ASSIGNMENT - I

B-EEE

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CLASS :- CSE - B

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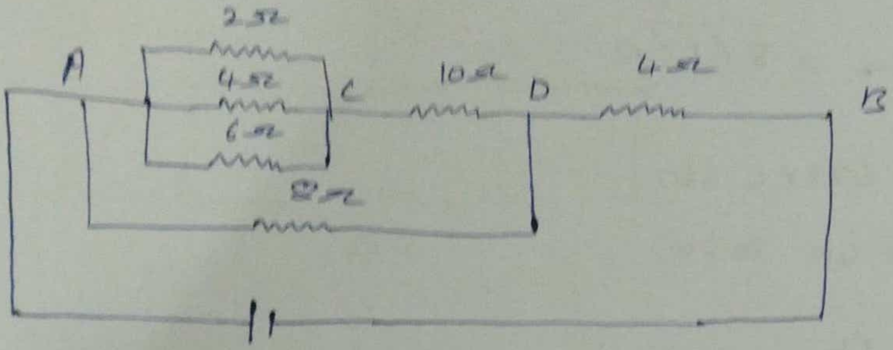
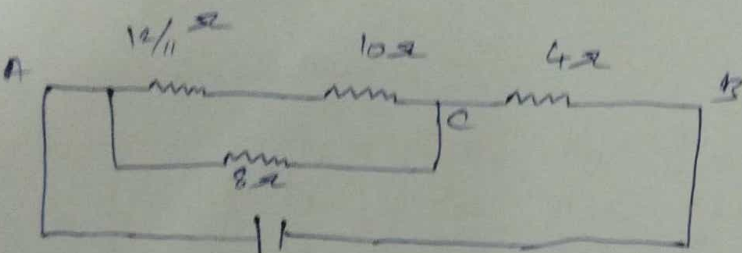
1) In the figure shown a combination resistance, If the voltage across A & B is 75 volts. Determine.

(i) The equivalent resistance of the circuit

(ii) voltage drop across each resistance

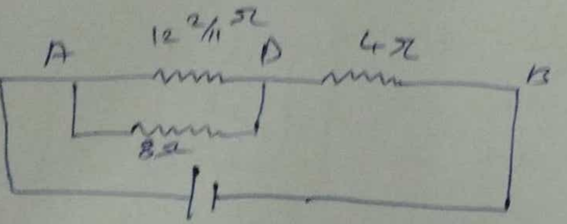


Sol:



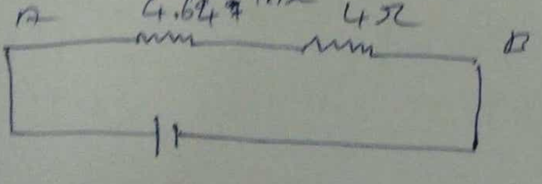
$$\frac{1}{R} = \frac{1}{2} + \frac{1}{4} + \frac{1}{6}$$

