FE DEPARTMENT

BEE INTERNAL ASSESMENT TEST II SOLUTIONS

B.E.E, IAT-II FE (All branches)

SOLUTION.

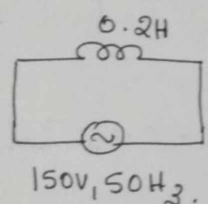
Q1. a.) given; $v(t) = 10 \sin(1000t)$ V

$V_{C_{max}} = 400$V (capacitor peak voltage)

Quality factor $Q = \dfrac{V_C}{V_m} = \dfrac{V_{Max}}{V_m} = \dfrac{400}{10} = 40$ (1M)

$\boxed{\therefore Q = 40}$ (1M)

Q b)



general equation for

voltage $v = V_m \sin \omega t$

current $i = I_m \sin \omega t$.

Given; $V_{rms} = 150$V; $V_m = \sqrt{2} \times 150 = 212.13$V

inductance $L = 0.2$H

$X_L = 2\pi f L = 2 \times \pi \times 50 \times 0.2 = 62.83\,\Omega$

(1M)

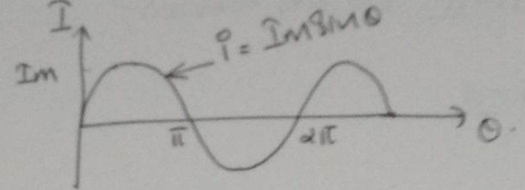
$I_m = \dfrac{V_m}{X_L} = \dfrac{212.13}{62.83} = \underline{\underline{3.37\text{ A}}}$

$\therefore$ voltage $v = 212.13 \sin(314.15t)$ (1M)

current $i = 3.37 \sin(314.15t - \pi/2)$

(purely inductive).

c)



$$i = I_m \sin\theta \qquad 0 < \theta < 2\pi$$

Symmetrical waveform, avrage value is calculated over half cycle.

[1M]

$$\therefore I_{avg} = \frac{1}{\pi}\int_0^{\pi} i(\theta)\,d\theta$$

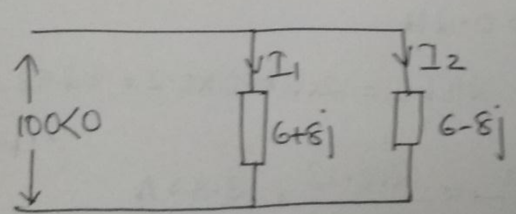
$$= \frac{1}{\pi}\int_0^{\pi} I_m \sin\theta\, d\theta = \frac{I_m}{\pi}\left[-\cos\theta\right]_0^{\pi}$$

$$I_{avg} = \frac{I_m}{\pi}\left[1+1\right] = \frac{2I_m}{\pi} = 0.636 I_m.$$

$$\boxed{I_{avg} = 0.636 I_m}$$

[1M]

d)



$Z_1 = 6+8j = 10\angle 53.13\,\Omega$

$Z_2 = 6-8j = 10\angle -53.13\,\Omega$

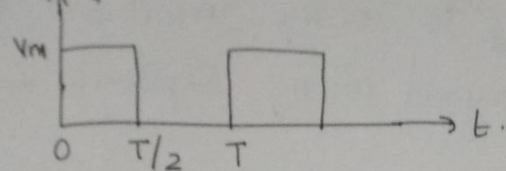
$$I_1 = \frac{V}{Z_1} = \frac{100\angle 0}{10\angle 53.13} = \underline{\underline{10\angle -53.13\text{ A}}} \quad (6-7.99j)\text{A}$$

[1M]

$$I_2 = \frac{V}{Z_2} = \frac{100\angle 0}{10\angle -53.13} = \underline{\underline{10\angle 53.13\text{ A}}} \quad (6+7.99j)\text{A}$$

[1M]

e)



$$v(t) = V_m \quad 0 < t < T/2 \quad [0.5M]$$
$$= 0 \quad T/2 < t < T.$$

$$V_{avg} = \frac{1}{T}\left[\int_0^{T/2} V_m dt + \int_{T/2}^{T} 0 dt\right] \quad [0.5M]$$

