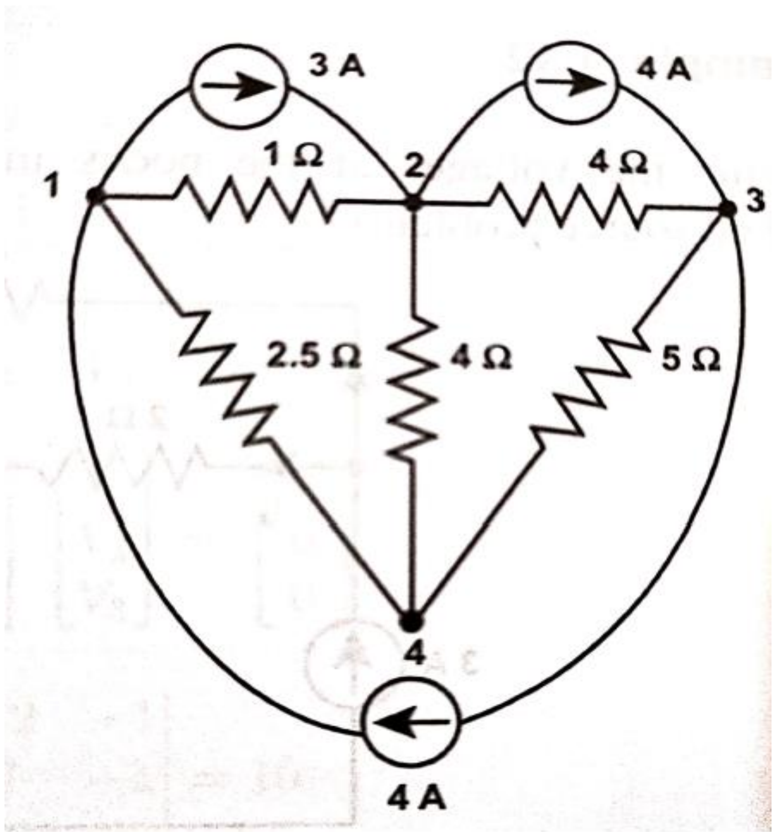
5. For the given electrical circuit, estimate the voltage across 4 Ω resistances and 2.5 Ω resistance.



If the circuit contains 3 major nodes then matrix will be 3X3 matrix

$$\begin{bmatrix} G_{11} & G_{12} & G_{13} \\ G_{21} & G_{22} & G_{23} \\ G_{31} & G_{32} & G_{23} \end{bmatrix} \begin{bmatrix} V_1 \\ V_2 \\ V_3 \end{bmatrix} = \begin{bmatrix} I_1 \\ I_2 \\ I_3 \end{bmatrix}$$

$I_1 \longrightarrow$ Sum of the currents flowing towards node no. 1

$I_2 \longrightarrow$ Sum of the currents flowing towards node no. 2

$I_3 \longrightarrow$ Sum of the currents flowing towards node no.3

$$G_{11} = \frac{1}{1} + \frac{1}{2.5} = 1.4$$

$$G_{22} = \frac{1}{4} + \frac{1}{1} + \frac{1}{4} = 1.5$$

$$G_{33} = \frac{1}{4} + \frac{1}{5} = 0.45$$

$$G_{13} = G_{31} = 0$$

$$G_{12} = G_{21} = \frac{1}{1} = 1 = -1$$

$$G_{32} = G_{23} = \frac{1}{4} = 0.25 = -0.25$$

$$I_1 = 4 - 3 = 1$$

$$I_2 = 3 - 4 = -1$$

$$I_3 = 4 - 4 = 0$$

$$\begin{bmatrix} 1.4 & -1 & 0 \\ -1 & 1.5 & -0.25 \\ 0 & -0.25 & 0.45 \end{bmatrix} \begin{bmatrix} V_1 \\ V_2 \\ V_3 \end{bmatrix} = \begin{bmatrix} 1 \\ -1 \\ 0 \end{bmatrix}$$

$$\Delta_2 = \begin{bmatrix} 1.4 & 1 & 0 \\ -1 & -1 & -0.25 \\ 0 & 0 & 0.45 \end{bmatrix} = -0.28$$

$$\Delta = \begin{bmatrix} 1.4 & -1 & 0 \\ -1 & 1.5 & -0.25 \\ 0 & -0.25 & 0.45 \end{bmatrix} = 0.665$$

