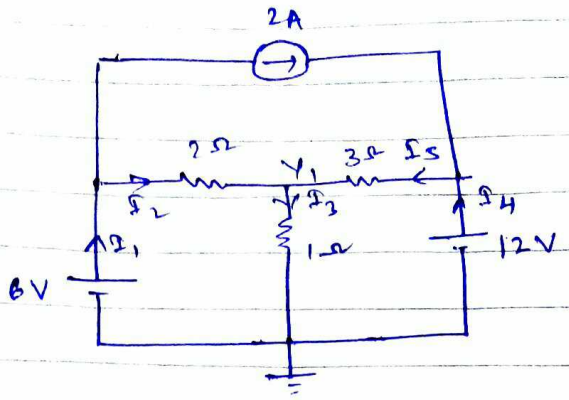
1)



Using Nodal Analysis:

$$I_1 = 2 + I_2 \quad -(I)$$

$$\frac{6 - V_1}{2} = I_2 \quad -(II)$$

$$\frac{V_1 - 0}{1} = I_2 \quad -(III)$$

$$I_5 = I_4 + 2 \quad -(IV)$$

~~$I_2 + I_5 = I_3$~~

$$\frac{12 - V_1}{3} \quad -(V)$$

$$I_2 + I_5 = I_3 \quad -(VI)$$

From (II), (IV), (V), (VI)

$$\left(\frac{6 - V_1}{2}\right) + \left(\frac{12 - V_1}{3}\right) = \left(\frac{V_1 - 0}{1}\right)$$

$$\Rightarrow \frac{3 - V_1}{2} + \frac{4 - V_1}{3} = V_1$$

$$\Rightarrow 7 = V_1\left[1 + \frac{1}{2} + \frac{1}{3}\right]$$

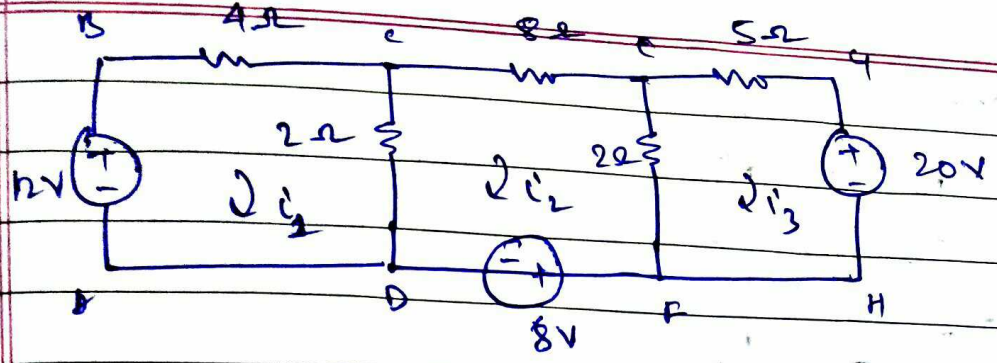
$$\Rightarrow V_1 = \frac{6 \times 7}{11} = 3.81\ V \quad -(VII)$$

$$I_2 = \frac{6 - 3.81}{2} = 1.09\ A$$

$$I_3 = \frac{V_1 - 0}{1} = 3.81\ A$$

$$I_5 = \frac{12 - V_1}{3} = 2.72\ A$$

2)



In ABCD

$$12 - 4i_1 - 2(i_1 - i_2) = 0$$

$$\Rightarrow 12 = 6i_1 - 2i_2 \quad \text{---(I)}$$

In DCEF

$$-8 - 2(i_2 - i_1) - 8i_2 - 2(i_2 - i_3) = 0$$

$$\Rightarrow -8 - 12i_2 + 2i_1 + 2i_3 = 0$$

$$\Rightarrow -12i_2 + 2i_1 + 2i_3 = 8 \quad \text{---(II)}$$

In FEGH

$$-20 - 2(i_3 - i_2) - 5i_3 = 0$$

$$-20 - 7i_3 + 2i_2 = 0$$

$$2i_2 - 7i_3 = 20 \quad \text{---(III)}$$

$i_1 = 1.71A$

i_2.

