EE-102 Electrical

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2K19/A14/35

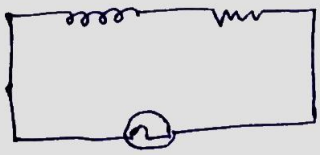
Assignment - 3.

(1) $V_1 = 25H_2$
$V_1 = 10V$
$I_1 = 100 \times 10^{-3} A$
$Z_1 = 100\Omega$

$V_2 = 25H_2$
$V_2 = 10V$
$I_2 = 60 \times 10^{-3A}$
$Z_2 = 166.66\Omega$

$Z \uparrow, Z \uparrow$
2×2

The Circuit Contains a indoctor and resistor



$X_2 = W_2$
$= 2\pi VL$

let resistance be R.

When $V = 25H_2$
$X_2 = 2\pi \times 2.5 \times L = 50\pi L$
$Z = \sqrt{R^2 + X_L^2}$
$100 = \sqrt{R^2 + (50\pi L)^2}$ — (1)
$R^2 = 10000 - 2500 \times 10 \times 0.09$
$R^2 = 7750$
$R = \sqrt{7750} \Rightarrow 88.1\Omega$ Ans

When $V = 75H_2$
$X_2 = 2\pi \times 75 \times L = 150\pi L$
$Z = \sqrt{R^2 + X_2^2}$
$\frac{500}{3 \times 2} = \sqrt{R^2 + 150\pi L}$
Putting $R^2 = 100^2 - 50\pi L^2$
$\frac{(1000)^2}{36} = (100)^2 + (100\pi L)^2 \times 2$
$\Rightarrow 100(100)^2 = 36(100)^2 + (100)^2 (\pi L)^2 \times 2 \times 36$
$100 = 36(\pi L)^2 \times 2 \times 36$
$36 \times 2 \times \pi^2 L^2 = 64$
$L = \sqrt{\frac{64}{2\pi^2 \times 36}} = \frac{8}{6\pi\sqrt{2}} = \frac{8}{6\sqrt{2}\pi}$

$L = 0.3H$ Ans

If Impedence $z = 200\Omega$

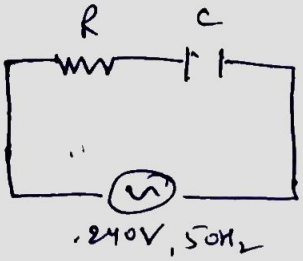
$z^2 = R^2 + w^2L^2$

$(200)^2 = (84.1)^2 + 4\pi^2 \times 0.09 \times \nu^2$

$32238.39 = 3.62\nu^2$

$\nu = \sqrt{\frac{32238}{3.6}} = 95.22 H_z$ Ans

(2)



$\frac{V_2}{R} = P \Rightarrow \frac{10000}{R} = 300$

$R = 100/3\ \Omega$

$I^2R = P, \quad I^2 \times \frac{100}{3} = 300$

$I = 3A$

Impedence $z = \frac{V}{I} = \frac{240}{3}$

$= 80\Omega$

$z = 80\Omega$

$z^2 = R^2 + X_C^2$

$6400 = \frac{10000}{9} \times X_C^2$

$X_C = \sqrt{\frac{57600 - 10000}{9}} = \sqrt{\frac{47600}{9}}$

$X_C = \frac{218.17}{3} = 72.72\ \Omega$

$\frac{1}{2\pi\nu C} = 72.72$

$\nu = 50 H_z$

Voltage across Capacito $= I \times X_C$

$= 3 \times 72 - 72$

$\Rightarrow 218.17V$

$$C \Rightarrow \frac{1}{2\pi 50 \times 72.72} = 0.0000437\,f = 43.7\,\mu f.$$

$$Q = CV = 43.7 \times 10^{-6} \times 218.16$$
$$= 9533.59 \times 10^{-6}$$
$$= 0.95\,C \text{ Ans}$$

$$Q \text{ Max} = 240 \times 43.7 \times 10^{-6}$$
$$= 0.0104\,C \text{ Ans}$$

$$\text{Max energy} = \tfrac{1}{2} CV^2$$
$$= \tfrac{1}{2} \times 43.7 \times 240 \times 240 \times 10^{-6}$$
$$= 1.2\,J \text{ Ans}$$

