PHYSICS

The following questions 36 to 41 consists of two statements each, printed as Assertion and Reason. While answering these questions you are to choose any one of the following four responses.

(A) If both Assertion and Reason are true and the Reason is correct explanation of the Assertion.

(B) If both Assertion and Reason are true but Reason is not explanation of the Assertion.

(C) If Assertion is true but the Reason is false.

(D) If Assertion is false but Reason is true

Q.1 **Assertion** : A low voltage bulb in a coil glows when a.c. is passed through a neighbouring coil.
Reason : Bulb glows because of e.m.f. induced in the coil due to self induction. **[C]**

Q.2 **Assertion** : A glowing bulb becomes dim when an iron bar is put in the inductor in the a.c. circuit.
Reason : Resistance of the circuit increases. **[C]**

Q.3 **Assertion** : The number of turns in secondary coil of a transformer is 10 times the number of turns in primary. An output voltage of 15 V can be obtained using a cell of 1.5 V.
Reason : This is because in a transformer, $\frac{E_s}{E_p} = \frac{n_s}{n_p}$ **[D]**

Q.4 **Assertion** : In series LCR resonance circuit, the impedance is equal to the ohmic resistance.
Reason : At resonance, the inductive reactance is equal to the capacitative reactance **[A]**

Q.5 **Assertion** : In series LCR circuit, the resonance occurs at one frequency only
Reason : At this frequency, inductive reactance is equal to capacitative reactance **[A]**

Q.6 **Assertion** : A parallel resonance circuit is called a rejector circuit.
Reason : At resonance frequency, current is completely cut off. **[A]**

Q.7 **Assertion :** An electric bulb is first connected to a DC source and then to a AC source having the same voltage. Bulb glows with same brightness in both the cases.
Reason : The peak value of voltage for an AC source is $\sqrt{2}$ times the root mean square voltage.

Sol. **[D]**
Assertion is false but reason is true.
Voltage of DC source is constant but in AC source, the peak value of voltage is $\sqrt{2}$ times the r.m.s. voltage. Hence, bulb will glow with more brightness when connected to an AC source of the same voltage.

Q.8 **Assertion :** Long distance transmission of A.C is carried out at extremely high voltage.
Reason : For large distance, voltage has to be large. **[C]**

Sol. In order to reduce transmission loss transmission is carried out at high voltage.

Q.9 **Assertion :** An alternating current does not show any magnetic effect.
Reason : Alternating current varies with time. **[D]**

Q.10 **Assertion :** Power factor of an inductor is zero.
Reason : In the inductor emf and current differ in phase by $\frac{\pi}{2}$. **[A]**

Sol. Power factor = cos ϕ
and in inductor ϕ
i.e. phase difference between emf and current = $\frac{\pi}{2}$

Power factor = $\cos\frac{\pi}{2} = 0$

Q.11 **Assertion :** Direct current and alternating current both can be measured by a hot wire ammeter.
Reason : Hot wire ammeter is based on principle of magnetic effect of current. **[C]**

Q.12 **Assertion :** If an electric heater is provided same value of DC supply and AC supply then it will take more time in AC to get heated.

Reason : Resistance of coil to alternating current is more than resistance to direct current. **[A]**

Sol. Power = $\frac{V^2}{R}$

there V is same for both

In AC resistance = $\sqrt{(\omega L)^2 + R^2}$

In DC resistance = R

$\therefore$ Resistance AC > Resistance DC

Power AC < Power DC for same supply

Q.13 **Assertion:** In the series RCL circuit, the impedance is minimum at resonance.

Reason: The current in inductance and capacitance are out of phase at resonance. **[B]**

Q.14 **Assertion :** The DC and AC both can be measured by a hot wire instrument.

Reason : The hot wire instrument is based on the principle of magnetic effect of current.

[C] (A) is true but (R) is false

Q.15 **Statement I :** In series LCR circuit , the resonance occurs at one frequency only.

Statement II : At this frequency, inductive reactance is equal to capacitative reactance. **[A]**

Q.16 **Statement I :** A glowing bulb becomes dim when an iron bar is put in the inductor in the a.c. circuit.

Statement II : Resistance of the circuit increases. **[C]**

Q.17 **Statement I :** A capacitor blocks d.c.

Statement II : This is because capacitative reactance of condenser is $X_C = \frac{1}{\omega C} = \frac{1}{2\pi f C}$ and for d.c. f = 0. **[A]**

Q.18 **Statement I :** In 220 V ; 50 Hz a.c. wall plug peak value of alternating emf is 220 V.

Statement II : Only rms value is specified. **[D]**

Q.19 **Statement I :** Series RLC circuit behaves as RC circuit for $f < f_r$.

Statement II : Because for $f < f_r$ capacitative reactance is more than inductive reactance. **[A]**

Q.20 **Statement I :** A capacitor blocks direct current in the steady state .

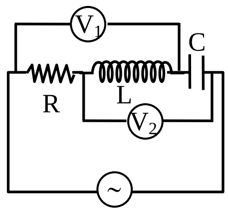
Statement II : The capacitive reactance of the capacitor is inversely proportional to frequency f of the source of emf. **[B]**

Sol. Statement (I) and (II) both are correct and (II) is also correct explanation of (I).

Q.1 In column I some AC circuits with meter readings are given and in Column II some circuit quantities are given. Match the entries of column I with the entries of column II.

Column-I **Column-II**

(A)

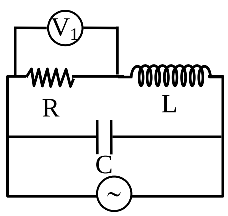


250 Volt
$V_1 = 158.11V; V_2 = 200V$

volt

(P) $V_R = 150$

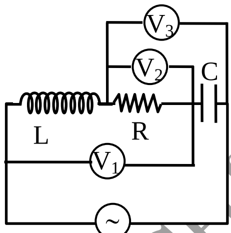
(B)



250 Volt $V_1 =$ 150 Volt

(Q) $V_L = 50$ volt

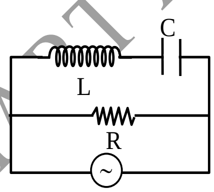
(C)



250 Volt
$V_1 = 158.11V; V_2 = 291.6V$
$V_3 = 150$ Volt

(R) $V_C = 250$ volt

(D)



250 Volt

(S) Power factor of the circuit is $\frac{3}{5}$

Sol. **A → P,Q, R, S ; B → P, R;**
C → P, Q, R, S ; D → R

For A : $V_R^2 + V_2^2 = V^2$

or $V_R = \sqrt{V^2 - V_2^2} = \sqrt{(250)^2 - (200)^2}$

$= \sqrt{450 \times 50} = 150$ volt

$V_R^2 + V_L^2 = V_1^2$

$\therefore \quad V_L = \sqrt{V_1^2 - V_R^2} = \sqrt{(158.11)^2 - (150)^2}$

$= 50$ volt

$|V_L - V_C| = V_2$ or $V_C = 250$ volt

$\cos\phi = \frac{V_R}{V} = \frac{150}{250} = \frac{3}{5}$

For B : $V_C = V = 250$ volt

and $V_R^2 + V_L^2 = (250)^2$

$V_R = V_1 = 150$ volt. so $V_L = 200$ V

Power factor can be computed by determining the net reactance.