Solving (I), (II) & (III).

$$i_1 = 1.7\,A$$

$$i_2 = -0.9\,A$$

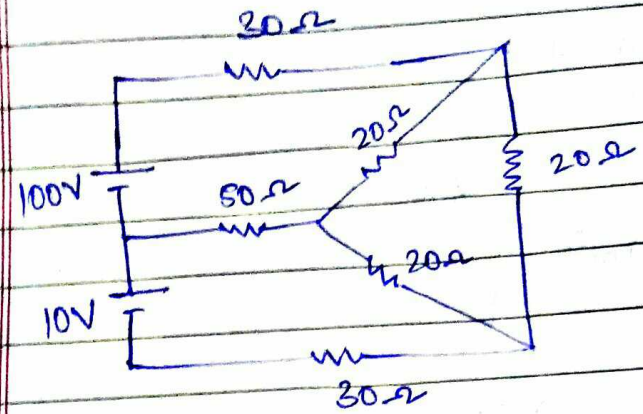
$$i_3 = -3.11\,A$$

$$P_{8\Omega} = i_2^2 R$$

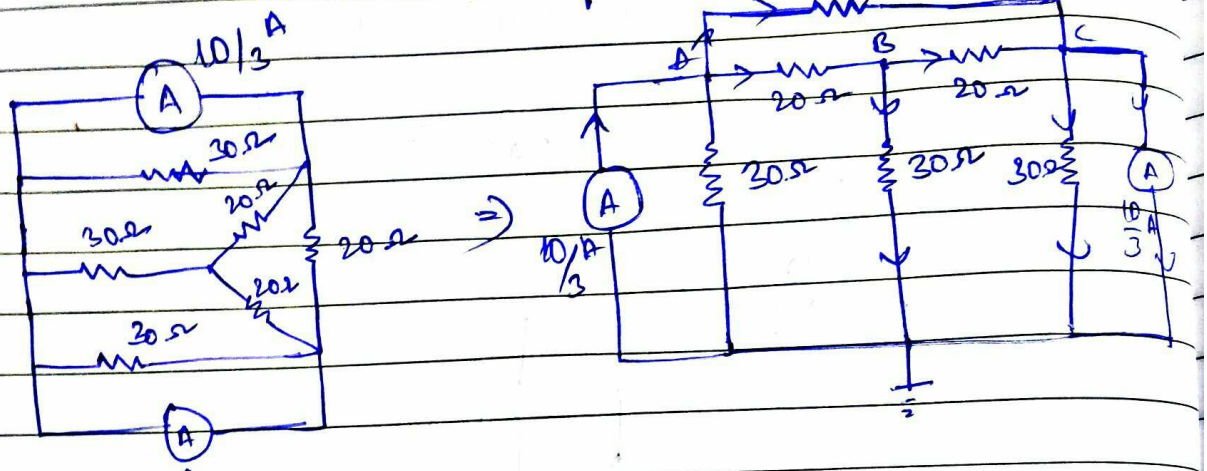
$$= (0.9)^2 \cdot 8$$

$$= 6.48\,W$$

3)



On Source transformation



Using Nodal Analysis

Node A

$$\frac{10}{3} = \frac{V_A}{30} + \frac{V_A - V_B}{20} + \frac{V_A - V_C}{20}$$

$$\Rightarrow \frac{100}{3} = \frac{V_A}{3} + \frac{V_A - V_B + V_A - V_C}{2}$$

$$\Rightarrow \frac{100}{3} = \frac{2V_A + 6V_A - 3V_B - 3V_C}{6 \times 2}$$

$$\Rightarrow 200 = 8V_A - 3V_B - 3V_C$$

$$\boxed{8V_A - 3V_B - 3V_C = 200} \quad \text{(i)}$$

Node B

$$\frac{V_A - V_B}{20} = \frac{V_B - 0}{30} + \frac{V_B - V_C}{20}$$

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

$$\Rightarrow \boxed{3V_A - 8V_B + 3V_C = 0} \quad -(ii)$$

Node C

$$\frac{V_B - V_C}{20} + \frac{V_A - V_C}{20} = \frac{V_C}{30} + \frac{10}{3}$$

$$\Rightarrow \frac{V_B - V_C}{2} + \frac{V_A - V_C}{2} - \frac{V_C}{3} = \frac{100}{3}$$

