

7. Alternating Current

Self-Assessment

Module 1: AC Voltage and Current

Q.7.1.1 A light bulb is rated at 200 W for a 220 V AC supply. Which of the following statements is correct?

- (A) 220 V is the average value of voltage.
- (B) 220 V is the peak value of voltage.
- (C) 220 V is the instantaneous value of voltage.
- (D) 220 V is the rms value of voltage.

Q.7.1.2 A light bulb is rated at 25 W, 220 V AC supply. Which of the following combinations of parameters is correct (approximately) for the rating of a light bulb at 25 W, 220 V supply?

- (A) $R = 1900 \, \Omega$, $V_m = 311 \, \text{V}$, $I_{\text{rms}} = 0.1036 \, \text{A}$
- (B) $R = 1936 \, \Omega$, $V_m = 301 \, \text{V}$, $I_{\text{rms}} = 0.1136 \, \text{A}$
- (C) $R = 1900 \, \Omega$, $V_m = 310 \, \text{V}$, $I_{\text{rms}} = 0.1136 \, \text{A}$
- (D) $R = 1936 \, \Omega$, $V_m = 311 \, \text{V}$, $I_{\text{rms}} = 0.1136 \, \text{A}$

where R = Resistance of the bulb, V_m = Peak voltage of the source, I_{rms} = rms current through the bulb.

Q.7.1.3 A home appliance draws a current of A (*rms* value) from the main which supplies AC at 50 Hz. If the instantaneous current is zero at some instant, what will be its value after $\frac{1}{400}$ th of a second ?

- (A) $\sqrt{2} \, \text{A}$
- (B) $1 \, \text{A}$
- (C) $\frac{1}{\sqrt{2}} \, \text{A}$
- (D) $0 \, \text{A}$

Q.7.1.4 Which of the following statements/statements are correct about AC?

- (A) The current changes direction with twice the source frequency.
- (B) Transformers do not work with AC.



- (C) The AC ampere must be defined in terms of Joule's heating effect which is independent of the direction of the current.
- (D) Root mean square value of AC is $\sqrt{2}I_m$, where I_m is its peak value.

Q.7.1.5 Electrical energy is transmitted over large distances at high alternating voltages. Which of the following statements is (are) correct?

- (A) For a given power transmitted, a lower current is possible.
- (B) Thinner transmission wires are better than thicker wires.
- (C) Lower current implies lesser power loss.
- (D) It is easy to reduce the voltage at the receiving end using step-down transformers.

Q.7.1.6 For pure resistive AC circuits, which of the following statements is true?

- (A) Both the instantaneous power and average power are positive.
- (B) Average power is always positive but instantaneous power may be negative.
- (C) Both the average power and instantaneous power are negative.
- (D) Average power is zero.

Q.7.1.7 For alternating current,

- (A) Average value for a complete cycle is zero
- (B) Average value for half a cycle is $0.637 I_m$
- (C) Average value for a complete cycle is $0.637 I_m$
- (D) Average value for half a cycle is zero.

Q.7.1.8 A pure inductor of 50.0 mH is connected to a source of 220 V. If the frequency of the source is 50 Hz, *rms* current in the circuit is.

- (A) 1.4 A
- (B) 14 A
- (C) 0.14 A
- (D) 0.41 A

Q.7.1.9 A $30.0\ \mu\text{F}$ capacitor is connected to a $220\ \text{V}$, $50\ \text{Hz}$ source. Then, the current in the circuit oscillates between

- (A) $+2.92\ \text{A}$ and $-2.92\ \text{A}$
- (B) $+2\ \text{A}$ and $-2\ \text{A}$
- (C) $+2.5\ \text{A}$ and $-2.5\ \text{A}$
- (D) $+3.0\ \text{A}$ and $-3.0\ \text{A}$

Q.7.1.10 A $50.0\ \mu\text{F}$ capacitor is connected to a $220\ \text{V}$, $50\ \text{Hz}$ source. The rms current in the circuit is

- (A) $34.5\ \text{A}$
- (B) $3.45\ \text{A}$
- (C) $3.54\ \text{A}$
- (D) $0.345\ \text{A}$

Module 2: AC Circuits with Frequency Dependent Components

Q.7.2.1 An AC voltage is $V(t) = 220 \sin(100\pi t)$; volt. What is

(i) peak value of AC voltage?