$$= \frac{11}{12}$$



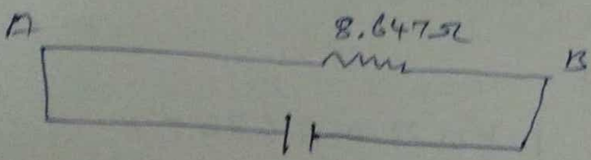
$$R = \frac{12}{11} + 10$$

$$R = \frac{122}{11}$$



$$\frac{1}{R} = \frac{11}{122} + \frac{1}{8}$$

$$\frac{1}{R} = \frac{210}{976}$$



∴ The Equivalent resistance across the circuit is 8.647 Ω

(ii) $V = 75V$

$R = 8.647\Omega$

$I = V/R = \frac{75}{8.647} = 8.673A$

$\therefore I_{8.647\Omega} = 8.673A$

$I_{4.647\Omega} = I_{4\Omega} = 8.613A$

$V_{4.647\Omega} = 8.673 \times 4.647$

$\therefore V_{4.647\Omega} = 40.303V$

$V_{4\Omega} = 8.673 \times 4$

$V_{4\Omega} = 34.692V$

$I_{122/11\Omega} = \frac{8.673 \times 8}{8 + \frac{122}{11}}$

$\therefore I_{122/11\Omega} = 3.634A$

$V_{\frac{122}{11}\Omega} = 3.634 \times \frac{122}{11}$

$= 40.304V$

$I_{8\Omega} = \frac{8.673 \times \frac{122}{11} \times 11}{88 + 122}$

$\therefore I_{8\Omega} = 5.038A$

$V_{8\Omega} = 5.038 \times 8 \Rightarrow 40.304V$

$I_{12/11\Omega} = I_{10\Omega} = 3.634A$

$V_{12/11\Omega} = 3.634 \times 12/11$ | $V_{10\Omega} = 3.634 \times 10$

$V_{12/11\Omega} = 3.964V$ | $V_{10\Omega} = 36.34V$

$I_{2\Omega} = \frac{4}{2+4+\frac{2\times 4}{6}} \times 3.634$

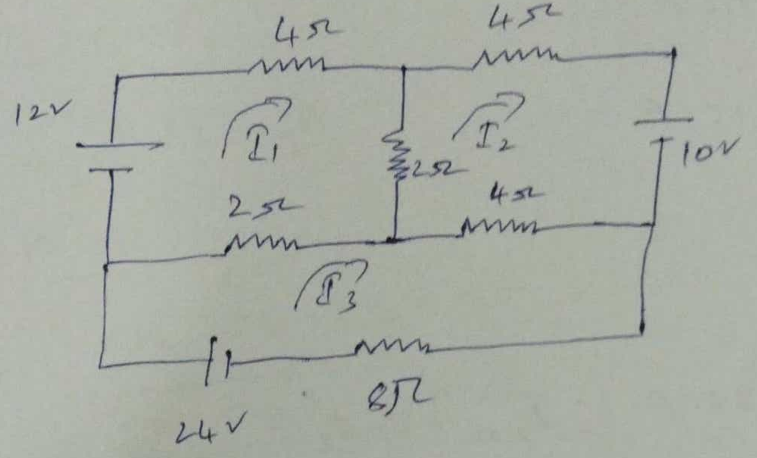
$\therefore I_{2\Omega} = 1.982A$

$\therefore V_{2\Omega} = 1.982 \times 2$

$V_{2\Omega} = 3.964V$

$\therefore V_{2\Omega} = V_{4\Omega} = V_{6\Omega} = 3.964V$ ($\because$ Parallel)

1. Determine the current in each resistors in the circuit shown in figure.



Sol:

$V = IR$

By Inspection method:

$$\begin{bmatrix} V_1 \\ V_2 \\ V_3 \end{bmatrix} = \begin{bmatrix} I_1 \\ I_2 \\ I_3 \end{bmatrix} \begin{bmatrix} R_{11} & R_{12} & R_{13} \\ R_{21} & R_{22} & R_{23} \\ R_{31} & R_{32} & R_{33} \end{bmatrix}$$

$$\begin{bmatrix} 12 \\ -10 \\ 24 \end{bmatrix} = \begin{bmatrix} I_1 \\ I_2 \\ I_3 \end{bmatrix} \begin{bmatrix} 30 & -24 & -2 \\ -24 & 32 & -4 \\ -2 & -4 & 14 \end{bmatrix}$$

$\Delta = 4,384$

$$\Delta_1 = \begin{vmatrix} 12 & -24 & -2 \\ -10 & 32 & -4 \\ 24 & -4 & 14 \end{vmatrix} = 12(32.14 - 16) + 24(-140 + 24.4) + (2)(40 - 24.32)$$
$$= 5584$$

$$\Delta_2 = \begin{vmatrix} 30 & 12 & -2 \\ -24 & -10 & -4 \\ -2 & 24 & 14 \end{vmatrix} = 30(-140 + 4.24) - 12(-24.14 - 8) - 2(-24.24 - 10.2)$$
$$= 4000$$

$$\Delta_3 = \begin{vmatrix} 30 & -24 & 12 \\ -24 & 32 & -10 \\ -2 & -4 & 24 \end{vmatrix} = 30(32.24 - 40) + 24(-24.24 - 10.2) + 12(24.4 + 2.32)$$
$$= 9456$$