For C : $V_R = V_3 = 150$ volt

$V_1^2 = V_R^2 + V_L^2$ or $V_L = 50$ volt

$V_2^2 = V_C^2 + V_R^2$ or $V_C = 250$ volt

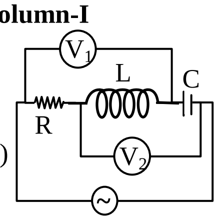
$\cos\phi = \frac{150}{250} = \frac{3}{5}$

For D : $V_R = V = 250$ volt

Q.2 In column I some AC circuits with meter readings are given and in column II some circuit quantities are given. Match the entries of column I with the enteries of column II (Assume all the voltmeter are ideal)

Column-I **Column-II**

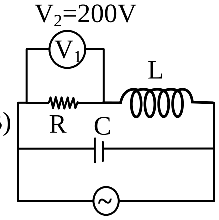
(A)



250volt
V_1=158.11V;
V_2=200V

(P) $V_R = 150$ volt

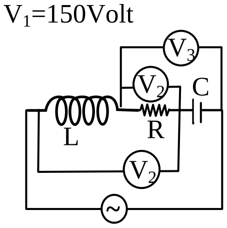
(B)



250volt
V_1=150Volt

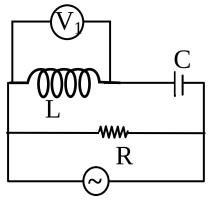
(Q) $V_L = 50$ volt

(C)



250volt
V_1=158.11V;V_2=291.6V
V3 = 150V

(R)V_C=250Volt

(D) 

250volt
V_1=0

(S) Power factor of the circuit is $\frac{3}{5}$

Sol. **A → PQRS ; B → PR ; C → PQRS ; D → R**

For A :

$V_R^2 + V_2^2 = V^2$

or $V_R = \sqrt{V^2 - V_2^2} = \sqrt{(250)^2 \times (200)^2}$

$V_R^2 + V_2^2 = V_1^2$

$\therefore$ VL = $\sqrt{V_1^2 - V_R^2} = \sqrt{(158.11)^2 - (150)^2}$

= 50 cot

$|V_L - V_C| = V_2$ or V_C = 205 Volt

$\cos\phi = \frac{V_R}{V} = \frac{150}{250} = \frac{3}{5}$

For B :

$V_C = V$ = 205 Volt

and $V_R^2 + V_L^2 = (205)^2$

$V_R = V_1$ = 150 volt, wo V_L = 200V

Power factor can be computed by determining the net reactance.

For C :

VR = V3 = 150 Volt

$V_1^2 + V_R^2 = V_L^2$ or V_L = 50 volt

$V_2^2 = V_C^2 + V_R^2$ or V_C = 205 volt

cos f = $\frac{150}{205} = \frac{3}{5}$

For D :

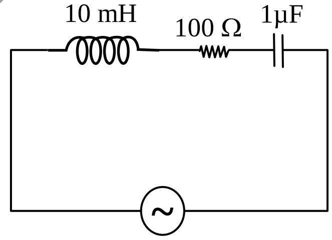
$V_R = V$ = 250 volt

Q.3

Column-I	**Column-II**
(A) To increase current in a series RL circuit	(P) decrease R
(B) To increase phase angle in a series RL circuit	(Q) increase R
(C) To decrease the phase angle in a series RL circuit	(R) increase frequency
(D) To decrease the current in a series RL circuit	(S) connect C in series

Ans. A → P, S ; B → Q ; C → P, R ; D → Q

Q.4 Referring to the given circuit, match column-I with column-II :



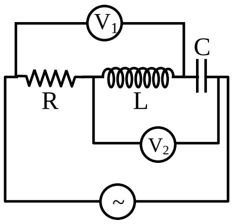
V = 10 sin ωt (Volt)

Column-I	**Column-II**
(A) For ω = 8000 rad/s	(P) Peak current in the circuit is less than 0.1 A
(B) For ω = 10000 rad/s	(Q) Voltage across the combination and the current are in same phase
(C) For ω = 10500 rad/s	(R) Voltage across the combination leads the current
(D) For ω = 10000 rad/s, if R = 50 Ω instead of 100 Ω	(S) Current through the circuit leads the voltage across it

Ans. A → P, S ; B → P, R ; C → Q, S ; D → Q, R

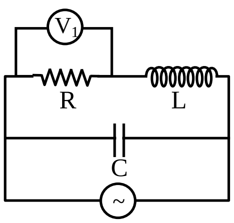
Q.5 In column I some AC circuits with meter readings are given and in column II some circuit quantities are given. Match the entries of column I with the entries of column II.

Column I | **Column II**

(A)


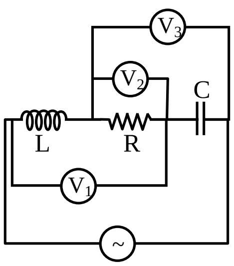
250 Volt
$V_1 = 158.11$ V;
$V_2 = 200$ V

(P) $V_R = 150$ volt

(B)


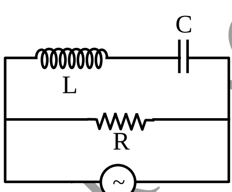
250Volt, $V_1 = 150$Volt

(Q) $V_L = 50$ volt

(C)


250Volt, $V_1 = 158.11$V
$V_2 = 291.6$V;$V_3 = 150$V

(R) $V_C = 250$ volt

(D)


250Volt

(S) Power factor of the circuit is $\frac{3}{5}$

Sol. **A → P, Q, R, S** **B → P, R**
C → P, Q, R **D → R**

For A :

$$V_R^2 + V_2^2 = V^2$$

or $V_R = \sqrt{V^2 - V_2^2} = \sqrt{(250)^2 - (200)^2}$

$= \sqrt{450 \times 50} = 150$ volt

$$V_R^2 + V_L^2 = V_1^2$$

$\therefore \quad V_L = \sqrt{V_1^2 - V_R^2} = \sqrt{(158.11)^2 - (150)^2}$

$= 50$ volt

$|V_L - V_C| = V_2$ or V_C or $V_C = 250$ volt

$$\cos\phi = \frac{V_R}{V} = \frac{150}{250} = \frac{3}{5}$$

For B :

$V_C = V = 250$ volt

and $V_R^2 + V_L^2 = (250)^2$

$V_R = V_1 = 150$ volt, so $V_L = 200$ V

power factor can be computed by determining the net reactance.