(ii) frequency of AC?

(A) (i) 220 V ; (ii) 50 Hz

(B) (i) 220 V ; (ii) 100 Hz

(C) (i) $220\sqrt{2}$ V ; (ii) 50 Hz

(D) (i) $220\sqrt{2}$ V ; (ii) 100 Hz

Q.7.2.2 A bulb is rated as 50 W and 200 V . The resistance of the bulb is R . I is the current drawn by the bulb.

Which of the following is correct?

(A) $R = 400 \Omega$; $I = \left(\frac{1}{\sqrt{2}}\right)$ A

(B) $R = 400 \Omega$; $I = \left(\frac{1}{2}\right)$ A

(C) $R = 800 \Omega$; $I = \left(\frac{1}{2}\right)$ A

(D) $R = 800 \Omega$; $I = \left(\frac{1}{4}\right)$ A

Q.7.2.3 The instantaneous current I in an AC circuit is $I = 0.2 \sin(120\pi t)$ A

(i) $I = 0.1$ A at $t = t_1$

(ii) $I = 0.174$ A at $t = t_2$ For the first time,

Then value of $(t_2 - t_1)$ is

(A) $\left(\frac{1}{720}\right)$ s

(B) $\left(\frac{1}{360}\right)$ s

(C) $\left(\frac{1}{480}\right)$ s

(D) $\left(\frac{1}{240}\right)$ s

Q.7.2.4 An AC current of 40 mA flows through

(i) a DC ammeter, (ii) an A.C ammeter. The ammeter readings in the two cases are.

(A) (i) 0 (ii) 0

(B) (i) 0 (ii) 40 mA

(C) (i) 40 mA (ii) 0

(D) (i) 40 mA (ii) 40 mA

Q.7.2.5 A power station at a place A; generates 100 kW of power at 250 V. The power is to be transmitted to another far off place B, with minimum transmission loss. The transmission voltage is of the order of

(A) 250 V

(B) 1 kV

(C) 5 kV

(D) 20 kV

Q.7.2.6 For a pure resistive A.C circuit which of the following statement(s) is(are) correct?

(A) current and applied voltage are in phase.

(B) Current and applied voltage are not in phase.

(C) The power factor is one

(D) The instantaneous power consumed is the same at all times.

Q.7.2.7 An AC $v(t) = 10 \sin(100t)$; V is applied across a pure circuit element Z. The instantaneous current is $I(t) = -0.5 \cos(100t)$ A; The element Z is

(A) An inductance of reactance 10Ω

(B) An Inductance of reactance 20Ω

(C) A capacitor of reactance 10Ω

(D) A capacitor of reactance 20Ω

Q.7.2.8 An alternating voltage 5 V is applied across the series combination of the inductor of inductance 1 H and resistor of resistance $100\ \Omega$ as shown in Fig.Q.7.2.4. Impedance of the circuit is approximately equal to

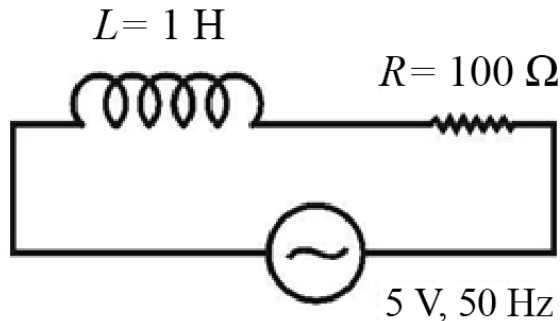


Fig. Q.7.2.4

- (A) $101\ \Omega$
- (B) $329.54\ \Omega$
- (C) $100\ \Omega$
- (D) $297.65\ \Omega$

Q.7.2.9 Consider an AC circuit consisting of capacitance $10\ \mu\text{F}$ and a resistor of $100\ \Omega$ in series with an AC source of 5 V and frequency 50 Hz. Then

- (A) Current Lags behind the applied voltage by phase $\tan^{-1}(3.18)$
- (B) Current leads the voltage by phase $\tan^{-1}(3.18)$
- (C) Current and Voltage are in the same phase
- (D) Current leads the voltage by phase $\tan^{-1}(6.36)$

Q.7.2.10 For three independent circuit elements E_1, E_2 and E_3 ; curves I, II and III show the reactance(X) versus frequency of AC (ν) graphs [Fig.Q.7.2.5]. The elements (i) E_1 , (ii) E_2 and (iii) E_3 are