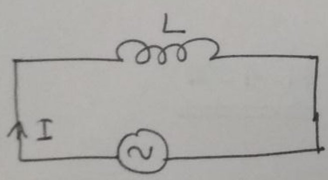
$$= \frac{1}{T} \times \int_0^{T/2} V_m \, dt.$$

$$= \frac{V_m}{T}\left[t\right]_0^{T/2}$$

$$V_{avg} = \frac{V_m}{\cancel{T}} \times \frac{\cancel{T}}{2} = \frac{V_m}{2} = 0.5 V_m \quad [1M]$$

$$V_{avg} = 0.5 V_m$$

f). Pure inductive circuit

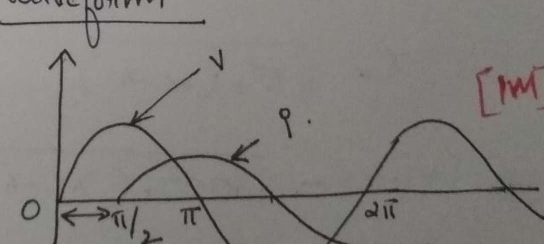


$V = V_m \sin \omega t$

$V = V_m \sin \omega t$

$i = I_m \sin(\omega t - 90°)$

waveform

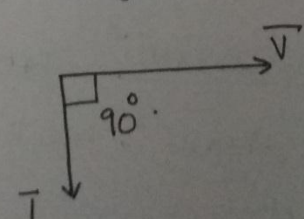


[1M]

phase difference $\phi = 90°$

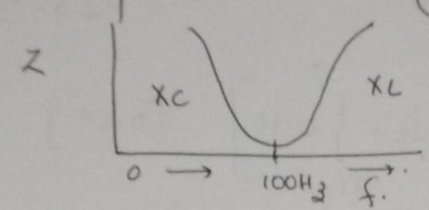
$p.f = 0$

Phasor diagram



[1M]

2·a) given from 1 Hz to 100 Hz circuit is capacitive and beyond 100 Hz, impedance increases.



$\therefore$ Resonant frequency $f_r = 100\,Hz$.

At resonance

$f_r = 100\,Hz$.

$P = 100\,W$

$I = 1\,A$.

$P = VI\cos\phi$

$V = 100\,V$

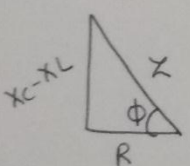
$R = \frac{V}{I} = \frac{100}{1} = 100\,\Omega$

$f_r = \frac{1}{2\pi\sqrt{LC}}$

[2M]

$100 = \frac{1}{2\pi\sqrt{LC}} \Rightarrow LC = 2.53\times10^{-6}$ —— ①

Case II At $70\,Hz$; $\cos\phi = 0.707$



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

$Z = \frac{R}{\cos\phi} = \frac{100}{0.707} = 141.4\,\Omega$

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

$\Rightarrow 141.44 = \sqrt{100^2 + (X_C - X_L)^2}$

$\Rightarrow (141.44)^2 = 100^2 + \left(\frac{1}{2\pi\times70\times C} - 2\pi\times70\times L\right)^2$

$\Rightarrow 100.02 = \frac{2.273\times10^{-3}}{C} - 140\pi L$

$\Rightarrow 100.02\,C = 2.273\times10^{-3} - 140\pi LC$ —— ②

Substitute ① in ②

$\Rightarrow 100.02\,C = 2.273\times10^{-3} - 140\pi\left[2.53\times10^{-6}\right]$

$$\Rightarrow C = \frac{1.1602\times10^{-3}}{100.02}$$

[2M]

$$C = 11.59\,\mu F$$

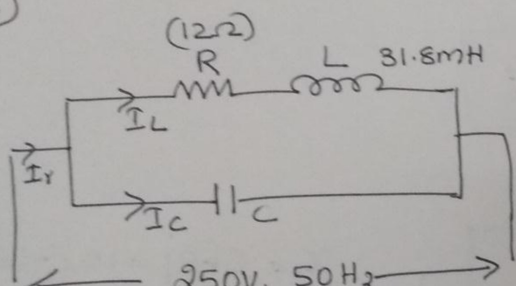
eq ① $\Rightarrow$ $LC = 2.53\times10^{-6}$

$$L = \frac{2.53\times10^{-6}}{11.59\times10^{-6}} = 0.218\,H$$

[1M]

$$\boxed{\begin{array}{l} L = 11.59\,\mu F \\ C = 0.218\,H \\ R = 100\,\Omega \end{array}}$$

2 b)



The given parallel circuit is in ~~at~~ resonance at 50Hz.

$\therefore f_r = 50\,Hz$.

[$\because$ net reactive current is drawn].

given; $R = 12\,\Omega$

$L = 31.8\,mH$; $X_L = 2\pi f L = 2\pi\times50\times31.8\times10^{-3}$

$X_L = 9.99\,\Omega$ [1M]

$V = 250\,V$

$f_r = 50\,Hz$.