$$\Rightarrow \frac{3V_B - 3V_C + 3V_A - 3V_C - 2V_C}{6} = \frac{100}{3}$$

$$\Rightarrow \boxed{3V_B + 3V_C - 8V_C = 200} \quad (iii)$$

Using calculator

$V_A = 18.18V$

$V_B = 0V$

$V_C = -18.18V$

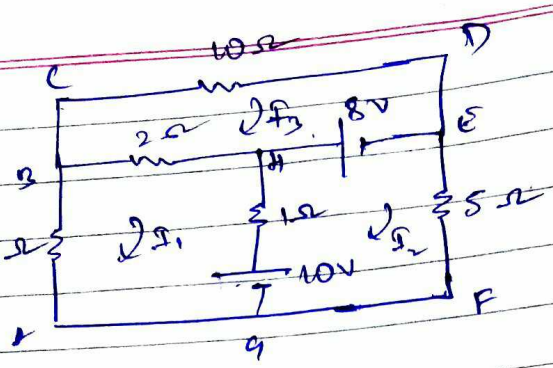
$V_{CD} = V_A - V_C = 18.18 - (-18.18) = 36.36V$

$$I = \frac{V_{CD}}{R} = \frac{36.36}{20} = 1.818A$$

$\boxed{V_{CD} = 36.36V}$

$\boxed{I = 1.818A}$

4)



2n ABHG

$$-4I_1 - 2(I_1 - I_3) - 1(I_1 - I_2) - 10 = 0$$

$$-7I_1 + I_2 + 2I_3 = 10 \quad \text{(I)}$$

2n GHEF

$$10 - 1(I_2 - I_1) - 8 - 5I_2 = 0$$

$$I_1 - 6I_2 = -2 \quad \text{(II)}$$

2n BCDE

$$-10I_3 + 8 - 2(I_3 - I_1) = 0$$

$$2I_1 - 12I_3 = -8 \quad \text{(III)}$$

Solving (I), (II) & (III)

$$I_1 = -1.28\ A$$

$$I_2 = 0.12\ A$$

$$I_3 = 0.45\ A$$

$$I = I_2 - I_1$$

$$= 0.12 + 1.28$$

$$I = 1.4A \quad \text{Ans.}$$

5) $\frac{X_L - X_C}{R} = \tan\phi$

$\omega = 314$ rad/s

$X_C = \frac{1}{\omega C} = 63.7\ \Omega$

$z^2 = R^2 + (X_L - X_C)^2$ —(i)

$\tan 30^\circ = \frac{X_L - X_C}{R}$

$\frac{R}{\sqrt{3}} = X_L - X_C$ —(ii)

Now: $z^2 = R^2 + \frac{R^2}{3}$ from (i) & (ii)

$z^2 = \frac{4R^2}{3}$ (iii)

$z = \frac{V_m}{I_m} = \frac{230}{2} = 115$ —(iv)

From (iii) & (iv)

$(115)^2 = \frac{4R^2}{3}$

$R = 99.59\ \Omega \simeq 99.6\ \Omega$

$X_L = X_C + \frac{R}{\sqrt{3}} = 63.7 + 57.5 = 121.2$

$L = \frac{121.2}{314} = 0.386\ H$

(ii) $V_{coil} = I \cdot X_L$

$= \left(2 \times \frac{\sqrt{3}}{2} + \frac{2}{2}\hat{j}\right) \cdot (0.386\,\hat{j})$