- (A) (i) resistance (ii) inductance and (iii) capacitor
- (B) (i) resistance (ii) capacitor and (iii) inductance
- (C) (i) inductance (ii) resistance and (iii) capacitor
- (D) (i) capacitor (ii) inductance and (iii) resistance

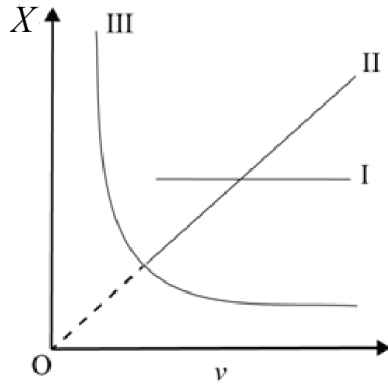


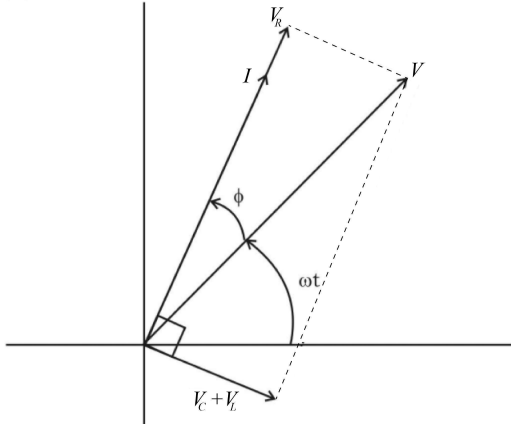
Fig.Q.7.2.5



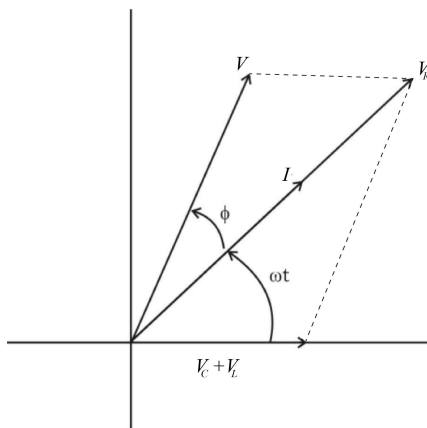
Module 3: Oscillation and Resonance in AC Circuit

Q.7.3.1 An alternating voltage is applied across LCR series circuit in which $\frac{1}{\omega C} > \omega L$. The correct diagram representing the relation between the phasors V_L , V_R and $V_L + V_C$ is

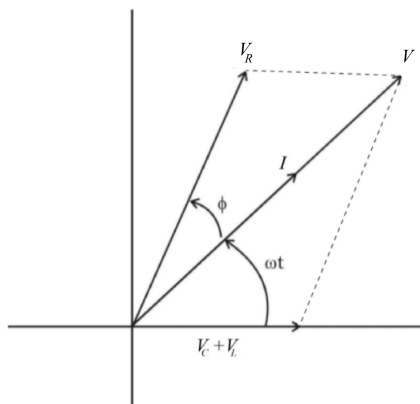
(A)



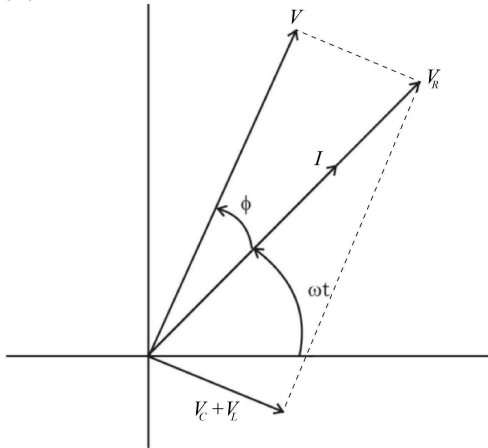
(B)



(C)



(D)



Q.7.3.2 An alternating voltage is applied across a series LCR circuit where $X_C > X_L$ and $Z > 1$ as shown graphically in the Fig. Q.7.3.1. The magnitude of V and I are proportional to the lengths of the vectors representing them.