$$V_2 = \frac{\Delta_2}{\Delta} = \frac{-0.28}{0.665} - 0.421 Volts$$

$$V_{4\Omega} = V_2 - V_4 = -0.421 - 0 = -0.421 Volts$$

$V_{2.5ohm}$=V_1-V_4

V_1=0.1625/0.665=0.244Volts

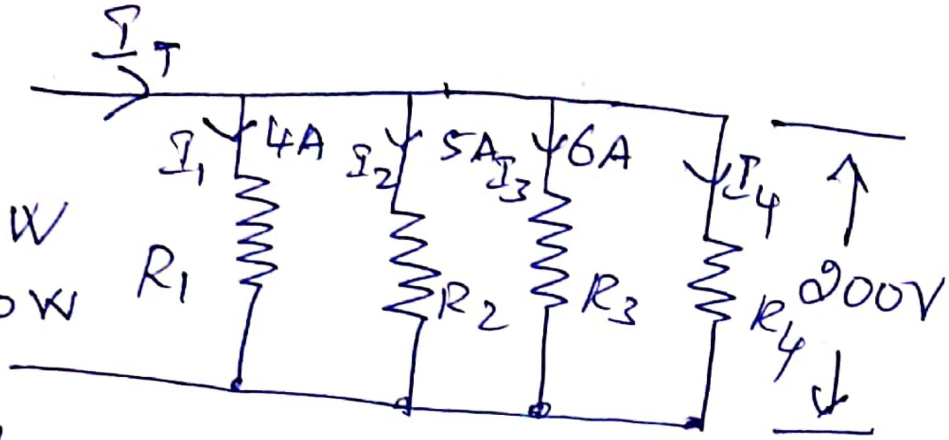
$V_{2.5ohm}$=V_1-V_4=0.244-0=0.244Volts

Ans; $V_{2.5ohm}$=0.244 Volts

V_{4ohm}=-0.412 Volts

6. Solution:

$P = 5kW$
$= 5000 W$



Voltage across (since $V_{R_4} = 200V$)

$V_{R_1} = 200V$ ∴ ∥el resistor has same voltage

$V_{R_2} = 200V$

$V_{R_3} = 200V$ $\boxed{V_T = 200V}$

$P_T = V_T \times I_T = 200 \times I_T$

$I_T = P/V = \frac{5000}{200} = 25A$

$R_1 = \frac{V_{R_1}}{4A} = \frac{200}{4}$; $R_2 = \frac{V_{R2}}{5A} = \frac{200}{5}$; $R_3 = \frac{V_{R3}}{6A} = \frac{200}{6}$

$\boxed{R_1 = 50\Omega}$ $\boxed{R2 = 40\Omega}$ $\boxed{R3 = 33.33\Omega}$

$I_4 = I_T - (I_1 + I_2 + I_3)$
$= 25 - (4+5+6)$
$\boxed{I_4 = 10A}$

$R_T = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \frac{1}{R_4}$
$= 1/50 + 1/40 + \frac{1}{33.33} + \frac{1}{20}$

$R_4 = \frac{200}{I_4} = \frac{200}{10} = 20\Omega$

$\boxed{R_T = 0.125\Omega}$

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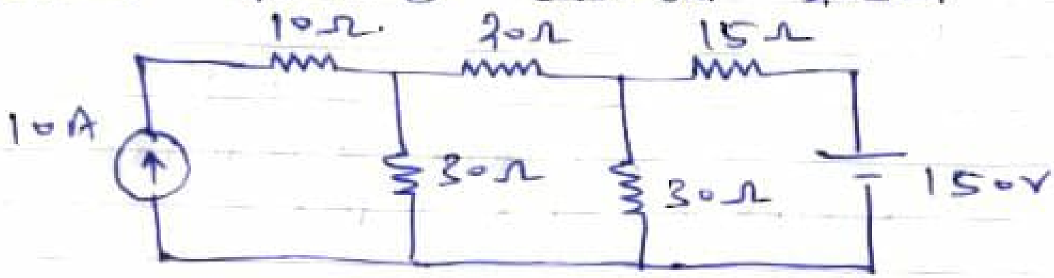
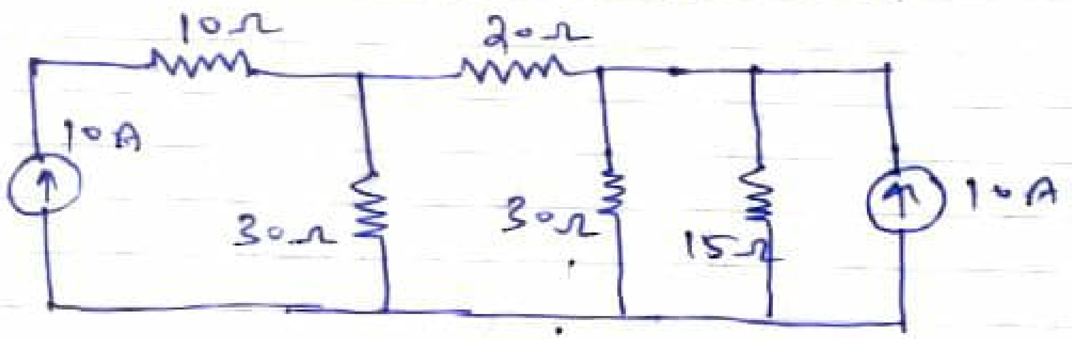
7. Evaluate the node voltages in the given circuit using Nodal analysis. Also find the current flowing through 20Ω.