(3) $V = 80 + j60 = 100 \angle 36.86^\circ$

$I = -4 + j100 = 10.97 \angle 111.80^\circ$

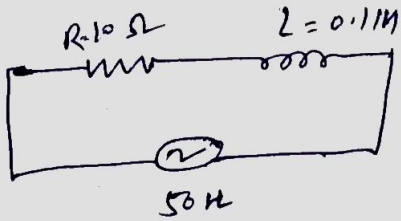
a) Impedance $= Z = \frac{V}{I} = \frac{100 \angle 36.86}{10.77 \angle 111.8} = 9.285 \angle -74.94^\circ$

(Phase angle)

(b) Power $= 100 \times 10.97 \times \cos(74.94)$
$= 279.83\,w$ Ans

(c) Phase angle $= 74.94 \cong 75^\circ$ (I leading). Ans

(4)



$R = 10\,\Omega$

$Z = 10 + j31.41$

$Z = 32.96 \angle 72.34$

$X_L = SWL$
$= 2\pi \times 50 \times 0.1$
$X_L = 10\pi$

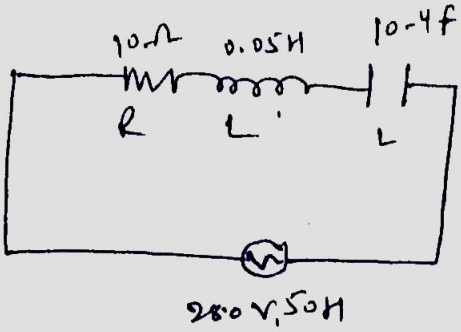
$$Y = \frac{1}{Z} = \frac{1}{32.96} \angle 72.34$$

$Y = 0.0303 \angle -72.34$ $\quad y = 0.0303$ Ans. mho.

$y = a + jB \Rightarrow Y = 9.19 \times 10^{-3} - j0.028.$

$\Rightarrow$ $G = 0.00919$ Mho $\quad B = 0.028$ Mho Ans

5A



$X_L = \omega L$

$= 2\pi \times 50 \times 0.05$

$X_L = 15.7\ \Omega$

$X_C = \frac{1}{\omega L} = \frac{1}{2\pi \times 150 \times 10^{-9}} = \frac{100}{\pi} = 31.8\ \Omega$

$\Rightarrow Z = 10\ \Omega$ Ans

$I = \frac{V}{R} = \frac{200}{10} = 20A$

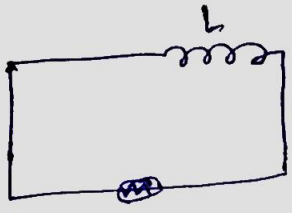
Power $VI = 4000W$ Ans

Power factor $= R/Z = \frac{10}{10} = 1$ Ans

$\rightarrow V_R$

$\rightarrow I$

(b)

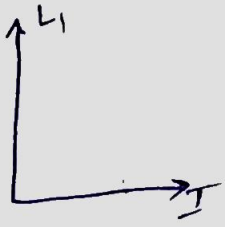


$X_L = \omega L$

$= 100\pi \times 50 \times 10^{-3}$

$X_L = 15.7\ \Omega$

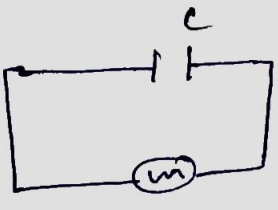
$I = \frac{200}{15.7} = 12.73A$



$P = VI\cos\phi = 0$ W

Power factor $= \cos 90 = 0$ Ans

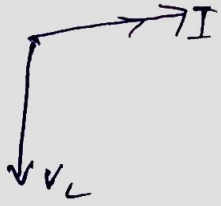
(c)