For C:

$V_R = V_3 = 150$ volt

$V_1^2 = V_R^2 + V_L^2$ or $V_L = 50$ volt

$V_2^2 = V_C^2 + V_R^2$ or $V_C = 250$ volt

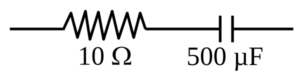
$\cos\phi = \frac{150}{250}$ volt

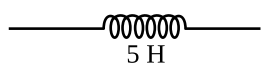
For D :

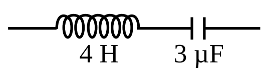
$V_R = V = 250$ volt

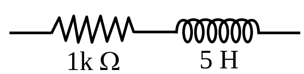
Q.6 Four different circuit components are given in each situation of column-I and all the components are connected across an ac source of same angular frequency ω = 200 rad/sec. The information of phase difference between the current and source voltage in each situation of column-I is given in column-II -

Column-I | **Column-II**

(A)


(B)


(C)


(D)


(P) the magnitude of required phase difference is π/2

(Q) the magnitude of required phase difference is π/4

(R) the current leads in phase to source voltage

(S) the current lags in phase to source voltage

(T) the magnitude of required phase

Ans. **A → Q,R ;** **B → P,S ;**
C → P,R ; **D → Q,S**

PHYSICS

Q.1 In an AC series circuit, the instantaneous current is zero when the instantaneous voltage is maximum. Source may be connected with a

(A) pure inductor
(B) pure capacitor
(C) pure resistor
(D) combination of an inductor and a capacitor

[A,B,D]

Q.2 The reactance of a circuit is zero. It is possible that the circuit contains -

(A) an inductor and a capacitor
(B) an inductor but no capacitor
(C) a capacitor but no inductor
(D) neither an inductor nor a capacitor

[A,D]

Q.3 An AC source rated 100 V(rms) supplies a current of 10 A (rms) to a circuit. The average power delivered by the source -

(A) must be 1000 W
(B) may be 1000 W
(C) may be greater than 1000 W
(D) may be less than 1000 W **[B,D]**

Q.4 An inductor coil having some resistance is connected to an AC source. Which of the following quantities have zero average value over a cycle -

(A) current
(B) induced emf in the inductor
(C) Joule heat
(D) magnetic energy stored in the inductor

[A,B]

Q.5 To convert mechanical energy into electrical energy, one can use -

(A) DC dynamo (B) AC dynamo
(C) motor (D) transformer

[A,B]

Q.6 An alternating voltage of angular frequency ω is applied to an R-L-C circuit. If for the circuit, $\omega^2 = \frac{1}{LC}$, then for the resistance R -

(A) The current is maximum
(B) The current is minimum
(C) The voltage is minimum
(D) The voltage is maximum **[A,D]**

Q.7 L, C and R represent the physical quantities inductance, capacitance and resistance respectively. The combinations which have the dimensions of frequency are - **[IIT -JEE 84]**

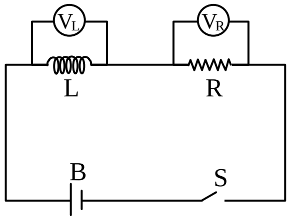
(A) $\frac{1}{RC}$ (B) $\frac{R}{L}$

(C) $\frac{R}{\sqrt{LC}}$ (D) $\frac{C}{L}$ **[A,B]**

Q.8 Which of the following statement is/are correct -

(A) A capacitor acts as an infinite resistance for AC as well as DC current
(B) An electric transformer can set up or down the AC as well as DC voltage both
(C) A hot wire ammeter and voltmeter can measure current & voltage for an AC & DC voltage both
(D) We use a choke coil in series with a tube light to reduce voltage across tube light, without loosing electrical energy in the form of heat, as an ideal inductor does not consume power in a circuit **[C, D]**

Q.9 An inductance L, resistance R, battery B and switch S are connected in series. Voltmeter V_L & V_R are connected across L & R respectively. When 'S' is closed -



(A) the initial reading in V_L will be greater than that in V_R

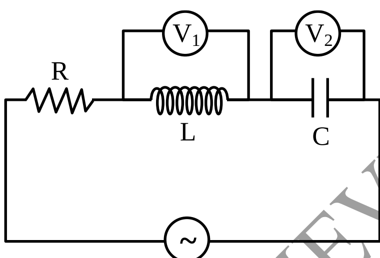
(B) the initial reading in V_L will be less than that in V_R

(C) the initial readings in V_L & V_R will be same

(D) the reading in V_L will decrease as time increases, while that in V_R will increase to maximum value

Sol.[A,D]

Q.10 In the circuit shown, resistance R = 100Ω, inductance L = $\frac{2}{\pi}$ H and capacitance C = $\frac{8}{\pi}$ μF are connected in series with an ac source of 200volt and frequency 'f '. If the readings of the hot wire voltmeters V_1 and V_2 are same then -



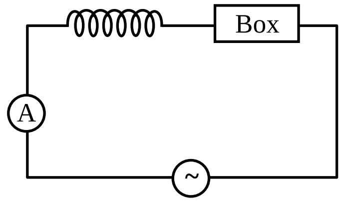
(A) f = 125 Hz (B) f = 250 πHz

(C) current through R is 2A

(D) $V_1 = V_2 = 1000$ volt

Sol.[A,C,D]

Q.1 An inductor of 0.1 Henry and a box are connected to AC supply of 25 volts and ω = 100 rad/sec over all power factor of circuit is 1 and the reading of AC ammeter (I_{rms}) is 5A. Find the power factor of box.



Ans .[0000] $z = x + y\,i + \omega L\, i$

$= x + i\,(y + \omega L)$ for power factor to be one $y + \omega L = 0 \Rightarrow y = -10$

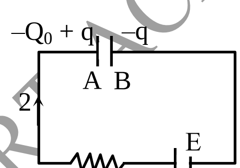
$I = \dfrac{V_0}{x}$, $\quad x = \dfrac{V_0}{I} = \dfrac{25}{5} = 5$

Impedance of box = $5 - 10\,i$

$\cos\phi = \dfrac{5}{\sqrt{10^2 + 5^2}} = \dfrac{1}{\sqrt{5}} = 0.447$

Q.2 The figure shows a RC circuit with a parallel plate capacitor, before switching on the circuit plate A of the capacitor has a charge $-Q_0$, while plate B has no net charge. Now at t = 0, the circuit is switched on. How much time (in second) will elapse before the net charge on plate A becomes zero. (Given C = 1 μF, Q_0 = 1 mC, E = 1000 V and $R = \dfrac{2\times10^6}{\log_e 3}\,\Omega$).