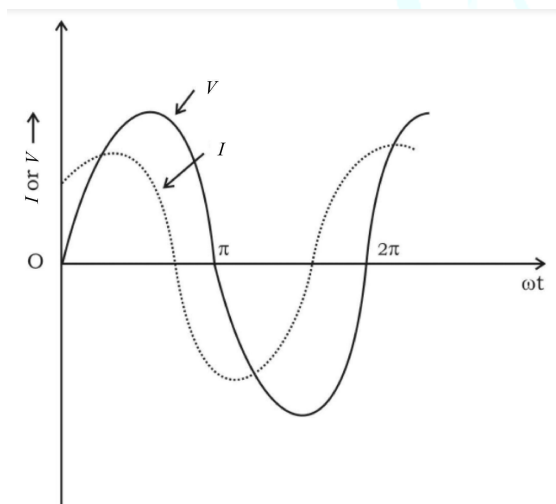
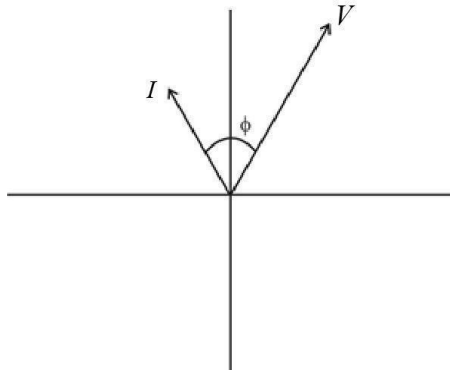


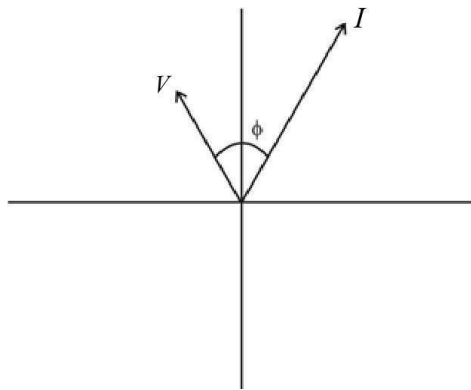
Fig. Q.7.3.1

The diagram correctly representing the phasors V and I is

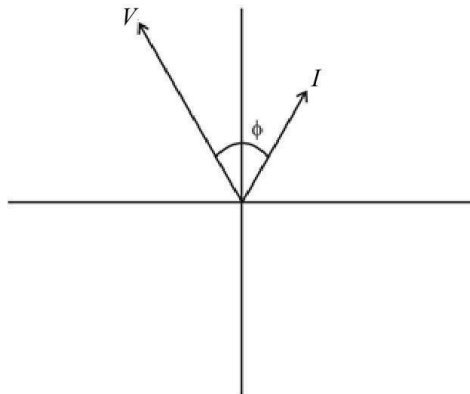
(A)

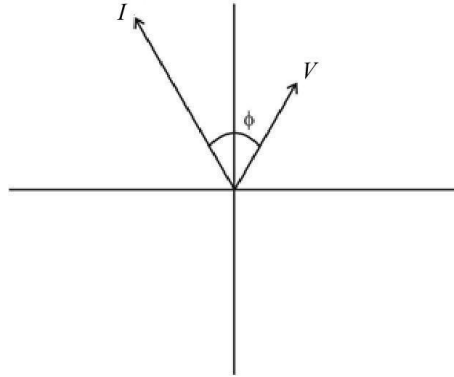


(B)



(C)





(D)

Q.7.3.3 An alternating voltage is applied across a series LCR circuit where $X_L > X_C$ and $Z > 1$. The magnitude of V and I are proportional to the lengths of the vectors representing them. The diagram correctly representing the phasors V and I is