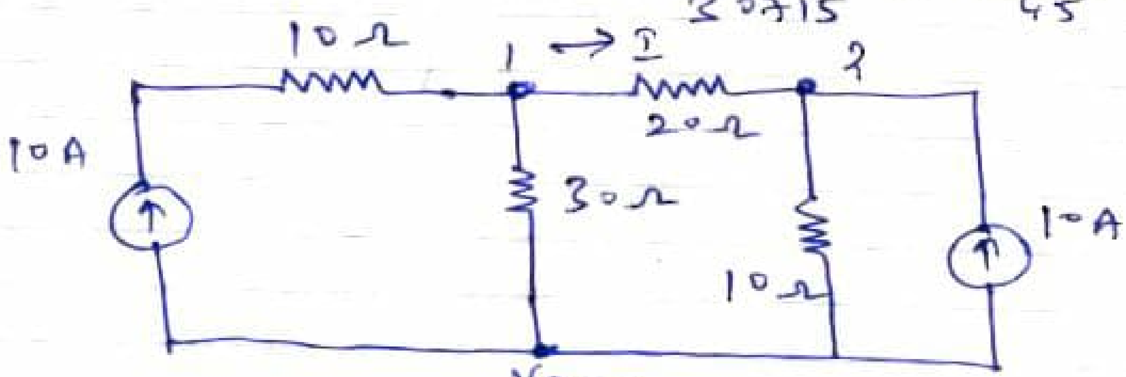




$$I = \frac{V}{R} = \frac{150}{15} = 10A$$

30Ω ∥ 15Ω

$$\frac{30 \times 15}{30 + 15} = \frac{450}{45} = 10\Omega$$



$V_R = 0$

$$\begin{bmatrix} \frac{1}{10} + \frac{1}{30} + \frac{1}{20} & -\frac{1}{20} \\ -\frac{1}{20} & \frac{1}{20} + \frac{1}{10} \end{bmatrix} \begin{bmatrix} V_1 \\ V_2 \end{bmatrix} = \begin{bmatrix} 10 \\ 10 \end{bmatrix}$$

$$\begin{bmatrix} 0.183 & -0.05 \\ -0.05 & 0.15 \end{bmatrix} \begin{bmatrix} V_1 \\ V_2 \end{bmatrix} = \begin{bmatrix} 10 \\ 10 \end{bmatrix}$$

$$\Delta = (0.183 \times 0.15) - (0.05 \times 0.05) = 0.027 - 0.0025$$
$$= 0.0245$$

$$\Delta_1 = \begin{bmatrix} 10 & -0.05 \\ 10 & 0.15 \end{bmatrix} = 10(0.15) + 10(0.05)$$
$$= 1.5 + 0.5$$
$$= 2$$

$$\Delta_2 = \begin{bmatrix} 0.183 & 10 \\ -0.05 & 10 \end{bmatrix} = 0.183(10) + 10(0.05)$$
$$= 1.83 + 0.5$$
$$= 2.33$$

$$V_1 = \frac{\Delta_1}{\Delta} = \frac{2}{0.0245} = 81.63\,V$$

$$V_2 = \frac{\Delta_2}{\Delta} = \frac{2.33}{0.0245} = 95.10\,V$$

$$I_{20\Omega} = \frac{V_1 - V_2}{20} = \frac{81.63 - 95.10}{20}$$

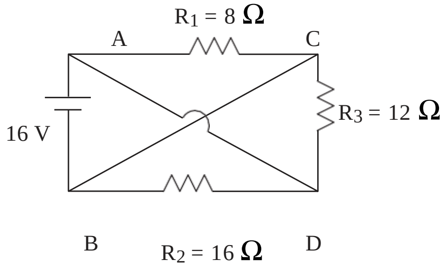
$$= \frac{-13.47}{20} = -0.6735\,A.$$ (Anticlockwise Direction)