$X_C = \frac{1}{\omega C} = \frac{1}{100\pi \times 100 \times 10^{-6}}$

$X_C = 31.8\ \Omega$

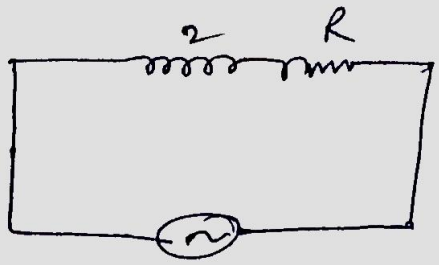
$I = \frac{200}{31.8} = 6.28$ Ans



$P = VI\cos\phi = 0$

Power factor $= \cos 90 = 0.$

(d)



Impedence $Z = 10 + j15.7$

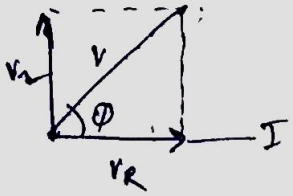
$= 18.61 \angle 57.5$

Current $= 10.74 \angle -57.5°$

Power $= VI \cos\phi$

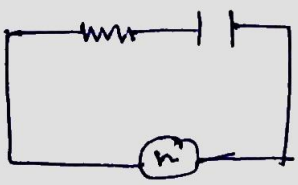
$= 200 \times 10.74 \times \cos(57.5)$

$= 1.154$ kw



$\cos\phi = 0.53$ (lag)

(e)



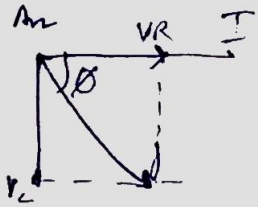
Impedence $= 10 - j31.8 = 33.33\,\Omega \angle -72.54°$ Ans

Current $= 6 \angle 72.54°$

Power $= VI \cos\phi = 200 \times 6 \times \cos(72.54)$

$= 360.04$ w Ans

Power factor $= 0.3$ (lead) Ans



(f)

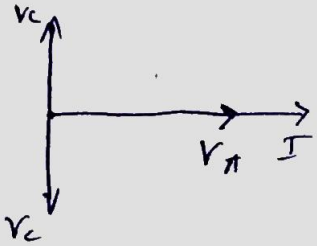
Impedence $= 10 j15.7 - j31.8$

$= 10 - j16.13$

$Z = 18.97 \angle -58.20°$ Ans

$I = \frac{V}{Z} = \frac{200}{18.97} = \angle +58.202$

$I = 10.54 \angle 58.20°$ Ans



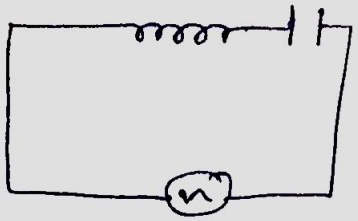
Power $= VI \cos\phi$

$= 200 \times 10.54 \cos(58.2)$

$= 1110.76$ w

Power factor $= \cos\phi = 0.526$.

(9)

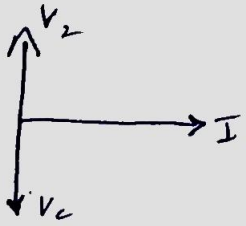


Impedence = $-j1.61\ \Omega = 16.1\angle -90$ Ans

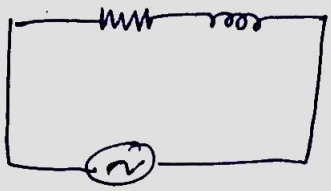
Curse = 12.42 Ans

Power = 0 Ans

Power factor = 0



(6)



$\phi = 37°$

$I = 3A\ \angle -37°$

$V_L = 171V$

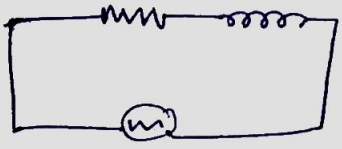
$Z = \frac{V}{I} = \frac{240}{32.37} = 80 \angle 37.$

$Z = 63.89 + j48.14$ Ans

Reaction of Inductor = 48.14 Ω Ans

Resistance of Resistor = 63.89 Ω Ans

(7)