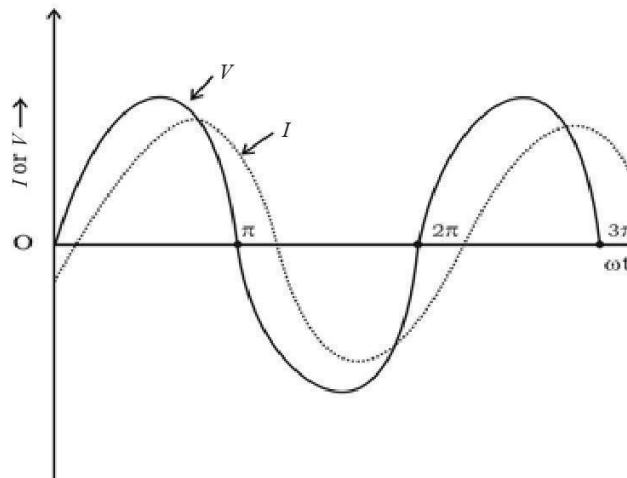
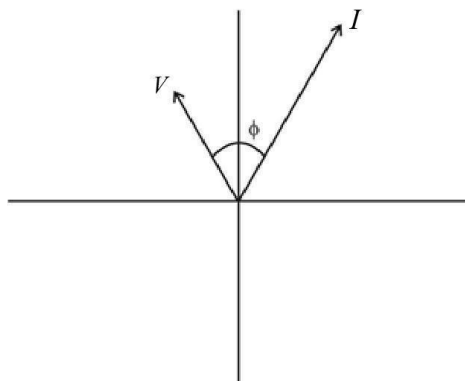
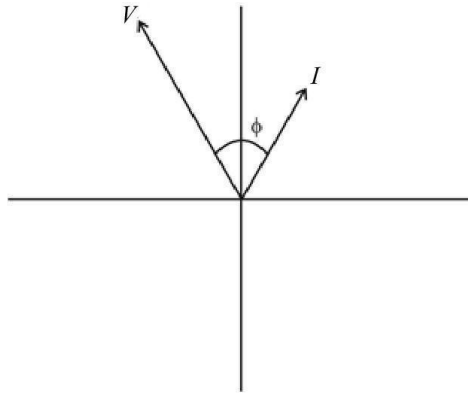


Fig. Q.7.3.2

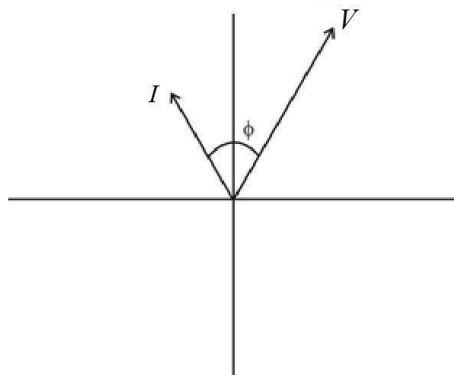
(A)



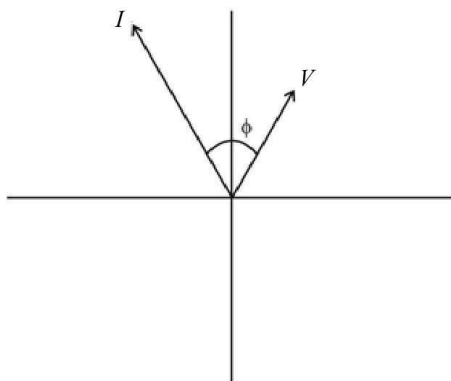
(B)



(C)



(D)



Q.7.3.4 Which of the following combinations should be selected for better tuning of an LCR series circuit used for communication?

- (A) $R = 20 \, \Omega$, $L = 1.0 \, \text{H}$, $C = 30 \, \mu\text{F}$
- (B) $R = 30 \, \Omega$, $L = 2.0 \, \text{H}$, $C = 40 \, \mu\text{F}$
- (C) $R = 10 \, \Omega$, $L = 3.0 \, \text{H}$, $C = 30 \, \mu\text{F}$
- (D) $R = 30 \, \Omega$, $L = 1.0 \, \text{H}$, $C = 40 \, \mu\text{F}$

Q.7.3.5 For a series RLC circuit operating at frequency ω and driven by voltage of amplitude V_m .

The Fig. Q.7.3.3 shows the variation of I_m with ω .