Node voltages

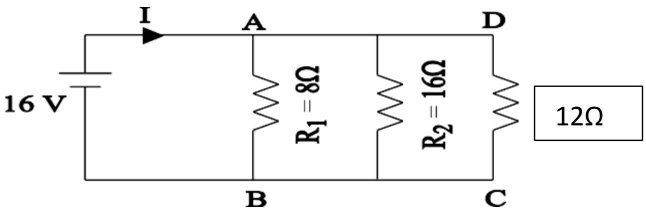
$V_1 = 81.63V$
$V_2 = 95.10V$

Current flow through the $20\,\Omega$ Resistor is $0.6735A$.

8.Calculate the total resistance and battery current in the given circuit



The given above circuit can be re-drawn as,



8 Ω, 16 Ω, 12 Ω are connected in parallel. Its equivalent resistance,

$$R_T = \frac{R_1 R_2 R_3}{R_1R_2 + R_2R_3 + R_3R_1}$$

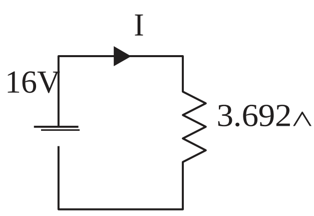


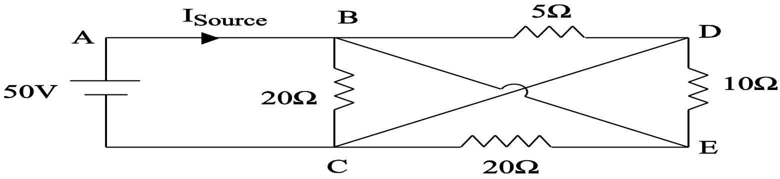
Figure 1.28

$$R_T = \frac{8*6*12}{128+192+96} = 3.692\ \Omega$$

$$R_T = 3.692\ \Omega$$

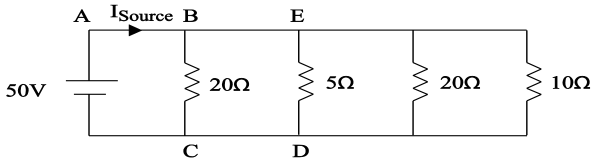
$$I = \frac{V}{R} = \frac{16}{3.692} = 4.33A$$

9. Calculate the equivalent resistance offered by the circuit to the voltage source and also find its source current



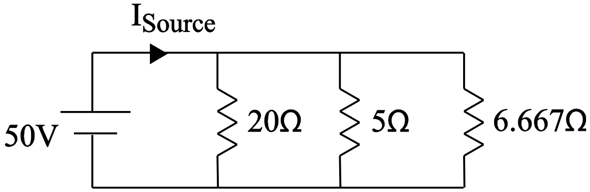
A

Solution: The given above circuit can be re-drawn as



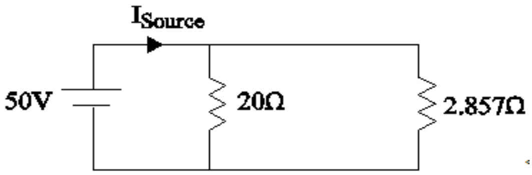
20 Ω and 10 Ω resistors are connected in parallel, its equivalent resistance is given by, $\frac{20 * 10}{20 + 10} = 6.667\ \Omega$

The given circuit is reduced as,



6.667 Ω and 5 Ω resistors are connected in parallel, its equivalent resistance is given by, $\frac{6.667 * 5}{6.667 + 5} = 2.857\ \Omega$