$V_1 = 80H_2$

$I_1 = 15.6A$

$V = 110V$

$Z_1 = \frac{V}{I} = \frac{110}{15.6} = 7.05$

$V_2 = 40\ H_2$

$I_2 = 19.7A$

$V = 110V$

$Z_2 = \frac{V}{I} = \frac{110}{19.7} = 5.58$

$R_2 + \omega_2 L_2 = (7.05)^2$

$R^2 + 4\pi^2 \times 6400 L^2 = (7.05)^2 - (1)$

$R^2 + \omega^2 L^2 = (5.58)^2$

$R^2 + 4\pi \times 1600 L^2 = (5.58)^2$ — (2)

from (1) & (2)

$R = 4.98\ \Omega$, $L = 0.01H$

Const. of Coil = L/R = 2 MS Ans

(8) $V_b = 3V_a \angle 90^\circ$ [$\because$ V_a & V_b are in quadrature]

$$\frac{V_b}{V_a} = 3\angle 90^\circ$$

$Z_b = 6 + j(2\pi 0.025 \times 50) = 6 + j\,8.011\ \Omega$

$Z_b = 10.008 \angle 53.16^\circ$ =.

$\boxed{I_a - I_b}$

$\Rightarrow \frac{V_b}{Z_b} = \frac{V_a}{Z_b} \Rightarrow \frac{Z_b}{Z_a} = \frac{V_b}{V_a} = 3\angle 90^\circ$.

$= \frac{100.05 \angle 53.16^\circ}{Z_a} = 3\angle 90^\circ$

$Z_a \Rightarrow 3.336 \angle -36.84^\circ$

$\boxed{Z_a = 2.669 - j\,2}$ $\begin{bmatrix} R = 2.669 \\ X_L = 2 \end{bmatrix}$

$\Rightarrow R = 2.669\ \Omega$

$\Rightarrow C = \frac{1}{200\pi} = \frac{1}{2\pi 50 \pi \times 2}$ $\left(C = \frac{1}{2\pi \nu \times L}\right)$

$\boxed{C = 1.591 \times 10^{-3} f}$ Ans

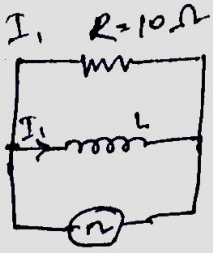
(9) $Z = 10 + j5 \Rightarrow 11.18 \angle 26.56^\circ$

$Y = \frac{1}{Z} = \frac{1}{11.18}$ $\angle = 26.56 \Rightarrow 0.0894 \angle -26.56^\circ$

$\Rightarrow 0.079 - j\,0.039$.

$\boxed{g = 0.079;\ B = -0.039}$ Ans

(a)



$$Z = \frac{Z_1 Z_2}{Z_1 + Z_2} = \frac{jRwL}{R + jwL}$$

$Z_1 = R.$

$Z_2 = jX_2 = j2\pi\nu L = jwL$

$$I_1 = \frac{V}{Z_1} = \frac{V}{R}, \quad I_2 = \frac{V}{Z_2} = \frac{V}{jwL}$$

Total Current $= \frac{V}{Z} = \frac{V}{jRwL}(R + jwL)$ $\boxed{\cos\phi = 0.91}$

$$Z = \frac{j(10 \times 21.94)}{10 + j(21.99)}$$

$$Z = \frac{219.9\angle 90}{24.15\angle 65.54} = 9.105\angle 24.46\,\Omega$$

Power factor

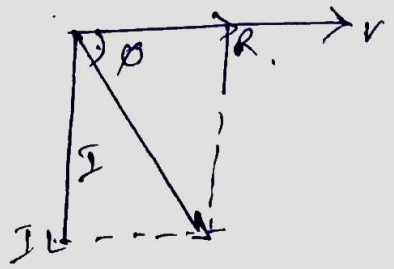
$$\frac{Z}{R} = \cos\phi$$

$$I_R = \frac{200}{10} = 20A$$

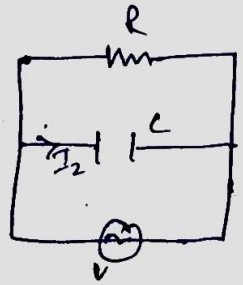
$$I_I = \frac{200}{\times 1.93} = 9.09\,A$$

I. Total $= 21.96\,A$

$$\cos\phi = \frac{\sqrt{R^2 + w^2 + L^2}}{R} \quad 0.91 \text{ Ans}$$



(b)