$= 0.386 + 0.669\,\hat{j}$

$= 0.77 \angle 315^\circ$ V

(iii) $V_c = I \cdot X_c$

$= (\sqrt{3} + \hat{j})(-50\mu\,\hat{j})$

$= -50\mu - 50\sqrt{3}\,\mu$

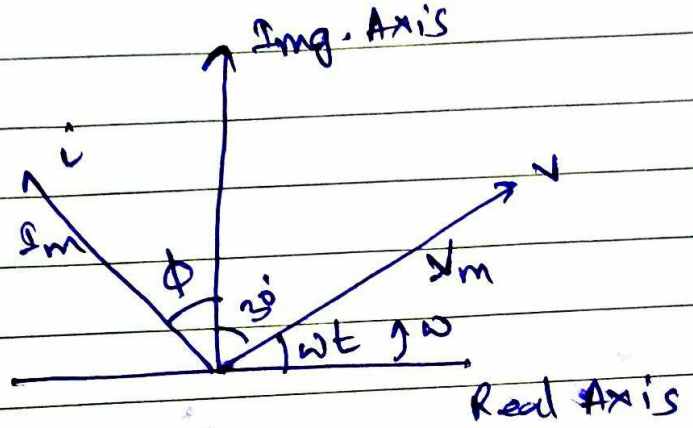
$= 50 \times 4\,\mu \angle -60^\circ$

$= 200 \times 10^{-6} \angle -60^\circ$

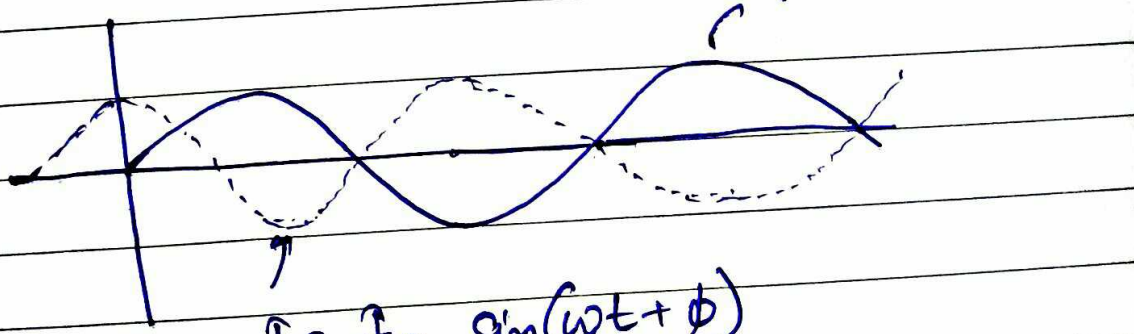
$V_c = 0.2 \times 10^{-3} \angle -60^\circ$ V

(iv) $\phi = 30^\circ$

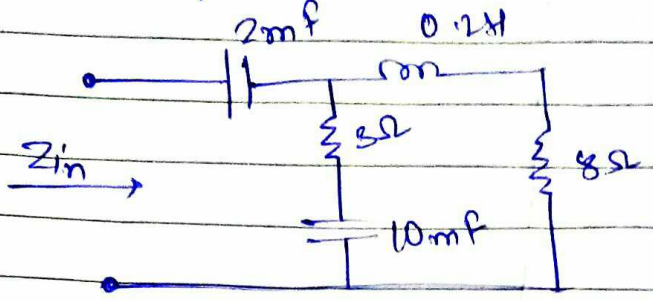
(v) (iv) Phasor



Phase - Difference



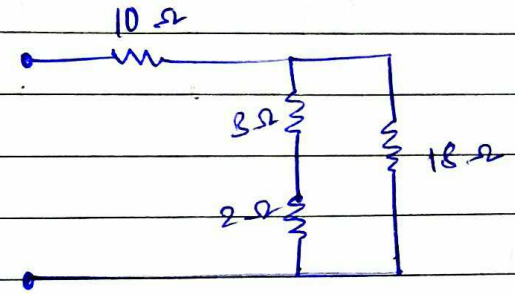
6) $\omega = 50$ rad/sec

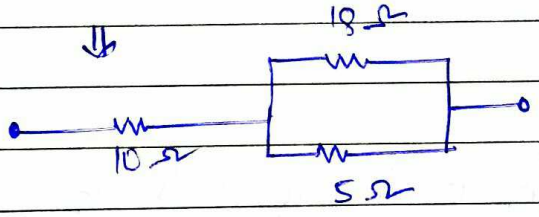


$X_L = \omega L = 50 \times 0.2 = 10\Omega$

$X_{C_1} = \frac{1}{\omega C} = \frac{1}{50 \times 10 \times 10^{-3}} = \frac{1}{100 \times 10^{-2}} = 10\Omega$

$X_{C_2} = \frac{1}{\omega C} = \frac{1}{50 \times \frac{10}{2} \times 10^{-3}} = \frac{10}{5} = 2\Omega$





$R_{eq} = (18 \| 5) + 10$

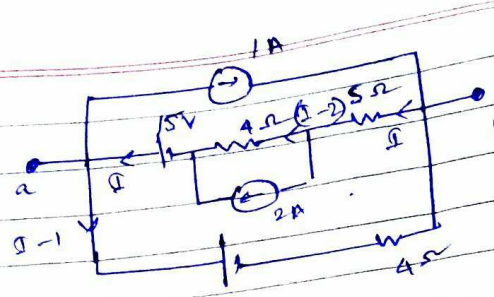
$= \frac{18 \times 5}{23} + 10$

$= \frac{90}{23} + 10$

$= \frac{90 + 230}{23} = \frac{320}{23} = 13.91\Omega$

$\therefore \boxed{Z_{in} = 13.91\Omega}$

7)