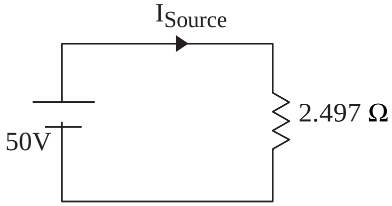
The circuit is reduced as,



20 Ω and 2.857 Ω are connected in parallel. It equivalent resistance is,

$\frac{20 * 2.857}{20 + 2.857} = 2.497\ \Omega$

The Circuit is re-drawn as,

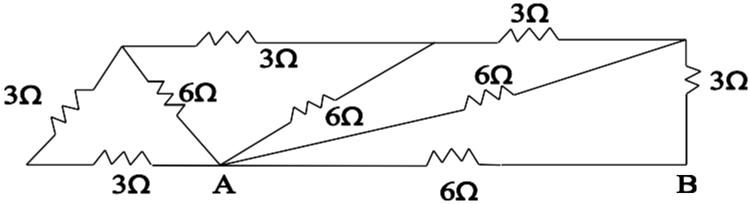


Hence the equivalent resistance of the Circuit is R_T= 2.497 Ω = 2.5 Ω

Source Current of the Circuit is given by,

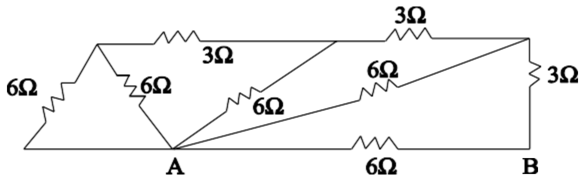
$$I_{source} = \frac{V}{R} = \frac{50}{2.5} = 20A$$

10. Find the equivalent resistance between the terminals A and B.



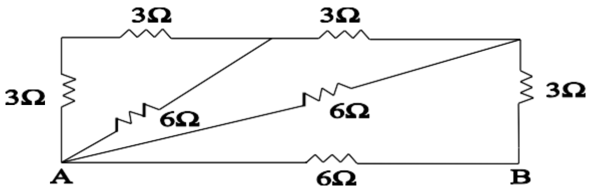
Solution:

3 Ω and 3 Ω are connected in Series, it equivalent resistance is, (3 + 3) = 6 Ω. The Circuit gets reduced as



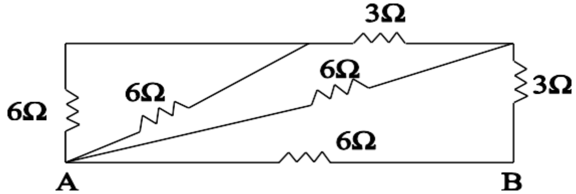
6 Ω and 6 Ω are connected in parallel. The circuit gets reduced as,

$$\frac{6*6}{6+6} = 3\text{ohms.}$$



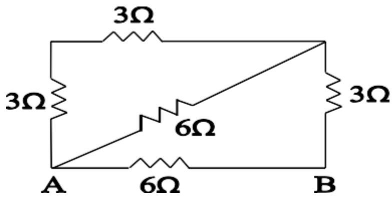
3 Ω and 3 Ω are connected in series (3 + 3 = 6 Ω).

The reduced Circuit is,

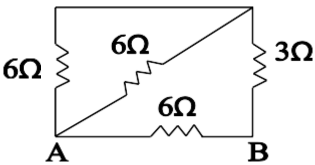


6 Ω and 6 Ω are connected in parallel. Its equivalent resistance, $\frac{6*6}{6+6} = 3\ \Omega$

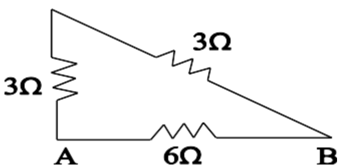
The circuit can be reduced as,

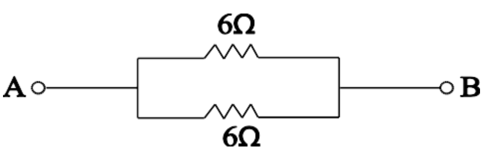


3 Ω and 3 Ω are connected in series. (3 + 3 = 6 Ω).



6 Ω and 6 Ω are connected in parallel. It equivalent resistance, $\frac{6*6}{6+6} = 3\ \Omega$



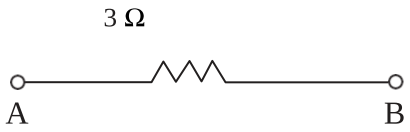


3 Ω and 3 Ω are connected in series, the reduced Circuit is 3 + 3 = 6 Ω

6 Ω and 6 Ω are connected in parallel.

The equivalent resistance between the terminals A and B

given by $R_{AB} = 3\ \Omega$.



$$\therefore\ R_{AB} = 3\ \Omega$$