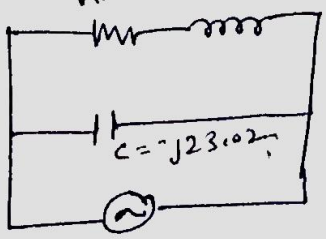


$$Z = \frac{Z_1 Z_2}{Z_1 + Z_2} = \frac{\cdot jR}{wR} = \frac{jX10X25.02}{10 - j25.02}$$

$$\frac{R - j\frac{1}{wL}}{}$$

$\Rightarrow 9.28\angle -26.8.$

(a)



$Z = 57.83\angle 7.61^\circ$

$I_{total} = 3.45\angle 0^\circ$

$\cos\phi = \cos 7.61 = 0.99$ (lag)

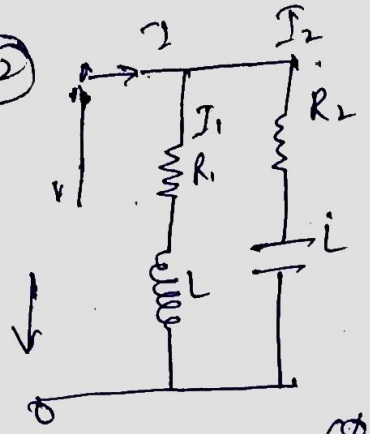
$Z_1 = 10 + j21.99$

$Z_2 = -j25.02$

$Z = \dfrac{Z_1 Z_2}{Z + Z_2}$

$= \dfrac{604.23\angle(24.48)}{10 - j3.03}$

(b) (12)



$I_1 = \dfrac{V}{Z_1}$, $I_2 = \dfrac{V_0}{Z_2}$ Let take the angular frequ

$I_1 = \dfrac{V}{R_1 + j\omega L}$ & $I_2 = \dfrac{V}{R_2 - \frac{1}{\omega L}}$

$\phi_1 = \tan^{-1}\left(\dfrac{X_L}{R}\right)$; $\phi_2 = \tan^{-1}\left(\dfrac{X_C}{R}\right)$

Since I_1 & I_2 are in quadrature

$\phi_1 - \phi_2 = 90^\circ$

$\tan^{-1}\left(\dfrac{X_L}{R_1}\right) + \tan^{-1}\left(\dfrac{X_C}{R_1}\right) = 90^\circ$

taking tan on both sides

$$\frac{\frac{X_2}{R_1} + \frac{X_C}{R_2}}{1 - \frac{X_L X_C}{A \cdot R}} = \tan 90^\circ$$

(9) $1 - \dfrac{X_2 X_C}{R_1 R_2} = 0 \Rightarrow$ $\boxed{R_1 R_2 = X_L X_C = \dfrac{L}{C}}$

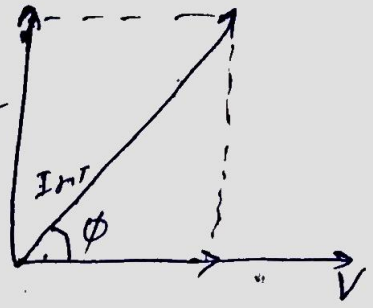
(b) $|T| = \sqrt{T_1^2 + I^2 + 2 I_1 T_2 \cos\phi}$

$\phi = 90^\circ$

$$Z = 9.28\angle -21.8^\circ$$

$$I_R = \frac{V}{R}, \quad I_c = \frac{V\omega L}{J} = jV\omega C$$

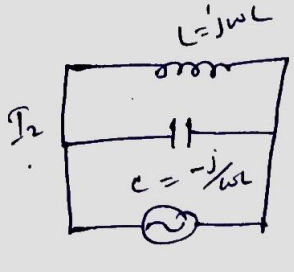
$$I_R = 10A, \quad I_c = \frac{200}{25.02} = 7.95 \quad \therefore I_c$$