KVL, KCL

$$15 - 8 - 4(I-1) - 5I - 4(I-2) = 0$$

$$\Rightarrow 15 - 8 + 4 + 8 - 13I = 0$$

$$\Rightarrow 13I = 19$$

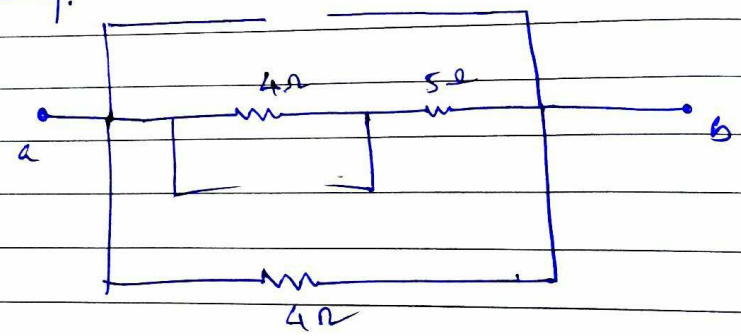
$$\Rightarrow I = \frac{19}{13}$$

$$V_{ab} = -8 - 4\left(\frac{19}{13} - 1\right)$$

$$= -8 - \frac{4 \times 6}{13}$$

$$V_{ab} = -9.85\,V \qquad [V_a - V_b]$$

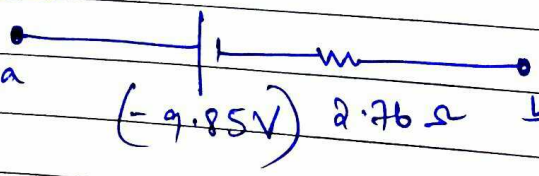
for R.eq.



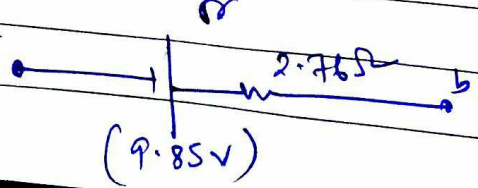
$$R_{ab} = (4+5) \,||\, 4$$

$$= \frac{9 \times 4}{13} = \frac{36}{13} = 2.76\,\Omega$$

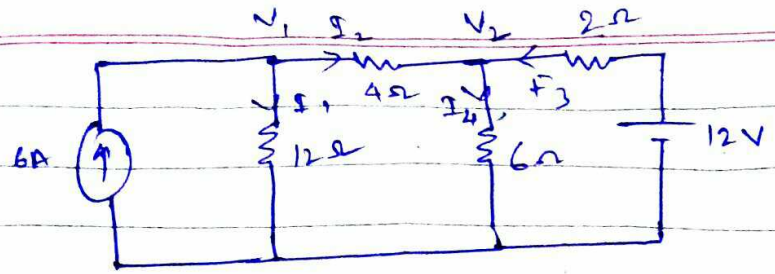
Eq. circuit:



or



1)



At V_1

$$\frac{V_1 - 0}{12} = I_1$$

$$\frac{V_1 - V_2}{4} = I_2$$

$$6 = I_1 + I_2$$

$$6 = \frac{V_1}{12} + \frac{V_1 - V_2}{4}$$

$$6 = V_1\left[\frac{1}{12} + \frac{1}{4}\right] - \frac{V_2}{4}$$

$$6 = \frac{V_1}{3} - \frac{V_2}{4} \quad -(1)$$

At V_2

$$\frac{V_2 - 0}{6} = I_4$$

$$\frac{12 - V_2}{2} = I_3$$

$$I_2 + I_3 = I_4$$

$$\frac{V_1 - V_2}{4} + \frac{12 - V_2}{2} = \frac{V_2}{6}$$

$$\frac{V_1}{4} + V_2\left(\frac{-1}{4} - \frac{1}{2} - \frac{1}{6}\right) = -6$$

$$\frac{V_1}{4} + V_2\left(\frac{-11}{12}\right) = -6 \quad -(11)$$

From (1) & (11)