$$I_1 = \frac{\Delta_1}{\Delta} = \frac{5584}{4384} = 1.273A$$

$$I_2 = \frac{\Delta_2}{\Delta} = \frac{4000}{4384} = 0.912A$$

$$I_3 = \frac{\Delta_3}{\Delta} = \frac{9456}{4384} = 2.156A$$

loop 1

$I_{4\Omega} = 1.273A$

$I_{24\Omega} = I_1 - I_2 = 0.361A$; $I_{2\Omega} = I_1 - I_2 = -0.883A$

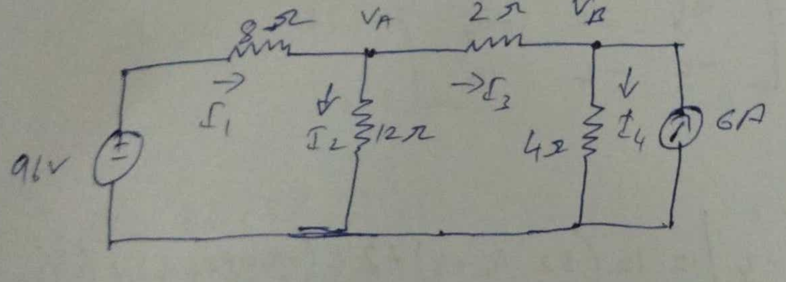
loop 2:

$I_{4\Omega} = 0.912A$; $I_{4\Omega} = -1.244$

loop 3:

$I_{8\Omega} = 2.156A$

3). Find voltage across 5Ω Resistor using Nodal analysis



Sol: At Node A: By KCL

$$I_1 = I_2 + I_3$$

$$\frac{96 - V_A}{8} = \frac{V_A}{12} + \frac{V_A - V_B}{2}$$

$$(\times 2)\quad \frac{96 - V_A}{4} = \frac{V_A}{6} + V_A - V_B$$

$$\frac{96 - V_A}{4_2} = \frac{V_A + 6V_A - 6V_B}{6_3}$$

$$288 - 3V_A = 14V_A - 12V_B$$

$$\boxed{17V_A - 12V_B = 288} \quad \text{— ①}$$

At node B:

By KCL

$I_3 + 6 = I_4$

$$\frac{V_A - V_B}{2} + 6 = \frac{V_B}{5}$$

$$\frac{V_A - V_B}{2} - \frac{V_B}{5} = -6$$

$$5V_A - 5V_B - 2V_B = -60$$

$$\boxed{5V_A - 7V_B = -60} \text{ --- (2).}$$

By (1) & (2).

$$\begin{bmatrix} 17 & -12 \\ 5 & -7 \end{bmatrix} \begin{bmatrix} V_A \\ V_B \end{bmatrix} = \begin{bmatrix} 288 \\ -60 \end{bmatrix}$$

$\Delta = 17(-7) - 5(-12)$

$\therefore \Delta = -59$

$$\Delta_1 = \begin{vmatrix} 288 & -12 \\ -60 & -7 \end{vmatrix} = -2736$$

$$\Delta_2 = \begin{vmatrix} 17 & 288 \\ 5 & -60 \end{vmatrix} = 17(-60) - 5(288)$$

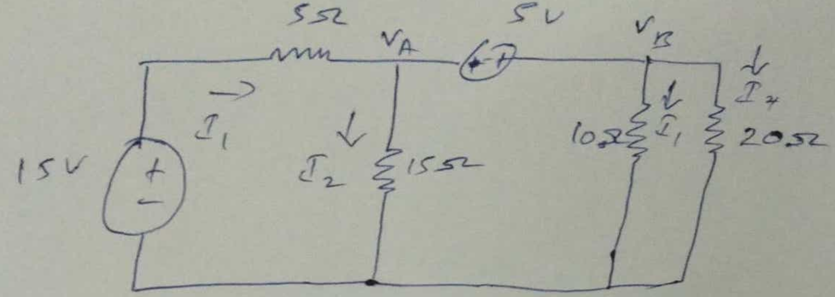
$$= -2460$$

$$\therefore V_A = \frac{\Delta_1}{\Delta} = \frac{-2736}{-59} = 46.372V$$

$$V_B = \frac{\Delta_2}{\Delta} = \frac{-2460}{-59} = 41.694V$$

$\therefore$ V across 5Ω resistor $= 41.694V$

4). Using Nodal analysis find voltage across 20Ω resistor in figure



Sol: From diagram using super nodal analysis, we get

$$\boxed{V_A - V_B = 5} \quad \text{— (1)}$$

At node A

By KCL

$$I_1 = I_2 + I_3 + I_4$$

$$\frac{15 - V_A}{5} = \frac{V_A}{15} + \frac{V_B}{10} + \frac{V_B}{20}$$

$\Rightarrow [\times 5]$

$$15 - V_A = \frac{V_A}{3} + \frac{V_B}{2} + \frac{V_B}{4}$$

$$15 - V_A = \frac{4V_A + 6V_B + 3V_B}{12}$$

$$180 - 12V_A = 4V_A + 9V_B$$

$$\boxed{16V_A + 9V_B = 180} \quad \text{— (2)}$$

from (1) & (2)