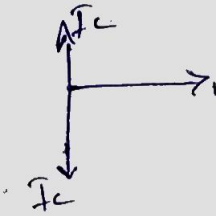


$$I \text{ Total} = 21.55^- A$$

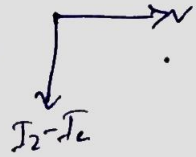
Power factor = $\cos\phi = \frac{I_R}{t} = \frac{\sqrt{R^2 - 1/\omega^2 C^2}}{R}$ = 0.92 Lagging behind I

(C) Inductance in parallel with C





$\Rightarrow$



$Z_1 = (j\omega L) = j21.95\ \Omega$

$Z_2 = -j\frac{1}{\omega C} = -j(25\ \Omega)$

$$Z_{eq} = \frac{Z_1 Z_2}{Z_1 + Z_2} = \frac{550.1898}{-j3.03} = \frac{550.1898\ \angle 0}{3.03\ \angle -90}$$

$$Z_{eq} = 181.58\angle 90^\circ \qquad \cos\phi = 0 \quad (\text{Lag})$$

$$I_L = \frac{V}{X_2} = \frac{200}{21.93} = 90.09\ A$$

$$I_c = \frac{V}{X_C} = \frac{200}{25.08} = 7.99\ A$$

$$I \text{ Total} = 1.10 A$$

Ans

$$I = \sqrt{\frac{V^2}{R_1^2 + \omega^2 L^2} + \frac{V^2 \omega^2 C^2 R_1^2}{R_1^2 + \omega^2 L^2}} \qquad |I| = \text{Max} \Rightarrow \frac{dI}{dR} = 0$$

$$I = \frac{V}{\sqrt{R_1^2 + \omega^2 L^2}} \sqrt{1 + \omega^2 C^2 R_1^2}$$

$$\frac{I}{dR_1} = V \left[\frac{\sqrt{R_1^2 + \omega^2 L^2}}{2\sqrt{1 + \omega^2 C^2 R_1^2}} \quad (\because R_1 \omega^2 C^2) \right.$$

$$\left. \frac{- \frac{\sqrt{1 + \omega^2 C^2 R^2}}{2\sqrt{R_1^2 + \omega^2 C^2}} \cdot 2R}{(R_1^2 + \omega^2 L^2)} \right]$$

Putting $\frac{dI}{dR_1} = 0$ & solving

$$\Rightarrow R_1^2 \omega^2 C^2 + R_1 \omega^2 L^2 C^2 - R_1 \omega^2 C^2 R_1^3 = 0$$

b) $\boxed{\omega = \frac{1}{\sqrt{2}S}}$ Ans

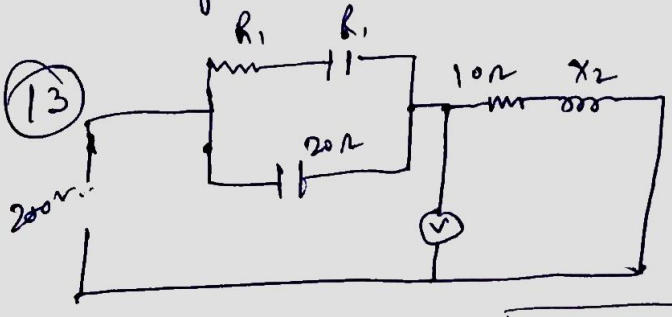
Hence, frequency at this condition $= \frac{1}{2\pi\sqrt{2}LC}$ //

Magnitude of Current $= \frac{V\sqrt{1 + \omega^2 C^2 R^2}}{\sqrt{R_1^2 + \omega^2 L^2}} = \frac{V\sqrt{1 + \frac{C}{L} R_1^2}}{\sqrt{1 + \frac{L^2}{C}}}$

$$= \frac{V\sqrt{\frac{L}{C}}\left(\sqrt{\frac{L}{C} + R_1^2}\right)}{\left(\sqrt{R_1^2 + \frac{L}{C}}\right)}$$

Magnitude of Current $= V\sqrt{\frac{L}{C}}$ Ans

(13)



when reading of voltmeter = 200V

$VI\cos\phi = 1.8 \times 10^3$

$\cos\phi = \frac{R_1}{X_2}$

$200 \times 12 \times \frac{10}{X_2} = 1.8 \times 10^3$

$\boxed{X_2 = 13.32\ \Omega}$ Ans