Ans .[0002]



At any time t charge q flow from plate B to plate A

Kirchoff's law

$$iR + \frac{2q - Q_0}{2C} - E = 0$$

$$\frac{dq}{dt}R + \frac{2q - Q_0}{2C} - E = 0$$

$$R.\frac{dq}{dt} = \frac{Q_0 - 2q}{2Rc} + E \Rightarrow \frac{dq}{dt} = \frac{Q_0 - 2q + CE}{2RC}$$

$$\int_0^{Q_0} \frac{1}{Q_0 - 2q + 2CE}\, dq = \int_0^t \frac{1}{2RC}\, dt$$

$$t = RC \log_e\left[\frac{2CE + Q_0}{2CE - Q_0}\right]$$

putting the value of

C, Q_0, E and R we get t = 2sec.

Q.3 A series LCR circuit containing a resistance of 120Ω has angular resonance frequency $4 \times 10^5 \text{rads}^{-1}$. At resonance the voltage across resistance and inductance are 60 V & 40 V respectively. At what frequency the current in the circuit lags the voltage by 45°. Give answer in

--------$\times 10^5$ rad/sec.

Sol. [8] At resonance reactance = 0

$$I = \frac{V}{R} = \frac{60}{120} = \frac{1}{2}\text{ Amp.}$$

$V_L = I \times X_L = I \times \omega L$

$\therefore L = \dfrac{V_L}{I\omega}$ ………(i)

$\omega_0 = \dfrac{1}{\sqrt{LC}}$

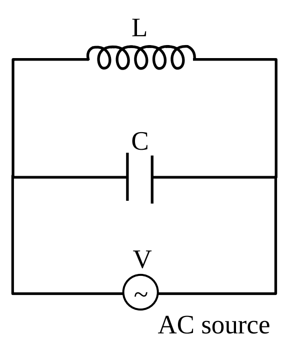
$C = \dfrac{1}{L\omega_0^{\,2}}$ ……….(ii)

Calculate L & C from (1) & (2) current will lag the applied voltage by 45°

if $\tan 45° = \dfrac{\omega L - \dfrac{1}{\omega c}}{R}$

Solve for ω $\quad \omega = 8 \times 10^5$ rad/sec

Q.4



AC source

Current in the inductance is 0.8 A while in the capacitance is 0.6 A. The current drawn from the source is ------$\times 10^{-1}$ Amp.

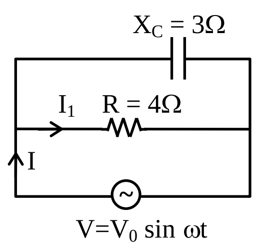
Sol. [2]

$I_{Net} = I_L - I_C$

$= 0.8 - 0.6$

$= 0.2$ Amp.

Q.5 A capacitor and Resistor are connected with an AC source as shown in figure.



Reactance of capacitor is $X_C = 3\Omega$ and resistance of resistor is 4Ω. Phase difference between current I and I_1 is approx …….$\times 10^{-1}$ radian.

Sol. **[6]**

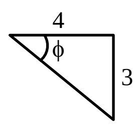
$Z = R - J \times C$

$Z = 4 - 3J$

$Z = 5\angle \tan\left(\frac{-3}{4}\right) = 5\angle -37^\circ$

$I = \frac{V_0 \sin \omega t}{Z}$

$I = \frac{V_0}{Z}\sin(\omega t + \phi)$ where $\tan\phi = \frac{3}{4} \Rightarrow \phi = 37^\circ$



phase difference between

I and $I_1 = 37^\circ$

Q.6 An inductor coil, capacitor and an A.C. source of rms voltage 24V are connected in series. When the frequency of the source is varied, a maximum rms current of 6.0 A is observed. If this inductor coil is connected to a battery of emf 12V and of internal resistance 4Ω, the current will be ……….. $\times$ 0.3 amp.

Sol. **[5]**

Current at resonance $= \frac{V}{R}$

$\Rightarrow R = \frac{V}{I} = \frac{24}{6} = 4\Omega$

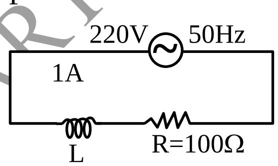
Current by 12V battery $= \frac{E}{R + r} = \frac{12}{4 + 4} = 1.5$ A

Q.1 In series LCR circuit voltage drop across resistance is 8 volt and across capacitor is 12 volt. Then :
(A Voltage of the source will be leading current in the circuit
(B) Voltage drop across each element will be less than the applied voltage
(C) power factor of circuit will be 4/3
(D) None of these **[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
$V = \sqrt{(V_L - V_C)^2} \qquad = \sqrt{(6-12)^2 + 8^2}$
V = 10 ; which is less than voltage drop across capacitor .

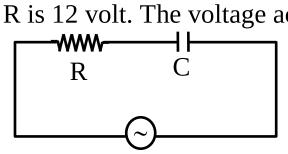
Q.2 A bulb is rated at 100 V, 100 W, it can be treated as a resistor. Find out the inductance of an inductor (called choke coil) that should be connected in series with the bulb to operate the bulb at its rated power with the help of an ac source of 200V and 50 Hz.
(A) $\frac{\pi}{\sqrt{3}}$ H (B) 100 H
(C) $\frac{\sqrt{2}}{\pi}$ H (D) $\frac{\sqrt{3}}{\pi}$ H **[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,
$_{rms} = \frac{V_{rms}}{Z} \therefore 1 = \frac{200}{\sqrt{100^2 + (2\pi 50L)^2}} \Rightarrow L = \frac{\sqrt{3}}{\pi}$ H

Q.3 A 50 Hz ac source of 20 volts is connected across R and C as shown in figure. The voltage across R is 12 volt. The voltage across C is –



(A) 8 V
(B) 16 V
(C) 10 V
(D) not possible to determine unless values of R and C are given **[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.4 The e.m.f E = 4 cos 1000t volts is applied to an L–R circuit containing inductance 3mH and resistance 4 Ω . The amplitude of current is -
(A) $4\sqrt{7}$ A (B) 1.0 A
(C) $\frac{4}{7}$ A (D) 0.8 A **[D]**

Sol. $i_0 = \frac{v_0}{Z}$,
$Z = \sqrt{R^2 + (\omega L)^2}$
$= \sqrt{4^2 + (1000 \times 3 \times 10^{-3})^2} = 5\ \Omega$
$i_0 = \frac{4}{5}$
$i_0 = 0.8A$

Q. 5 A 750 Hz, 20 volt source is connected to a resistance of 100 ohm, an inductance of 0.1803 henry and a capacitance of 10μF, all in series. The time in which the resistance (thermal capacity = 2 joule/ºC) will get heated by 10ºC is -
(A) 348 sec (B) 328 sec
(C) 248 sec (D) 228 sec