The possible values of R , L and C are

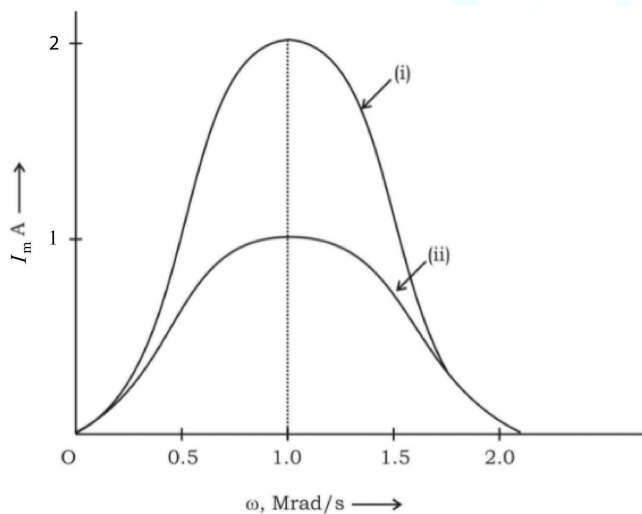


Fig. Q.7.3.3

- (A) $50 \, \Omega$, $100 \, \Omega$, $L = 1.00 \, \text{mH}$, $C = 1.00 \, \text{nF}$
- (B) $100 \, \Omega$, $50 \, \Omega$, $L = 1.00 \, \text{mH}$, $C = 1.00 \, \text{nF}$
- (C) $50 \, \Omega$, $100 \, \Omega$, $L = 1.00 \, \text{mH}$, $C = 1.00 \, \mu\text{F}$
- (D) $10 \, \Omega$, $5 \, \Omega$, $L = 1.00 \, \text{mH}$, $C = 1.00 \, \text{nF}$

Q.7.3.6 Draw the effective equivalent circuit of the Fig. Q.7.3.4 at very high frequencies.

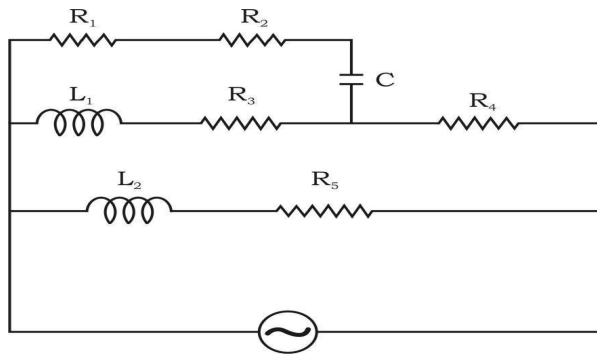
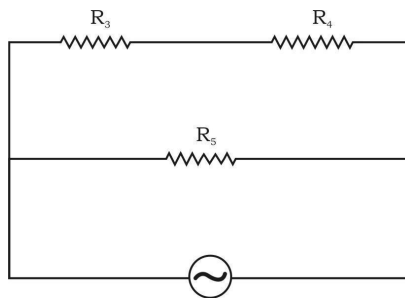
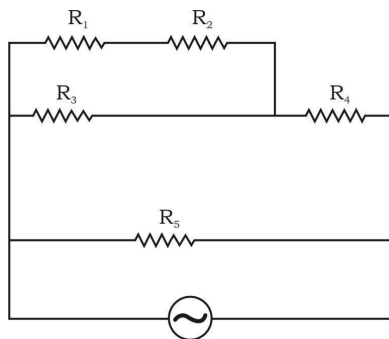


Fig. Q.7.3.4

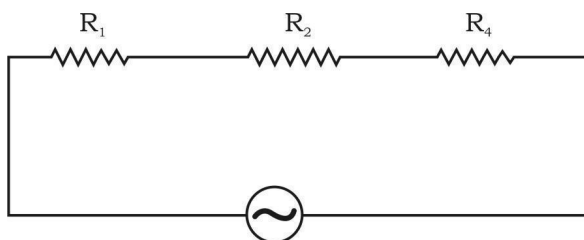
(A)



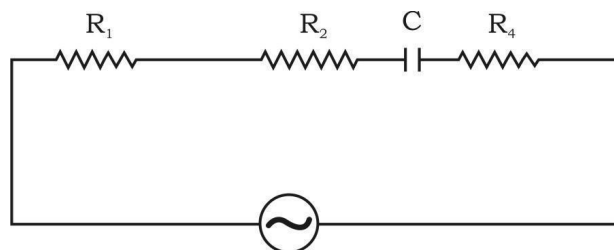
(B)



(C)



(D)



Q.7.3.7 Which of the following equations with symbols having their usual meaning, denotes sharpness of resonance of series *LCR* circuit (quality factor) ?

