XII – PHYSICS SOLUTIONS

Q.1 **[D]**

Sol. Since, $\cos\theta = \frac{R}{Z} = \frac{IR}{IZ} = \frac{8}{10} = \frac{4}{5}$

($\cos\theta$ can never be greater than 1)

Also, $Ix_C > Ix_L \Rightarrow X_C > X_L$

Current will be leading

In a LCR circuit

$$V = \sqrt{(V_L - V_C)^2 + R^2} \quad = \sqrt{(6-12)^2 + 8^2}$$

V = 10 ; which is less than voltage drop across capacitor .

Q.2 **[D]**

Sol. $V(t) = -V_0 + \frac{2V_0}{T} \times t$

$$V_{rms} = \sqrt{\frac{\int_0^T V^2 dt}{\int_0^T dt}}$$

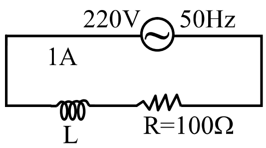
$$\sqrt{\frac{\int_0^T \left(V_0^2 + \frac{4V_0^2 t^2}{T^2} - \frac{4V_0^2 t}{T}\right) dt}{\int_0^T dt}}$$

$$\sqrt{\frac{V_0^2 T + \frac{4V_0^2 T}{3} - 2V_0^2 T}{T}} = \frac{V_0}{3}$$

Q.3 **[D]**

Sol. From the rating of the bulb, the resistance of the bulb can be calculated.

$$R = \frac{V_{rms}^{\ 2}}{P} = 100\Omega$$



For the full to be operated at its rated value the rms current through it should be 1A

Also,

$I_{rms} = \frac{V_{rms}}{Z}$ $\therefore 1 = \frac{200}{\sqrt{100^2 + (2\pi 50 L)^2}} \Rightarrow L = \frac{\sqrt{3}}{\pi}$ H

Q.4 **[B]**

Sol. $V_{source} = \sqrt{V_R^2 + V_C^2}$

$\therefore V_C = \sqrt{V_{Source}^2 - V_R^2}$

$= \sqrt{(20)^2 - (12)^2}$

= 16 V

Q.5 **[D]**

Sol. $i_0 = \frac{v_0}{Z}$,

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

$= \sqrt{4^2 + (1000 \times 3 \times 10^{-3})^2} = 5\ \Omega$

$i_0 = \frac{4}{5}$

$i_0 = 0.8$A

Q.6 **[A]**

Sol. From Kirchoff's current law,

$i_3 = i_1 + i_2 = 3 \sin \omega t + 4 \sin (\omega t + 90^o)$

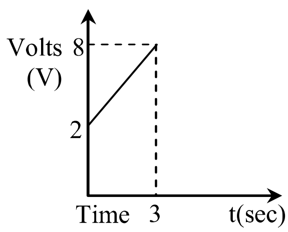
$= \sqrt{3^2 + 4^2 + 2(3)(4)\cos 90^o}\ \sin(\omega t + \phi)$

where $\tan \phi = \frac{4 \sin 90^o}{3 + 4\cos 90^o} = \frac{4}{3}$

$\therefore i_3 = 5\sin(\omega t + 53^o)$

Q.7 **[D]**

Sol.



$I = \frac{dq}{dt}$

$q = it + a$

$V = \frac{q}{c}$

$V = \frac{it + a}{c}$

$\therefore$ V is proportional to time.

Q.8 **[B]**

Sol. $P = V_{rms} I_{rms} \cos\phi$

$$P = V_{rms} \frac{V_{rms}}{Z} \frac{R}{Z}$$

$$= \frac{V_{rms}^2}{Z^2} R$$

$$Z = \sqrt{R^2 + (L\omega)^2} = \sqrt{(50)^2 + (0.2 \times 250)^2}$$

$$= \sqrt{2500 + (50)^2} = 50\sqrt{2}$$

$$\therefore P = \left(\frac{200}{\sqrt{2}}\right)^2 \times \frac{50}{50\sqrt{2}} \times \frac{1}{50\sqrt{2}}$$

$$= 200 \text{ watt}$$

Q.9 **[A]**

Sol. $$X_C = \frac{1}{C\omega} = \frac{1}{20 \times 10^{-6} \times 2\pi \times \frac{50}{\pi}} = 500\ \Omega$$