Sol. **[A]**
$I_{rms} = \frac{E_{rms}}{Z} = \frac{E_v}{\sqrt{R^2 + \left(\omega L - \frac{1}{\omega C}\right)^2}}$
= 0.023 amp
$\therefore H = I^2Rt = 2 \times 10$
or $(0.023)^2 \times 100 \times t = 20$

$$\therefore\ t = \frac{20}{(0.023)^2 \times 100} = 348 \text{ sec}$$

Q. 6 An AC ammeter is used to measure current in a circuit. When a given direct current passes through the circuit, the AC ammeter reads 3 ampere. When another alternating current passes through the circuit, the AC ammeter reads 4 ampere. Then the reading of this ammeter if DC and AC flow through the circuit simultaneously, is -

(A) 3 amper (B) 1 ampere

(C) 7 ampere (D) 5 ampere

Sol. **[D]**

Quantity of heat liberated in the ammeter of resistance R

(i) due to direct current of 3 ampere = [(3)2 R/J]

(ii) due to alternating current of 4 ampere

$= [(4)^2 R/J]$

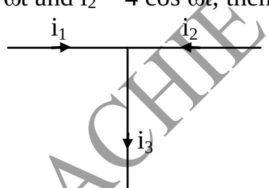
Total heat produced per second

$$= \frac{(3)^2 R}{J} + \frac{(4)^2 R}{J} = \frac{25R}{J}$$

Let the equivalent alternating current be I ampere; then $\frac{I^2 R}{J} = \frac{25R}{J}$

or I = 5 amp

Q.7 If $i_1 = 3 \sin \omega t$ and $i_2 = 4 \cos \omega t$, then i_3 is –



(A) 5 sin (ωt + 53º) (B) 5 sin (ωt + 37º)

(C) 5 sin (ωt + 45º) (D) 5 cos (ωt + 53º)

Sol. **[A]**

From Kirchoff's current law,

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

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

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

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

Q. 8 For An alternating current :

(A) r.m.s value may be equal to peak value

(B) average value may be equal to peak value

(C) r.m.s value may be equal to average value

(D) All of the above

Sol. **[D]**

If AC is the square wave then all these three options are possible

Q.9 For an alternating current -

(A) r.m.s. value may be equal to peak value

(B) average value be equal to peak value

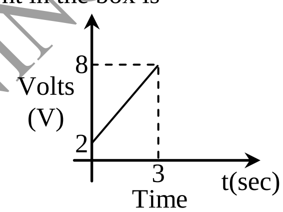
(C) r.m.s. value be equal to average value

(D) All of the above

Sol. **[D]**

If AC is the square wave then all these three options are possible.

Q.10 A circuit element is placed in a closed box. At time t = 0, a constant current generator supplying a current of I amp is connected across the box. Potential diff. across the box varies according to graph as shown in the figure. The element in the box is -



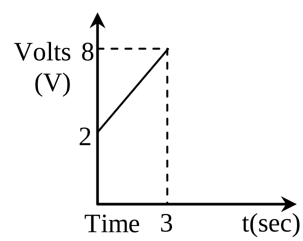
(A) a resistance of 2Ω

(B) a battery of emf 6V

(C) an inductance of 2H

(D) a capacitance

Sol. **[D]**



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

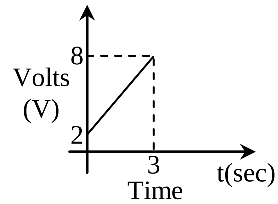
$q = it + a$

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

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

∴ V is proportional to time.

Q.11 A circuit element is placed in a closed box. At time t = 0, a constant current generator supplying a current of I amp is connected across the box. Potential diff. across the box varies according to graph as shown in the figure. The element in the box is -



(A) a resistance of 2Ω
(B) a battery of emf 6V
(C) an inductance of 2H
(D) a capacitance

Sol. **[D]**

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

$q = it + a$

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

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

$\therefore$ V is proportional to time

Q.12 An alternating current changes from a complete cycle in 1 μs, then the frequency in Hz will be -

(A) 10^{-6} (B) 50
(C) 100 (D) 10^{6} **[D]**

Q.13 In an ac circuit, the current is given by
$i = 4 \sin (100\pi t + 30^o)$ ampere. The current becomes maximum first time (after t = 0) at t equal to –

(A) (1/200) sec (B) (1/300) sec
(C) (1/50) sec (D) None of these **[B]**

Q.14 The r.m.s. value of potential due to superposition of given two alternating potentials $E_1 = E_0 \sin \omega t$ and $E_2 = E_0 \cos \omega t$ will be -

(A) E_0 (B) $2E_0$
(C) $E_0\sqrt{2}$ (D) 0 **[A]**

Q.15 The r.m.s. value of alternating current is 10 amp having frequency of 50 Hz. The time taken by the current to increase from zero to maximum and the maximum value of current will be –

(A) 2×10^{-2} sec and 14.14 amp
(B) 1×10^{-2} sec and 7.07 amp
(C) 5×10^{-3} sec and 7.07 amp
(D) 5×10^{-3} sec and 14.14 amp **[D]**

Q.16 The current through a wire changes with time according to the equation $I = \sqrt{t}$. The correct value of the rms current within the time interval t = 2 to t = 4s will be -

(A) $\sqrt{3}$ A (B) 3 A
(C) 3 A (D) None of these
[A]

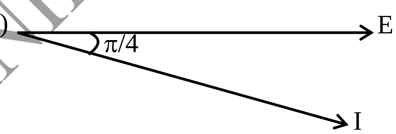
Q.17 In a circuit an A.C. current and a D. C. current are supplied together. The expression of the instantaneous current is given as

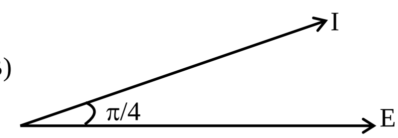
$i = 3 + 6 \sin \omega t$

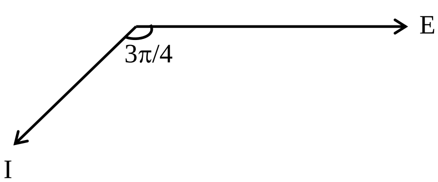
Then the rms value of the current is –

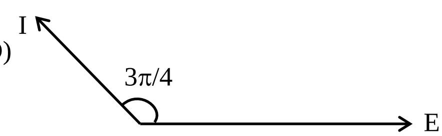
(A) 3 (B) 6
(C) $3\sqrt{2}$ (D) $3\sqrt{3}$ **[D]**

Q.18 In a certain circuit $E = 200 \cos (314t)$ and $I = \sin (314t + \pi/4)$. Their vector representation is –

(A)


(B)


(C)


(D)


[A]