$$\begin{bmatrix} 1 & -1 \\ 16 & 9 \end{bmatrix} \begin{bmatrix} V_A \\ V_B \end{bmatrix} = \begin{bmatrix} 5 \\ 180 \end{bmatrix}$$

$$\Delta = 9 + 16 = 25$$

$$\Delta_1 = \begin{vmatrix} 5 & -1 \\ 180 & 9 \end{vmatrix} = 45 + 180 = 225$$

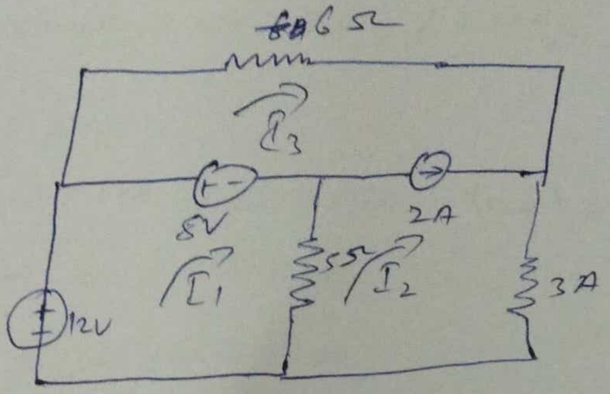
$$\Delta_2 = \begin{vmatrix} 1 & 5 \\ 16 & 180 \end{vmatrix} = 180 - 80 = 100$$

$$V_A = \frac{\Delta_1}{\Delta} = 9V$$

$$V_B = \frac{\Delta_2}{\Delta} = 4V$$

$\therefore$ V across 20Ω is 4V

Determine the voltage across 3 Ω resistor using mesh analysis for the circuit shown in fig.



Sol: From the diagram, applying super mesh analysis, we get

$$\boxed{I_2 - I_3 = 2A} \quad \text{— (1).}$$

loop 1:

$$8 + 5(I_1 - I_2) = 12$$

$$\boxed{5I_1 - 5I_2 = 4} \quad \text{— (2)}$$

loop 2:

loop 2 & loop 3 as single loop ∴ supesh Mesh

$$6I_3 + 3I_2 + 5(I_2 - I_1) = 8$$

$$6I_3 + 3I_2 + 5I_2 - 5I_1 = 8$$

$$\boxed{-5I_1 + 8I_2 + 6I_3 = 8} \quad \text{— (3).}$$

Solving (1) (2) and (3) get.

$$\begin{bmatrix} 0 & 1 & -1 \\ 5 & -5 & 0 \\ -5 & 8 & 6 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \\ I_3 \end{bmatrix} = \begin{bmatrix} 2 \\ 4 \\ 8 \end{bmatrix}$$

$$\Delta = 0 - 1(30 - 0) - 1(40 - 25)$$

$$= -30 - 15$$

$$\Delta = -45$$

$$\Delta_1 = \begin{bmatrix} 2 & 1 & -1 \\ 4 & -5 & 0 \\ 8 & 8 & 6 \end{bmatrix}$$

$$= 2(-30) - 1(24) - 1(32+40)$$

$$\therefore \Delta_1 = -156$$

$$\Delta_2 = \begin{vmatrix} 0 & 2 & -1 \\ 5 & 4 & 0 \\ -5 & 8 & 6 \end{vmatrix} \Rightarrow 0 - 2(30) - 1(40+20)$$

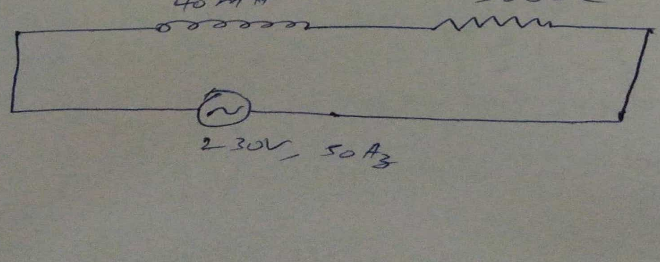
$$\Delta_2 = -120$$

$$I_2 = \frac{\Delta_2}{\Delta} = \frac{-120}{-45}$$

$$I_2 = 2.667\,A$$

$\therefore$ V across 3Ω $= 2.667 \times 3$
$= 8V$

6). A 500Ω resistor and a 40mH inductor are connected in series across 230V, 50 Hz supply. Find circuit impedance, admittance, current, voltage across resistance, voltage across inductor, apparent power, Active power power factor