(A) $Q = \omega_0 LR$

(B) $Q = \frac{\omega_0 R}{L}$

(C) $Q = \frac{R}{\omega_0 L}$

(D) $Q = \frac{\omega_0 L}{R}$

Q.7.3.8 An *LCR* series circuit consists of a resistance R , an inductance of 2500 mH, and a capacitance of 40 μF . When an AC voltage of 220 V of variable frequency is applied to the circuit, the maximum current is 11 A. Then the possible value of quality factor for the given *LCR* circuit is

(A) $Q = 12.5$

(B) $Q = 5.0$

(C) $Q = 1.25$

(D) $Q = 0.08$

Q.7.3.9 When an AC voltage of variable frequency is applied to an *LCR* series circuit, it is found that the current in the circuit is the same at frequency values of 25 kHz and 36 kHz. To attain the maximum current in the circuit, the value of frequency of applied AC voltage will be

(A) $\frac{5}{6}$ kHz

(B) $\frac{6}{5}$ kHz

(C) 30 kHz

(D) $\frac{1}{30}$ kHz

Q.7.3.10 In the circuit given below a charged capacitor is connected to an inductor

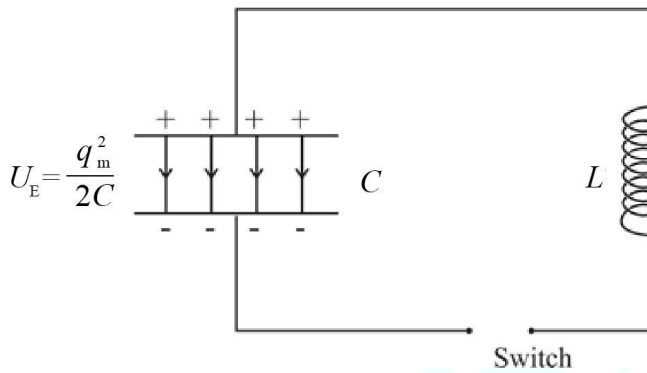


Fig. Q.7.3.5

At $t = 0$, when the switch is closed. Then which of the following is the appropriate state of the system during LC oscillation.

- (A) $U_E|_{t=T/4} = 0$, $U_B|_{t=T/2} = \frac{1}{2} L i_m^2$
- (B) $U_E|_{t=T/2} = 0$, $U_B|_{t=T/4} = \frac{1}{2} L i_m^2$
- (C) $U_E|_{t=T} = \frac{1}{2} \frac{q_m^2}{C}$, $U_B|_{t=T/4} = \frac{1}{2} L i_m^2$
- (D) $U_E|_{t=T} = \frac{1}{2} \frac{q_m^2}{C}$, $U_B|_{t=T/2} = \frac{1}{2} L i_m^2$

Module 4: Power in AC Circuit

Q.7.4.1 The output of a step-down transformer is measured to be 48 V when connected to a 36 W light bulb. The value of the peak current is

- (A) $\frac{3}{4}$ A
- (B) $\frac{3\sqrt{2}}{4}$ A
- (C) $3\sqrt{2}$ A
- (D) $\frac{3\sqrt{2}}{2}$ A

Q.7.4.2 A given power is transmitted at a certain voltage. Then, for the minimum power loss in transmission, the value of power factor is

- (A) 1
- (B) $\frac{1}{\sqrt{2}}$
- (C) 0.5
- (D) $\frac{\sqrt{3}}{2}$

Q.7.4.3 A graph of instantaneous power dissipated across a device X versus time is given in Fig. Q.7.4.1.