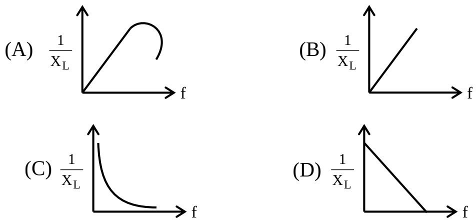
Q.19 The inductance of a resistance less coil is 0.5 Henry. In the coil the value of A.C. is 0.2 amp whose frequency is 50 Hz. The reactance of circuit is -

(A) 15.7 Ω (B) 157 Ω
(C) 1.57 Ω (D) 757 Ω **[B]**

Q.20 In an A.C. circuit, a capacitor of 1μF value is connected to a source of frequency 1000 rad/sec. The value of capacitive reactance will be –

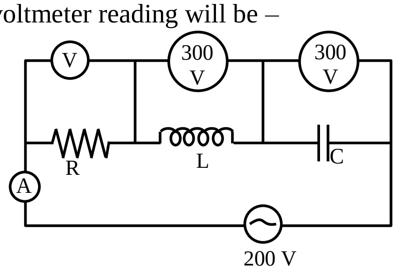
(A) 10 Ω (B) 100 Ω
(C) 1000 Ω (D) 10,000 Ω **[B]**

Q.21 In pure inductive circuit, the curves between frequency f and inductive reactance $1/X_L$ is –



[C]

Q.22 In the series circuit shown in the figure the voltmeter reading will be –

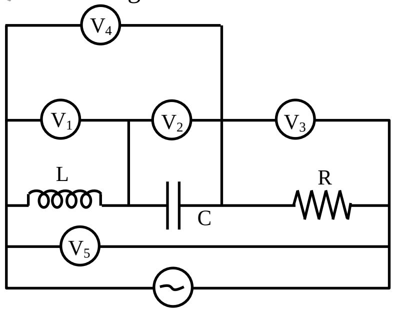


(A) 300 V (B) 900 V
(C) 200 V (D) 100 V **[C]**

Q.23 The series combination of resistance R and inductance L is connected to an alternating source of e.m.f. e = 311 sin (100 πt). If the value of wattless current is 0.5A and the impedance of the circuit is 311 Ω, the power factor will be –

(A) $\frac{1}{2}$ (B) $\frac{\sqrt{3}}{2}$
(C) $\frac{1}{\sqrt{3}}$ (D) $\frac{1}{\sqrt{5}}$ **[B]**

Q.24 In the adjoining A.C. circuit the voltmeter whose reading will be zero at resonance is-



(A) V_1 (B) V_2
(C) V_3 (D) V_4 **[D]**

Q.25 In the above problem, the two voltmeters whose readings are equal, will be –

(A) V_4 and V_1 (B) V_1 and V_3
(C) V_4 and V_5 (D) V_1 and V_2 **[D]**

Q.26 When 100 V dc is applied across a solenoid, a current of 1.0 A flows in it. When 100 V and 50 Hz ac is applied across it, the current drops to 0.5 A. The inductance and the impedance of the solenoid are respectively-

(A) 0.45 H, 100 ohm
(B) 0.045 H, 100 ohm
(C) 0.55 H, 200 ohm
(D) 0.055 H, 200 ohm **[C]**

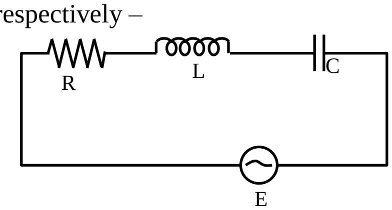
Q.27 The inductance of the motor of a fan is 1.0 H. To run the fan at 50 Hz the capacitance of the capacitor that will cancel its inductive reactance, will be -

(A) 10 μF (B) 40 μF
(C) 0.4 μF (D) 0.04 μF **[A]**

Q.28 The potential difference between the ends of a resistance R is V_R between the ends of capacitor is $V_C = 2V_R$ and between the ends of inductance is $V_L = 3V_R$, then the alternating potential of the source in terms of V_R will be -

(A) $\sqrt{2}\ V_R$ (B) V_R
(C) $V_R/\sqrt{2}$ (D) $5V_R$ **[A]**

Q.18 If E_0 = 200 volt, R = 25 ohm, L = 0.1 H and C = 10^{-5} F and the frequency is variable, then the current at f = 0 and f = ∞ will be respectively –



(A) 0 A, 8 A (B) 8 A, 0 A
(C) 8 A, 8 A (D) 0 A, 0 A **[D]**

Q.29 The frequency of an alternating current is 50 Hz, then the time to complete one cycle for current vector will be-

(A) 20 ms (B) 50 ms

(C) 100 ms (D) 1 s **[A]**

Q.30 The sinusoidal voltage wave changes from 0 to maximum value of 100 volt. The voltage when the phase angle is 30º will be -

(A) 70.7 volt (B) 50 volt

(C) 109 volt (D) – 100 volt **[B]**

Q.31 If the frequency of ac is 60 Hz the time difference corresponding to a phase difference of 60º is –

(A) 60 s (B) 1 s

(C) 1/60 s (D) 1/360 s **[D]**

Q.32 An LCR series circuit with 100 Ω resistance is connected to an AC source of 200 V and angular frequency 300 radians per second. When only the capacitance is removed, the current lags behind the voltage by 60º. When only the inductance is removed, the current leads the voltage by 60º. Then the current and power dissipated in LCR circuit are respectively

(A) 1A, 200 watt (B) 1A, 400 watt

(C) 2A, 200 watt (D) 2A, 400 watt **[D]**

Sol. When capacitance is removed

$\tan\theta = \dfrac{\omega L}{R}$ or $\omega L = 100 \tan 60^\circ$ …(1)

when inductance is removed

$\tan\phi = \dfrac{1}{(\omega C)(R)}$ or $\dfrac{1}{\omega C} = 100 \tan 60^\circ$ ….(2)

So Z = R = 100 Ω

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

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

Q.33 A 100 volt AC source of frequency 500 Hz is connected to a L–C-R circuit with L = 8.1 mH, C = 12.5 μF and R = 10 Ω, all connected in series. The potential difference across the resistance is -

(A) 100 V (B) 200 V

(C) 300 V (D) 400 V **[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 $X_C = \dfrac{1}{2\pi f C} = \dfrac{1}{2\times3.14\times500\times12.5\times10^{-6}}$
$= 25.4\ \Omega$

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

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.34 RMS value of ac $i = i_1 \cos\omega t + i_2 \sin\omega t$ will be–

(A) $\frac{1}{\sqrt{2}}(i_1 + i_2)$ (B) $\frac{1}{\sqrt{2}}(i_1 + i_2)^2$

(C) $\frac{1}{\sqrt{2}}(i_1^2 + i_2^2)^{1/2}$ (D) $\frac{1}{2}(i_1^2 + i_2^2)^{1/2}$