$L = 40 mH$

$L = 40 \times 10^{-3} H$;

$R = 500 \Omega$; $V = 230V$; $f = 50 Hz$

$X_L = L\omega$

$= 40 \times 10^{-3} \times 2 \times \pi \times 50$

$= 40 \times 10^{-3} \times 314$

$\therefore X_L = 12.56 \Omega$

(i) Impedance, $Z = \sqrt{R^2 + X_L^2}$

$= \sqrt{(500)^2 + (12.56)^2}$

$Z = 500.157 \Omega$

(ii) Admittance $= 1/Z$

$Y = 1.99 \times 10^{-3} \Omega^{-1}$

(iii) $I_{rms} = \frac{V_{Rms}}{Z}$

$= \frac{230}{500.157}$

$\therefore I_{rms} = 0.459 A$

(iv) V across R $= 0.459 \times 500$

$= 227.5 V$

(v) V across L $= 0.459 \times 12.56$

$= 5.765 V$

(vi) Apparent power $= VI$

$= 230 \times 0.459$

$= 105.57$ VA

vii) Active power $= VI \cos\phi$

$= VI(R/Z)$

$= 105.57 \times (500/500.157)$

$= 105.536 W$

viii) Power Factor $= R/Z$

$(\because \cos\phi = R/Z)$

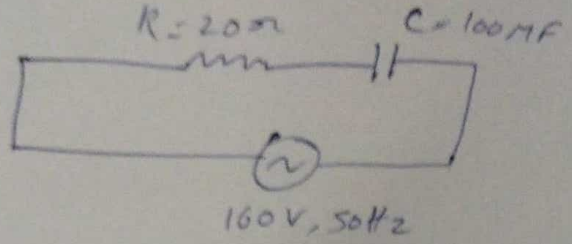
$= 500/500.157$

$= 0.999$

No unit

A series RC circuit with $R = 20\Omega$ and $C = 10\,MF$, 160 V, 50 Hz supply connected to it. Find (i) Impedance (ii) current (iii) Power factor (iv) Power. Draw phase Diagram.

Sol.



$R = 20\Omega$, $C = 100\,MF$; $V = 160V$, $f = 50\,Hz$

$= 100 \times 10^{-6}\,F$

$\boxed{C = 10^{-4}\,F}$

$X_c = \frac{1}{C\omega} = \frac{1}{10^{-4} \times 2 \times \pi \times 50}$

$= \frac{1}{314 \times 10^{-4}}$

$\therefore X_c = 31.847\Omega$

(i) Impedance, $Z = \sqrt{R^2 + X_c^2} = \sqrt{(20)^2 + (31.847)^2}$

$Z = 37.606\Omega$

(ii) Current, $I = \frac{V}{Z} = \frac{160}{37.606}$

$I = 4.254\,A$

(iii) Power Factor, $\cos\phi = R/Z$

$= 20/37.606$

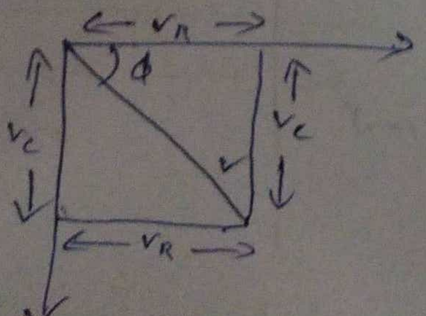
$= 0.531$

(iv) Power $= VI\cos\phi$

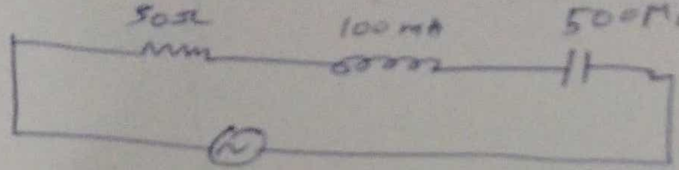
$= 160 \times 4.254 \times 0.531$

$= 361.419\,W$

v) Phase diagram.



In a Series RLC circuit $R = 50\Omega$, $L = 100mH$ and $C = 500\mu F$ given that the supply voltage is 230V, 50Hz. Find equivalent impedance, (ii) Power factor, (iii) Current, (iv) Power and Reactive power.