$$V_1 = 28.8$$

$$V_2 = 14.4$$

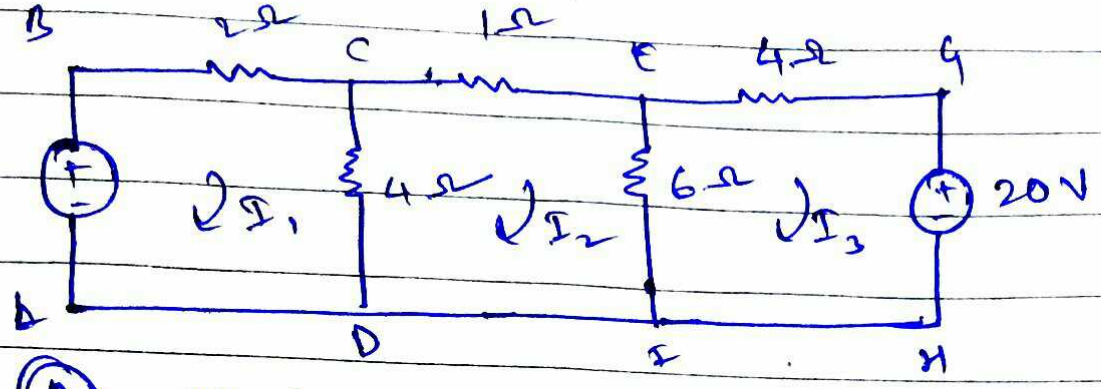
$$I_1 = \frac{V_1 - 0}{12} = \frac{28.8}{12} = 2.4\,A$$

$$I_2 = \frac{28.8 - 14.4}{4} = 3.6A$$

$$I_3 = \frac{12 - 14.4}{2} = -1.2A$$

$$I_4 = \frac{14.4}{6} = 2.4\,A$$

10)



(A) Mesh

In ABCD

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

$$10 = 6I_1 - 4I_2 \quad \text{(I)}$$

In DCEF

$$-4(I_2 - I_1) - I_2 - 6I_2 + 6I_3 = 0$$

$$\Rightarrow \quad +4I_1 - 11I_2 + 6I_3 = 0 \quad \text{(II)}$$

In EFGH

$$-4I_3 - 20 - 6(I_3 - I_2) = 0$$

$$\Rightarrow \quad 6I_2 - 10I_3 = 20 \quad \text{(III)}$$

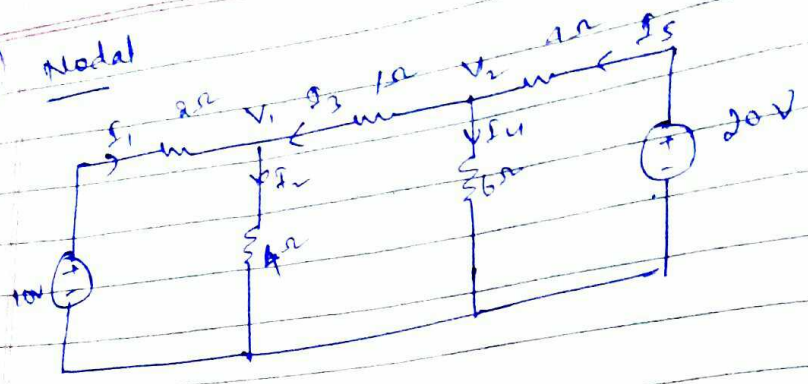
From (I), (II) & (III)

$$I_1 = 0.92\ A$$

$$I_2 = -1.13\ A$$

$$I_3 = -2.68\ A$$

(6) Nodal



$\frac{10 - V_1}{2} = I_1$ $\quad\quad$ $\frac{20 - V_2}{4} = I_5$

$\frac{V_1 - 0}{4} = I_2$ $\quad\quad$ $\frac{V_2 - 0}{6} = I_4$

$\frac{V_2 - V_1}{1} = I_3$

$I_1 + I_3 = I_2$

$\Rightarrow \frac{10 - V_1}{2} + \frac{V_2 - V_1}{1} = \frac{V_1 - 0}{4}$

$\Rightarrow 5 = V_1\left[\frac{1}{4} + \frac{1}{2} + 1\right] - V_2$

$\Rightarrow 5 = \frac{7V_1}{4} - V_2$ $\quad$ (i)

$I_5 = I_4 + I_3$

$\frac{20 - V_2}{4} = \frac{V_2 - 0}{6} + \frac{V_2 - V_1}{1}$

$\Rightarrow 5 = -\frac{V_1}{1} + V_2\left(\frac{1}{6} + 1 + \frac{1}{4}\right)$

$\Rightarrow 5 = -V_1 + \frac{17}{12}V_2$ $\quad$ (ii)