$$X_L = L\omega = L \times 2\pi \times \frac{50}{\pi} = 100\ \Omega$$

$$I_{rms} = \frac{E_{rms}}{2} = \frac{50}{\sqrt{R^2 + (X_C - X_L)^2}}$$

$$= \frac{50}{\sqrt{(300)^2 + (500 - 100)^2}}$$

$$= \frac{50}{500} = \frac{1}{10} A$$

$$V_C = I_{rms} \times X_C$$

$$= \frac{1}{10} \times 500 \text{ V}$$

$$= 50 \text{ V}$$

Q.10 **[C]**

Sol. As we know, that alternating volts leads the alternating current by a phase angle of 90º in an inductance coil. Therefore the answer is (C).

Q.11 **[D]**

Sol. When capacitance is removed

$$\tan\theta = \frac{\omega L}{R} \text{ or } \omega L = 100 \tan 60^\circ \quad \ldots(1)$$

when inductance is removed

$$\tan\phi = \frac{1}{(\omega C)(R)} \text{ or } \frac{1}{\omega C} = 100 \tan 60^\circ \quad \ldots(2)$$

So $Z = R = 100\ \Omega$

$I = V/R = 200/100 = 2A$

Power $P = I^2 R = 4 \times 100 = 400$ W

Q.12 **[C]**

Sol. $E_0 = 200\sqrt{2}$ V and $\omega = 100$ rad./s

So $X_c = \dfrac{1}{\omega c} = \dfrac{1}{100 \times 10^{-6}} = 10^4 \Omega$

As ammeter reads rms value of current

$\therefore\ I_{rms} = \dfrac{E_{rms}}{Z} = \dfrac{E_0}{(\sqrt{2})X_c}$

$= \dfrac{200\sqrt{2}}{\sqrt{2} \times 10^4}$

$= 20$ mA

Q.13 **[A]**

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

Here $X_L = 2\pi fL = 2 \times 3.14 \times 500 \times (8.1 \times 10^{-3})$

$= 25.4\ \Omega$

and $X_C = \dfrac{1}{2\pi f C} = \dfrac{1}{2 \times 3.14 \times 500 \times 12.5 \times 10^{-6}}$

$= 25.4\ \Omega$

$\therefore\ Z = \sqrt{(10)^2 + (25.4 - 25.4)^2} = 10\ \Omega$

Now $i_{rms} = \dfrac{E_{rms}}{Z} = \dfrac{100}{10} = 10$ A

$\therefore\ V_R = i_{rms} \times R$

$= 10 \times 10$

$= 100$ V

Q.14 **[C]**

Sol. $P = V_{rms} I_{rms} \cos\phi$

$= \left(\dfrac{100}{\sqrt{2}}\right)\left(\dfrac{100}{\sqrt{2}}\right) \times 10^{-3} \cos\dfrac{\pi}{3}$

$= 2.5$ W

Q.15 **[C]**

Sol. % efficiency $= \dfrac{P_{out}}{P_{in}} \times 100 = \dfrac{110 \times 9}{220 \times 5} \times 100$

$= 90\%$

Q.16 **[A]**

Sol. $L = 10$ mHz $= 10^{-2}$ Hz, $f = 1$MHz $= 10^6$ Hz

$f = \dfrac{1}{2\pi\sqrt{LC}} \Rightarrow f^2 = \dfrac{1}{4\pi^2 LC} \Rightarrow C = \dfrac{1}{4\pi^2 f^2 L}$

$$= \frac{1}{4\times10\times10^{-2}\times10^{12}} = \frac{10^{-12}}{4} = 2.5\text{ pF}$$

Q.17 **[D]**

Sol. Use $P_{av} = \left(\frac{V_{rms}}{Z}\right)^2 R$

Q.18 **[C]**

Sol. Use $\frac{V_s}{V_p} = \frac{N_s}{N_p}$ Frequency in transformer remains same.

