DPP – 03

SOLUTION

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1. $\lambda = 960\text{ m}; C = 256\mu F$

At resonance, $\omega_0 = \frac{1}{\sqrt{LC}}$

Squaring both sides, $\frac{4\pi^2 c^2}{\lambda^2} = \frac{1}{LC}$

$$\Rightarrow \frac{4 \times 10 \times (3 \times 10^8)^2}{(960)^2} = \frac{1}{L \times 2.56 \times 10^{-6}}$$

$\Rightarrow L = 10 \times 10^{-8} H$

2. $R = 5\Omega, L = 20mH$

$C = 0.5\mu F; V_{rms} = 250\text{ V}$

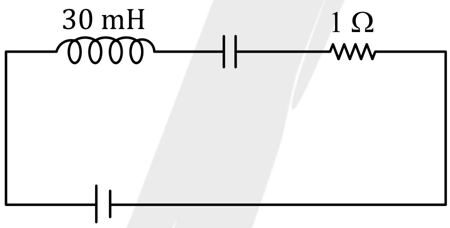
At resonance, $I_{rms} = \frac{V_{rms}}{R}$ as $R = Z$

$$\text{Power } = \frac{V_{rms}^2}{R} = \frac{250 \times 250}{5} = 125 \times 10^2\text{ W}$$

3. $\omega = 300 rads^{-1}; \phi = 45°$

$C = \frac{1}{x} \times 10^{-3}\text{ F}; L = 30mH, R = 1\Omega$

When current leads



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

$$1 = \frac{1}{\omega C} - \omega L; 1 = \frac{1}{300C} - 30 \times 10^{-3} \times 300$$

$$\Rightarrow C = \frac{1}{3} \times 10^{-3}\text{ F}$$

4. Given: $L = 100mH$,

$C = 100\mu F, R = 10\Omega, V = 220\text{ V}, f = 50\text{ Hz}$

$X_L = 2\pi fL = 2 \times 3.14 \times 50 \times 100 \times 10^{-3} = 31.4\Omega$

$$X_C = \frac{1}{2\pi fC} = \frac{1}{2 \times 3.14 \times 50 \times 100 \times 10^{-6}} = 31.85\Omega$$

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

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$Z = \sqrt{10^2 + (31.85 - 31.4)^2} = 10\Omega$

So, $i = \frac{V}{Z} = \frac{220}{10} = 22$ A

5. Here, $\omega = 100\text{rad/s}, L = 0.5\text{H},$

$C = 100\mu\text{F}, V = 20$ V

$\therefore X_L = \omega L = 100 \times 0.5 = 50\Omega$

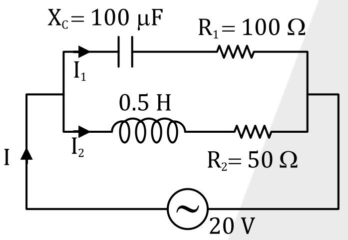
$$X_C = \frac{1}{\omega C} = \frac{1}{100 \times 100 \times 10^{-6}} = 100\Omega$$

Impedance across capacitor,

$$Z_1 = \sqrt{R^2 + X_C^2} = \sqrt{(100)^2 + (100)^2}$$

$$Z_1 = 100\sqrt{2}\Omega \;\therefore\; I_1 = \frac{20}{100\sqrt{2}} = \frac{1}{5\sqrt{2}}\text{ A}$$

Voltage across 100Ω



$$V = I_1 = 100 = \frac{1}{5\sqrt{2}} \times 100 = 10\sqrt{2}V$$

Impedance across inductance,

$$Z_2 = \sqrt{R^2 + (X_L)} = \sqrt{(50)^2 + (50)^2}$$

$$Z_2 = 50\sqrt{2}\Omega \;\therefore\; \frac{20}{50\sqrt{2}} = \frac{2}{5\sqrt{2}} = \frac{\sqrt{2}}{5}$$

Now voltage across $50\ \Omega = \frac{\sqrt{2}}{5} \times 50 = 10\sqrt{2}$

$I_1 = \frac{1}{5\sqrt{2}}$ A at 45^o leading

$I_2 = \frac{\sqrt{2}}{5}$ A at 45^o leading

$\therefore$ Current through circuit

$$I_{net} = \sqrt{I_1^2 + I_2^2} = 0.3\text{A}$$

6. **(A)**

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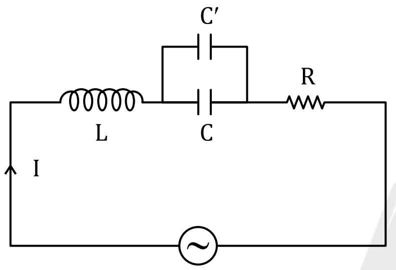
7. Since power factor has to be made 1.

$\therefore$ Effective capacitance should be increased thus connecting in parallel.

$\because \cos\phi = 1 \;\therefore \phi = 0$

$$I\omega L = \frac{I}{\omega(C + C')}$$



or $C + C' = \frac{1}{\omega^2 L}$ $\therefore$ $C' = \frac{1}{\omega^2 L} - C$

$\therefore$ $C' = \frac{1-\omega^2 LC}{\omega^2 L}$ in parallel

8. For current I_1,

$$\tan\phi = \frac{X_L}{R_1} = \frac{\omega L}{R_1} = \frac{100 \times \frac{\sqrt{3}}{10}}{10} = \sqrt{3}$$

$\phi = 60°$; V leads I_1

For current I_2,

$$\tan\phi' = \frac{X_C}{R_2} = \frac{1}{\omega C R_2} = \frac{1}{100 \times \frac{\sqrt{3}}{2} \times 10^{-6} \times 20}$$

$= \frac{1000}{\sqrt{3}} \cdot \phi' \simeq 90°$; V lags I_2.

The required phase difference between I_1 and I_2 is, $\phi + \phi' = 60° + 90° = 150°$

* None of the given options is correct.

9. Given: $R = 100\ \Omega, C = 2\ \mu F$,

$L = 80mH$

Quality factor, $Q = \frac{1}{R}\sqrt{\frac{L}{C}} = \frac{1}{100}\sqrt{\frac{80 \times 10^{-3}}{2 \times 10^{-6}}}$

$$Q = \frac{1}{10^2} \times \frac{1}{10^{-2}}\sqrt{4} = 2$$

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10. For series LR circuit, power factor is, $\cos\phi = \frac{R}{\sqrt{R^2+X_L^2}}$

When $X_L = R$, power factor,

$$P_1 = \frac{R}{\sqrt{R^2 + R^2}} = \frac{1}{\sqrt{2}}$$

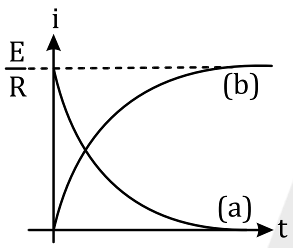
For a series LCR circuit, power factor is,

$$\cos\phi = \frac{R}{\sqrt{R^2 + (X_L - X_C)^2}}$$

When $X_L = X_C$, power factor, $P_1 = \frac{R}{\sqrt{R^2}}$

$$\therefore P_2 = 1; \therefore \frac{P_1}{P_2} = \frac{1}{\sqrt{2}}$$

11.



For RC circuit, $i = \frac{E}{R} e^{-t/RC}$

For RL circuit, $i = \frac{E}{R} (e^{-t(R/C)})$