Sol:

$R = 50\Omega$,

$L = 100mH$

$= 100\times10^{-3}$

$\therefore L = 10^{-1}H$,

$C = 500\mu F$

$C = 5\times10^{-4}F$,

$V = 230V$,

$f = 50Hz$

$X_L = L\omega$

$= 10^{-1}\times2\pi f$

$= 31.4\Omega$

$X_C = \frac{1}{C\omega}$

$= \frac{1}{5\times10^{-4}\times314}$

$X_C = 6.367\Omega$

(i) $Z = \sqrt{R^2+(X_L-X_C)^2}$

$= \sqrt{(50)^2+(31.4-6.367)^2}$

$Z = 55.915\Omega$

(ii) Power factor $= R/Z$

$= 0.894$

(iii) $I = \frac{V}{Z} \Rightarrow \frac{230}{55.915} \Rightarrow 4.113A$

(iv) Power $= VI\cos\phi$

$= VI(R/Z)$

$= 230\times4.113\times0.894$

$= 845.715W$

v) Reactive power $= VI\sin\phi$

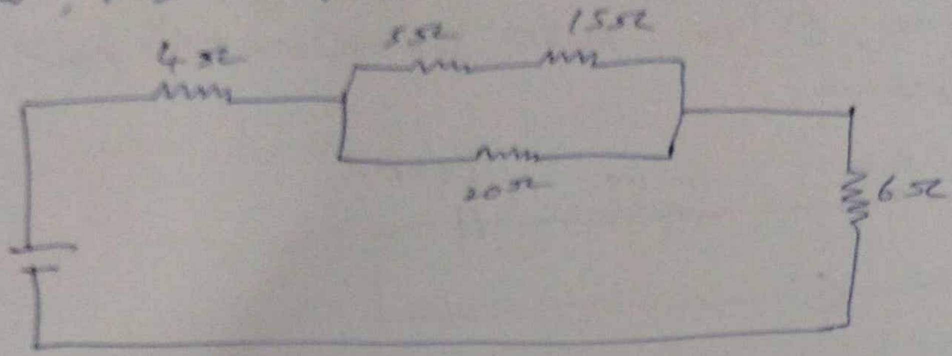
$= 230\times4.113\times\sin(26.619)$

$= 422.856$ kW

$\phi = \cos^{-1}R/Z$

$= 26.619$

9) A circuit shown, the power consumed by 6Ω resistor is 150W, Find the supply voltage.



Sol

$P_{6\Omega} = 150W$

$I^2R = 150$

$I_6^2 \Omega = \frac{150}{6}$

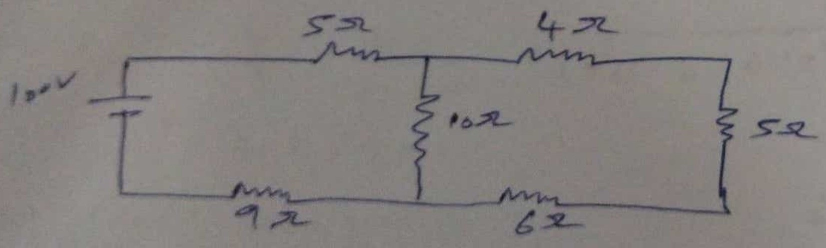
$\boxed{\therefore I_{6\Omega} = 5A}$

$R_{eq} = 4 + 6 + 10$

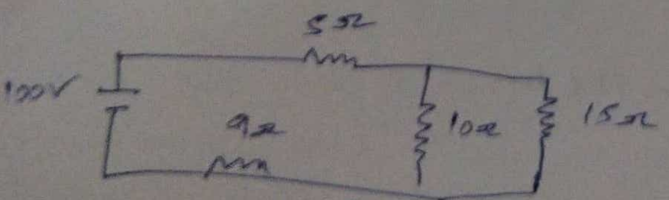
$\therefore R_{eq} = 20\Omega$

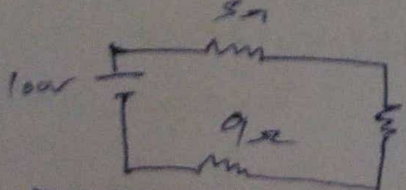
$\therefore$ ~~A~~ Supply voltage $= IR \Rightarrow 5 \times 20 \Rightarrow 100V$

10). For the circuit shown below, calculate equivalent resistance of the circuit and also the total current.



Sol:





$\boxed{\therefore R_{eq} = 20\Omega}$

$V = 100V$

$\therefore$ Total current $= \frac{100}{R} \left(\frac{V}{R}\right)$

$= \frac{100}{20}$

$\boxed{\therefore \text{Total current} = 5A \ (8)}$