[C]

Q.35 Alternating current lead the applied e.m.f. by π/2 when the circuit consists of -

(A) only resistance

(B) only capacitor

(C) only an inductance coil

(D) capacitor and resistance both **[B]**

Q.36 The percentage increase in the impedance of an ac circuit, when its power factor changes form 0.866 to 0.5 is -

(A) 73.2% (B) 86.6%

(C) 90.8% (D) 66.6% **[A]**

Q.37 The time required for a 50Hz alternating current to increase from zero to 70.7% of its peak value is -

(A) 2.5 ms (B) 10 ms

(C) 20 ms (D) 14.14 ms **[A]**

Q.38 The peak value of the following A.C. current $i = 4 \sin\omega t + 4 \sin(\omega t + 2\pi/3)$ is –

(A) $4\sqrt{2}$ (B) $2\sqrt{2}$

(C) 8 (D) 4 **[D]**

Q.39 In a series A.C. circuit $X_L = 300\Omega$, $X_C = 200\Omega$ and $R = 100\Omega$ the impedance of circuit is -

(A) 600Ω (B) 200Ω

(C) 141Ω (D) None of these

[C]

Q.40 When a material is inserted inside the inductor, current increases then the nature of material is –

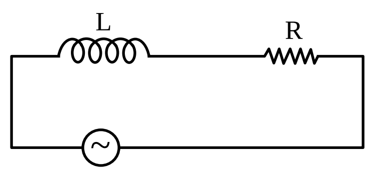


Fig.

(A) ferromagnetic (B) paramagnetic

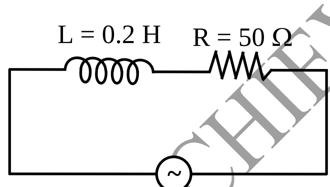
(C) diamagnetic (D) ferrimagnetic

[C]

Sol. L should decrease so that z

$= \sqrt{X_L^2 + R^2}$ decreases.

Q.41 In the given circuit the average power developed is –



V = 200 sin(250 t) volt

(A) $50\sqrt{2}$ watt

(B) 200 watt

(C) $150\sqrt{2}$ watt

(D) $200\sqrt{2}$ watt **[B]**

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

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

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

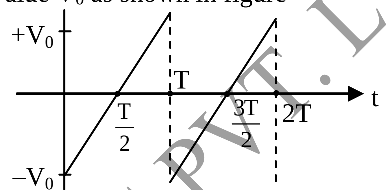
$$Z = \sqrt{R^2 + (L\omega)^2} = \sqrt{(50)^2 + (0.2 \times 250)^2}$$

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

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

= 200 watt

Q.42 Rms value of the saw-tooth voltage of peak value V_0 as shown in figure –



(A) $\frac{V_0}{2}$ (B) $\frac{V_0}{\sqrt{2}}$

(C) $\frac{V_0}{3}$ (D) $\frac{V_0}{\sqrt{3}}$ **[D]**

Sol.

$$v_{rms} = \sqrt{\frac{\int_0^T v^2 dt}{T}} = \sqrt{\frac{\int_0^T \left(-v_0 + \frac{2v_0 t}{T}\right)^2 dt}{T}}$$

Q.43 The voltage E and the current I in an instrument are represented by the equations:

$E = 2 \cos \omega t$ Volt

$I = 2 \sin \omega t$ Amp.

The power dissipated in the instrument will be-

(A) Zero (B) 1.0 W

(C) 4 W (D) 2.0 W **[A]**

Q.44 The ratio of apparent power and average power in an A.C. circuit is equal to -

(A) Reciprocal of power factor

(B) Efficiency

(C) Power factor

(D) Form factor **[A]**

Q.45 An ac circuit resonates at a frequency of 10 kHz. If its frequency is increased to 11 kHz, then :

(A) Impedance will increase by 1.1 times

(B) Impedance will remain unchanged

(C) Impedance will increase and become inductive

(D) Impedance will increase and become capacitive **[C]**

Q.46 In a series LCR circuit with an AC source R = 300 Ω, C = 20 μF, L = 1 H, E_{rms} = 50 V and $\nu = \frac{50}{\pi}$ Hz . The potential difference across the capacitor is –

(A) 50 V (B) $\frac{50}{\sqrt{2}}$ V

(C) 40 V (D) $\frac{40}{\sqrt{2}}$ V **[A]**

Sol. $X_C = \frac{1}{C\omega} = \frac{1}{20\times10^{-6}\times2\pi\times\frac{50}{\pi}} = 500\ \Omega$

$X_L = L\omega = L\times2\pi\times\frac{50}{\pi} = 100\ \Omega$

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

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

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

$V_C = I_{rms}\times X_C$

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

= 50 V

Q.47 A 60 W/120 V bulb is connected to a 240/60 Hz supply with an inductance in series. Find the value of inductance so that bulb gets correct voltage –

(A) $\frac{2.3}{\pi}$ H (B) $2\sqrt{3}$ H

(C) π H (D) $\frac{2\sqrt{3}}{\pi}$ H **[D]**

Sol. $R = \frac{(120)^2}{60} = 240\ \Omega$ we require i = 0.5 A

or |Z| = 480 Ω

$X_L = \sqrt{480^2-240^2} = 240\sqrt{3}\ \Omega$

$L = \frac{240\sqrt{3}}{60\times2\pi} = \frac{2.\sqrt{3}}{\pi}$ H

Q.48 An inductor 10 Ω/60º is connected to a 5Ω resistance in series. Find net impedance –

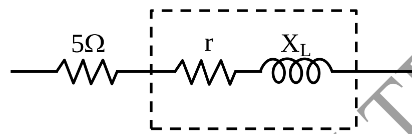


Fig.

(A) 15 Ω (B) 12 Ω

(C) 13.2 Ω (D) 18 Ω **[C]**

Sol. $10 = \sqrt{r^2+X_L^2}$ and $\frac{X_L}{r} = \tan 60$

$10 = \sqrt{r^2+(r\sqrt{3})^2}$ or r = 5 Ω, $X_L = 5\sqrt{3}\ \Omega$

$Z = \sqrt{(5+5)^2+(5+\sqrt{3})^2} = \sqrt{175} = 13.2\ \Omega$

$\tan\phi = \frac{X_L}{R+r} = \frac{5\sqrt{3}}{10}$

or $\phi = \tan^{-1}\left(\frac{\sqrt{3}}{2}\right)$.

Q.49 We have two cables of copper of same length. In one, only one wire of cross-section area A and in second ten wires each of cross-section area A/10 are present. When A.C. and D.C. flow in it. Choose the correct cable for better efficiency–

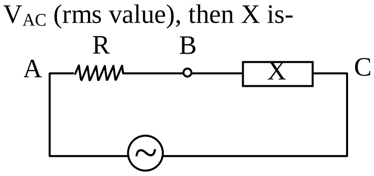
(A) Only one wire for D.C. and the other for A.C

(B) Only one wire for A.C. and the other for D.C.