At resonance; $I_C = I_L \sin\phi_L$.

$$Z_L = \sqrt{R^2 + X_L^2} = \sqrt{12^2 + 9.99^2} = 15.61\,\Omega.$$

$$P.f_L = \cos\phi_L = \frac{R}{Z_L} = \frac{12}{15.61} = 0.7687$$

current $I_L = \frac{V}{Z_L} = \frac{250}{15.61} = \underline{\underline{16.01A}}$ [2M]

$\therefore I_C = I_L \sin\phi_L$

$I_C = 16.01 \sin(39.75) = \underline{\underline{10.23A}}$

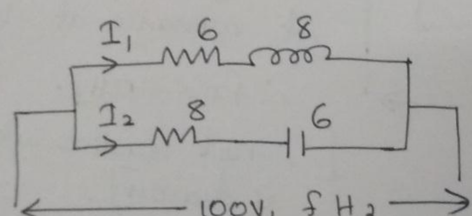
$X_C = \frac{V}{I_C} = \frac{250}{10.23} = \underline{\underline{24.43\Omega}}$ [2M]

$X_C = \frac{1}{2\pi f C}$

$\therefore C = \frac{1}{2\pi f X_C} = \frac{1}{2\pi \times 50 \times 24.43} = \underline{\underline{130.29\mu F}}$

$$\boxed{C = 130.29\mu F}$$

3a).



$Z_1 = 6+8j = 10\angle 53.13\Omega$

$Z_2 = 8-6j = 10\angle -36.86\Omega$

Branch ①

$I_1 = \frac{V}{Z_1} = \frac{100\angle 0}{10\angle -53.13} = 6-8i = \underline{\underline{10\angle -53.13 A}}$ [2.5M]

P.f of branch 1 $\cos\phi_1 = \cos(53.13) = \underline{\underline{0.6 \text{ lagging}}}$.

Power consumed $P_1 = I_1^2 R = 10^2 \times 6 = \underline{\underline{600\omega}}$.

Branch ②

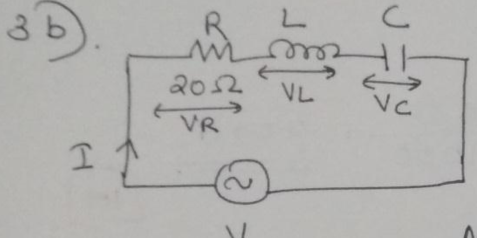
$I_2 = \frac{V}{Z_2} = \frac{100\angle 0}{10\angle -36.86} = 8+6j = \underline{\underline{10\angle 36.86A}}$

P.f of branch 2 $\cos\phi_2 = \cos(36.86) = 0.8$ leading.

Power consumed by branch 2 $P_2 = I_2^2 R$ [2.5M]

$P_2 = 10^2 \times 8 = 800W$

3 b).



given; current lags behind voltage by 45°; inductive circuit.

$\therefore X_L > X_C$. ; $\phi = 45°$.

Also given; $V_{Lmax} = 2V_{cmax}$.

$V_L = 300\sin(1000t)$

$R = 20\Omega$.

$V_{Lmax} = 2V_{cmax}$ $(V_{rms} = \sqrt{2}V_{max})$

$\sqrt{2}V_{Lmax} = \sqrt{2} \times 2 V_{cmax}$

[2M]

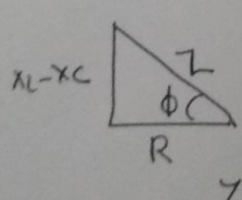
$V_L = 2V_C$

$[V = IX]$

$IX_L = 2IX_C$

$X_L = 2X_C$ —— ①

given $\phi = 45°$; $\cos\phi = \cos 45$



$\cos(45) = \frac{R}{Z} \Rightarrow Z = \frac{R}{\cos 45} = \frac{20}{.707} = 28.28\Omega$

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

$28.28 = \sqrt{20^2 + (2X_C - X_C)^2}$ $\because X_L = 2X_C$

$(28.28)^2 = 20^2 + X_C^2$

$X_C = 19.99 \simeq 20\Omega$

[2M]

$X_L = 2X_C = 2 \times 20 = 40\Omega$

given $\omega = 1000$ rad/sec

$X_L = 2\pi f L$

$\Rightarrow L = \frac{X_L}{2\pi f} = \frac{40}{1000} = 0.04H$

[1M]

$X_C = \frac{1}{2\pi f C}$

$C = \frac{1}{2\pi f \times C} = \frac{1}{1000 \times 20} = 50\mu F$

$$\boxed{\begin{array}{l} L = 0.04H \\ C = 50\mu F \end{array}}$$