From (i) & (ii)

$V_1 = 8.17\,V$

$V_2 = 9.29\,V$

$I_1 = \frac{10 - V_1}{2} = 0.92\,A$

$I_2 = \frac{V_1}{4} = 2.05\,A$

$I_3 = \frac{V_2 - V_1}{1} = 1.12\,A$

$I_4 = \frac{V_2 - 0}{6} = 1.54\,A$

$I_5 = \frac{20 - V_2}{4} = 2.67\,A$

11) $R = 1000\ \Omega$

$L = 100\ mH = 100 \times 10^{-3}\ H$

$C = 10\ pF = 10 \times 10^{-12}\ F$

$V = 100\ V$

(i) $\omega = \frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{10^{-1} \times 10^{-11}}}$

$\omega = 10^6$

$f = \frac{\omega}{2\pi} = \frac{10^6}{2\pi}$

$\therefore f = 159155\ sec^{-1}$

(ii) $Q = \frac{X_C}{R} = \frac{X_L}{R}$

$= \frac{\omega L}{R}$

$= \frac{10^6 \times 100 \times 10^{-3}}{1000}$

$Q = 100$

(iii) $P = \frac{P_{max}}{2}$

$\frac{V^2}{2} \cos\phi = \left(\frac{V^2}{2}\right)\frac{1}{2}$

$\cos\phi = \frac{1}{2} \quad \Rightarrow \phi = 60^\circ$

$\tan\phi = \frac{X_L - X_C}{R} = \tan 60^\circ$

$\frac{X_L - X_C}{R} = \sqrt{3}$

$X_L - X_C = \sqrt{3} R$

$$\omega \times 100 \times 10^{-3} - \frac{1}{\omega 10^{-11}} = \sqrt{3} \times 1000$$

$$\Rightarrow \omega^2 10^{-12} - 1 = \sqrt{3}\omega 10^{-8}$$

$$\Rightarrow \omega^2 10^{-3} - (\sqrt{3} \times 10^{-7}) - 1 = 0$$

$$\Rightarrow \omega = 31.6$$

$$f = \frac{\omega}{2\pi} = \frac{31.6}{2 \times 3.14} = 5 \text{ sec}^{-1}.$$

(iv) Band width = $\frac{f_c}{Q} = \frac{15915.5}{100} = 1591.55\ Hz$

2) a) $\omega = 314$

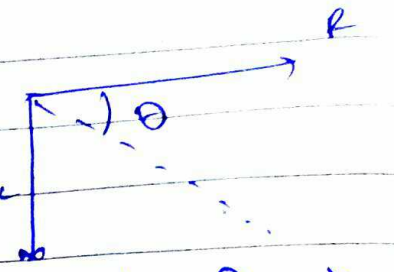
$$X_C = \frac{1}{\omega C} = \frac{10^6}{314 \times 80} = 39.8$$

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

$$= \sqrt{(25)^2 + (39.8)^2}$$

$$Z = 47\,\Omega$$

$$I_m = \frac{V}{Z} = \frac{100}{47} = 2.13\,A$$



$$\tan\theta = \frac{X_C}{R}$$

$$\theta = 58^\circ$$

$$i = i_m \sin(314t + \theta)$$

$$= 2.13 \sin(314t + 58^\circ)$$

b) $P = \frac{1}{2} V I \cos\phi = \frac{1}{2} \times 100 \times 2.13 \times \cos 58^\circ = 56.4\,W$

c) In RC circuit:

$$i = i_0' e^{-t/RC}$$

$$\Rightarrow i = \frac{i_0'}{2} \text{ at } t$$

$$\Rightarrow \frac{i_0'}{2} = i_0' e^{-t/RC}$$

$$\Rightarrow \frac{1}{2} = e^{-t/RC}$$

$$\Rightarrow \ln 2 RC = t \Rightarrow t = 1.4 \times 10^{-3} \text{ sec}$$

charge in circuit:

$$q = CV(1 - e^{-t/RC})$$

$$= 80 \times 10^{-6} \times 100 \left(1 - \frac{1}{2}\right)$$

$$= \frac{80 \times 100 \times 10^{-6}}{2}$$

$$q_i = 4 \times 10^{-3} \text{ C}$$

Voltage across $C = \frac{q_i}{C}$

$$= \frac{4 \times 10^{-3}}{80 \times 10^{-6}} = 50 \text{ V}$$