(C) Any wire for D.C. but only multy-wire cable for A.C.

(D) Only one wire for D.C. and only multy-wire packet for A.C. **[C]**

Q.50 A unknown circuit element X is connected in series with a resistor R to an ac source. If $V_{AB} = V_{AC}$ (rms value), then X is-



(A) Pure resistor

(B) Pure capacitor

(C) Pure conductor

(D) Combination of conductor & capacitor at resonance **[D]**

Sol. At resonance

$V_{BC} = 0$

$\therefore$ V_{AB} become equal to V_{AC}

Q.1 A transformer has 50 turns in the primary and 100 in the secondary. If the primary is connected to a 220 V DC supply, what will be the voltage across the secondary ?

Ans. zero

Q.2 Find the time required for a 50 Hz alternating current to change its value from zero to the rms value.

Ans. 2.5 ms

Q.3 A current is made of two components : a 5 amp D.C. component and a 60 cycle A.C. sinusoidal component of peak value 4 amp. Write down an expression for the resultant current and calculate the average current over a complete cycle and effective value of the current.

Ans. 5 amp, 5.75 amp

Q.4 Find out the rms value of the following alternating emf E = (8 sin ωt + 6 sin 2ωt) volts

Ans. 7.07 volts

Q.5 A current is made of two components, 3 amp d.c. component and an a.c. component given by I = 4 sin ωt amp. Find out an expression for the resultant current and calculate its effective value.

Ans. $\sqrt{17}$ amp

Q.6 The dielectric strength of air is 3.0×10^6 V/m. A parallel-plate air-capacitor has area 20 cm^2 and plate separation 0.10 mm. Find the maximum rms voltage of an AC source which can be safely connected to this capacitor.

Ans. 210V

Q.7 A 25 μF capacitor, 0.1 henry inductor and a 25.0 ohm resistor are connected in series with a source, whose e.m.f. is given by

E = 310 cos 314 t volts

(a) What is the frequency of the e.mf. ?

(b) What is the reactance of the circuit ?

(c) what is the current in the circuit ?

(d) what is the phase angle of the current by which it leads or lags the applied e.m.f. ?

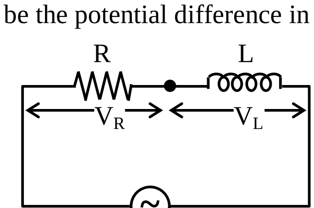
(e) what is the expression for the instantaneous value of current in the circuit ?

Ans. (a) 50 cps (b) 96 Ω (c) 2.21amp (d) 1.316 rad (e) 3.125 cos (314t + 1.316)

Q.8 The current in a discharging LR circuit is given by $i = i_0 e^{-t/\tau}$ where τ is the time constant of the circuit. Calculate the rms current for the period t = 0 to t = τ.

Ans. $\frac{i}{e}\sqrt{(e^2-1)/2}$

Q.9 The shown alternating current circuit has a resistanceless coil L and a resistance R. The potential difference across the choke is V_L = 160 volt and the potential difference across the resistance is V_R = 120 volt. Find the virtual value of the applied voltage. If the virtual current in the circuit is 1.0 ampere, then calculate the total impedance of the circuit. If a direct current be passed in the circuit, then what will be the potential difference in the circuit ?



$V = V_0 \sin\omega t$

Ans. 200 ohms, 120 volts

Q.10 A certain choke coil of negligible resistance takes a current of 8 amperes when connected to a supply of 100 volts, at 50 cycles per sec. A certain non-inductive resistance, under the same conditions, carries a current of 10 amp. If the two are transferred to a supply system working at 150 volts, at 40 cycles per second, what total current will they take (a) if joined in series (b) if joined in parallel.

Ans. 10.6 ampere, 21.2 ampere

Q.11 The operating coil of a relay of inductance 8mH and a resistance of 30 ohms in connected to an A.C. source of 5volts 800 cps. Find the current through the coil, and the phase angle of the current relative to the applied voltage. How could this phase angle be reduced to zero without altering the value of the current passing through the coil when the relay is operated from the same A.C. supply ?

Ans. 0.1amp, $\phi = 53^{\circ}\ 8'$, 5μF

Q.12 A lamp, which can carry a current of 10 ampere at 15 volts is connected to an alternating source of 220 volts. The frequency of the source is 50 cycles/sec. Find the inductance of the choke coil required to lit the lamp.

Ans. 0.07 H

Q.13 An inductance of 2.0 H, a capacitance of 18 μF and a resistance of 10 kΩ are connected to an AC source of 20 V with adjustable frequency. (a) What frequency should be chosen to maximise the current in the circuit ? (b) What is the value of this maximum current ?

Ans. (a) 27 Hz (b) 2 mA

Q.14 An e.m.f. E = 150 cos 314t volts is applied to a purely resistive branch having R= 30 ohms. Find out expressions for current and power as a function of time. Also calculate the frequencies of current and power variations.

Ans. I = 5 cos 314t, P = 375 + 375 cos 628 t, 50 cps & 100 cps

Q.15 Find the value of inductance which should be connected in series with a capacitance of 0.5 μF, a resistance of 10 ohms and an A.C. source of 50 cps so that the power factor of the circuit is unity.

Ans. 20.26 H

Q.16 An a.c. source has got an internal resistance of 10^4 ohms.

(i) What should be the secondary to primary turn ratio of a transformer to match the source to a load of resistance 10 ohms ?

(ii) It the voltage amplitude of the source is 100 volts, what is the voltage amplitude of the secondary in open circuit ?

Ans. (a) 3.16×10^{-2} (b) 3.16 volts

Q.17 A 60 cycles a.c. circuit has resistance 2 ohms and inductance 10 millihenry. What is the power factor ? What capacitance, placed in the circuit, will make the power factor unity? By how much does the insertion of the capacitance increase the current ?

Ans. 0.47, 704 μF and 53%

Q.18 A coil has a current at 1.0 ampere and a power of 100 watt from an A.C. source of 110 volt and 50 hertz. Find the inductance and resistance of the coil.

Ans. 1000 ohms, 0.146 henry

Q.19 Prove that in a series LCR circuit, the frequencies f_1 and f_2 at which the current amplitude falls to $1/\sqrt{2}$ of the current at resonance, are separated by an interval equal to $(R/2\pi L)$.

Q.20 A resistor of resistance 100 Ω is connected to an AC source $\varepsilon = (12\ V) \sin (250\ \pi s^{-1})\ t$. Find the energy dissipated as heat during t = 0 to t = 1.0 ms.

Ans. 2.16×10^{-4}J