Q.19 **[A]**

Sol. $i = \frac{V}{Z} = \frac{V}{\sqrt{R^2 + X_c^2}} = \frac{V}{\sqrt{R^2 + (1/\omega C)^2}}$

Q.20 **[B]**

Sol. Let ϕ is the phase difference between V and i

$\tan\phi = \frac{X_L}{R} = \frac{\omega L}{R} = \frac{100\times1}{100} = \frac{\pi}{4}$

From diagram it is clear that i lags with V

$\therefore$ Instantaneous current equation will be

$i_0 =$ sin (100 t $-\phi$) where $\phi = \frac{\pi}{4}$ and $i_0 = \frac{V_0}{Z}$

$$= \frac{V_0}{\sqrt{R^2 + (\omega L)^2}} = \frac{200}{\sqrt{(100)^2 + (100\times1)^2}} = \sqrt{2}$$

$\therefore i = \sqrt{2}\ \sin\left(100\,t - \frac{\pi}{4}\right)$

Q.21 **[A]**

Sol. $E = 10\sin(20t + \phi)$

$\tan\phi = \frac{8}{6}$

$i = \frac{10}{\sqrt{2}R} = \frac{10}{R} = \frac{2\text{amp}}{\sqrt{2}}$

Power dissipated = $i^2R = \frac{4\times5}{2}$

= 10 watt

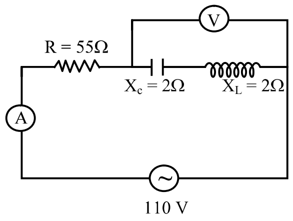
$\therefore C = \frac{1}{\omega^2 L} = \frac{1}{400\times0.2}$

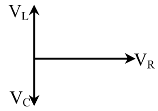
= 12.5 Mf

Q.22 **[B]**

Sol.

The circuit is RLC resonant circuit.





$\therefore$ Reading of voltmeter = $V_L - V_C = 0$

Reading of ammeter = $\dfrac{E_{rms}}{Z} = \dfrac{E_{rms}}{R} = \dfrac{110}{55} = 2A$

Q.23 **[D]**
Sol.

$V_R^2 + (V_L - V_C)^2 = E_{rms}^2$

$(V_L - V_C)^2 = (500)^2 - (400)^2$

$V_L - V_C = \sqrt{(500)^2 - (400)^2} = 300$

$V_C = V_L - 300 = 700 - 300 = 400$

$\therefore \quad V_C\,(peak) = \sqrt{2}\ V_C = \sqrt{2} \times 400$ volts

Q.24 **[D]**

Sol. $f_0 = \dfrac{1}{2\pi\sqrt{LC}}$

Q.25 **[D]**

Sol. $\dfrac{V_0}{\sqrt{2}} = V_0 \sin(\omega t)$

$\dfrac{2\pi}{T} \times t = \dfrac{\pi}{4} \Rightarrow t_1 = \dfrac{7}{8}T$

Time taken to reach the peak is $\dfrac{T}{4}$

$\therefore$ interval = $\dfrac{T}{4} - \dfrac{T}{8} = \dfrac{T}{8} = \dfrac{1}{8f} = \dfrac{1}{8 \times 50}$

$= \dfrac{1}{400} = 2.5 \times 10^{-3}$ sec.

Q.26 **[D]**

Sol. $I = \dfrac{V}{\sqrt{R^2 + (X_L - X_C)^2}} = \dfrac{240}{30} = 8A$

Reading of voltmeter is zero.

Q.27 **[A]**

Sol. At resonance $V_{net} = V_R \Rightarrow V_3 = V_1$

Q.28 **[A]**

Sol. $Z = \sqrt{3^2 + (15-11)^2} = 5$

$\therefore\ I = \frac{V}{Z} = \frac{10}{5} = 2$ amp

$\therefore\ V_L = I\,X_L = 2 \times 15 = 30$ V

$V_C = I\ X_C = 2 \times 11 = 22$ V

but V_L & V_C are in opposite phase $\Rightarrow$ net voltage of L & C = 30 – 22 = 8 volt

Q.29 **[B]**

Sol. $Q = \frac{1}{R}\sqrt{\frac{L}{C}}$

Q.30 **[C]**

Sol. $V_R = V_L = V_C = 10$ V

$\Rightarrow V_{supply} = 10$ volt & $R = X_L$

After removing capacitor

$V_{supply} = \sqrt{V_R^2 + V_L^2}\ \ \therefore\ V_R = V_L$

$\Rightarrow V_L = \frac{10}{\sqrt{2}}$ volt