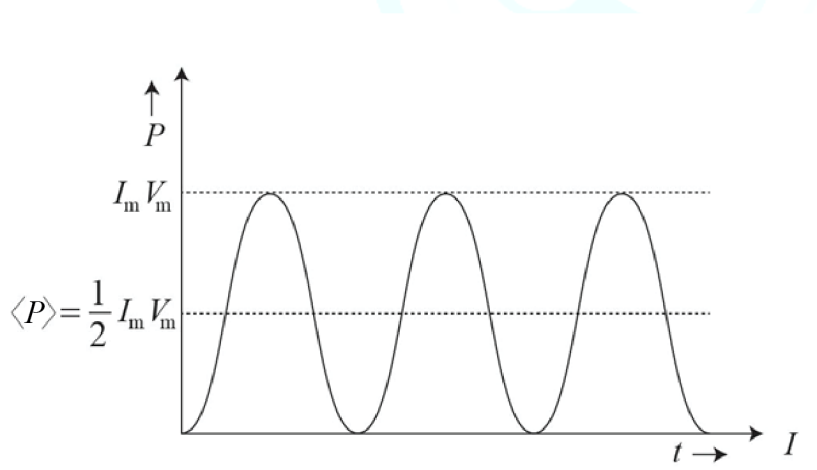


Fig. Q.7.4.1

The value of the power factor is

- (A) $\frac{1}{2}$
- (B) 1
- (C) $\frac{1}{\sqrt{2}}$
- (D) $\frac{1}{4}$

Q.7.4.4 A transformer operated on a 1100 V line. It supplies 10 A current in the primary coil. The ratio of the primary winding to the secondary is 10 : 1. If the transformer is 90% efficient, then the output power and voltage across the secondary coil are

- (A) 12222.22 W, 110 V
- (B) 9900 W, 110 V
- (C) 9900 W, 11000 V
- (D) 12222.22 W, 11000 V

Q.7.4.5 A transformer is used to light 100 W, 110 V lamps from 220 V mains. If the main current is 0.5 A, the efficiency of the transformer is-

- (A) 100%
- (B) 95%
- (C) 91%
- (D) 99%

Q.7.4.6 An AC source of the peak value of e.m.f 311.08 V and constant frequency of 50 Hz is applied to a *LCR* series circuit. If the power factor and r.m.s value of current are 0.6 and 10 A respectively, the power dissipated in *LCR* circuit will be

- (A) 1320 W
- (B) 1664.8 W
- (C) 1866.48 W
- (D) 1132 W

Q.7.4.7 Choose the **INCORRECT** statement

- (A) In the LCR series circuit, maximum power is dissipated at resonance.
- (B) To supply a given power at a given voltage, a low power factor implies large power loss in transmission.
- (C) As in the case of purely resistive circuit $\cos\phi = 1$, there is minimum power dissipation.
- (D) In an RL series circuit, power dissipation can be minimized by taking a very large L in comparison to R so that $R \ll \omega L$.

Q.7.4.8 A small town with a demand of 400 kW of electric power at 220 V, is situated 10 km away from an electric plant generating power at 4000 V. The resistance of the two wire lines is $1 \Omega/\text{km}$. The town gets power from the lines through a 4000 V - 220 V step-down transformer at a substation in the town. Assuming there is negligible power loss due to leakage, the power must supplied by the power plant is

- (A) 600 kW
- (B) 400 kW
- (C) 500 kW
- (D) 200 kW

Q.7.4.9 When an AC source of 220 V, 50 Hz is connected to an LR circuit shown in Fig. Q.7.4.2, the power factor will be

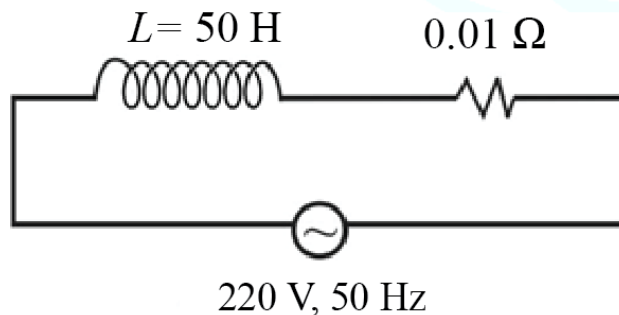


Fig. Q.7.4.2

- (A) 1
- (B) 0

- (C) 0.1
(D) 0.5

Q.7.4.10 An AC source of 10 V is operated to an *LCR* series circuit as shown in Fig. Q.7.4.3

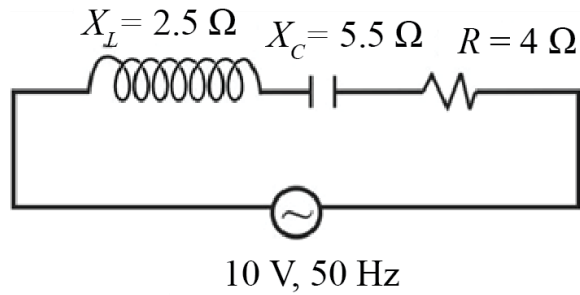


Fig. Q.7.4.3

Voltages across *R*, *L*, and *C* respectively are

- (A) 8 V, 5 V, 11 V
(B) 5 V, 11 V, 8 V
(C) 2.5 V, 5.5 V, 4 V
(D) 4 V, 2.5 V, 5.5 V



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