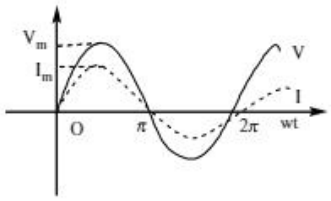
4. ALTERNATING CURRENT

SYNOPSIS

1. Alternating Current (ac) :

$V = V_m \sin \omega t$; $I = I_m \sin \omega t$



i) Average current over a complete cycle is zero

ii) Therefore for symmetric waves, the average value for half cycle is measured.

iii) Average value of a.c is equal to that d.c which transfers across any circuit the same charge as is transferred by that d.c during the same time

iv) Its magnitude is obtained by integrating instantaneous value of currents over one half cycle.

v) Average value $i_{ave} = \frac{2}{\pi} i_0 = 0.637\ i_o$

Similarly $e_{ave} = \frac{2}{\pi} e_0 = 0.637\ e_o$

vi) Even though average current for complete cycle is zero, power dissipation through the resistor is not zero, as joule heating effect is proportional to i^2

vii) Root mean square (rms) current is the square root of the average of squares of all the instantaneous values of current over one complete cycle.

viii) rms current is equal to that d.c which when flowing through a given circuit for a given time produces the same heat as produced by the a.c when flowing through the same circuit for the same time

ix) rms value of current is given by

$$i_{rms} = \frac{i_0}{\sqrt{2}} = 0.707\ i_0$$

x) Similarly rms value of voltage is

$$e_{rms} = \frac{e_0}{\sqrt{2}} = 0.707\ e_0$$

xi) When d.c ammeter is connected to an a.c source it shows zero reading.

xii) The reading given by a.c ammeter is rms current.

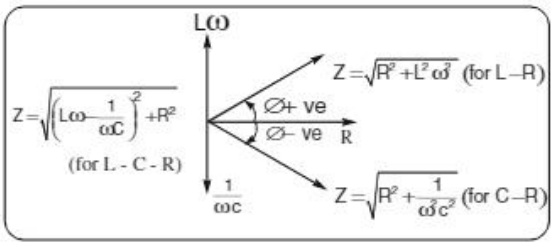
xiii) It is customary to measure and specify rms values for a.c quantities. For example, the household line voltage 220V is an rms value with a peak voltage of $V_0 = \sqrt{2}\ V_{rms} = 311\,V$

xiv) Average power loss (P), when a resistor is connected to an a.c source is given by

$P = V_{rms}^2 / R$ (or) $P = I_{rms} V_{rms}$ (or) $P = I_{rms}^2 R$

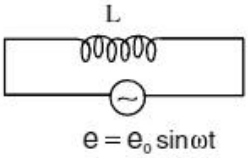
2. Ac Circuits :

The total Resistance a circuit offers is called **Impedance (Z).** And it is equal to $\sqrt{(X_L - X_C)^2 + R^2}$



A.c voltage applied to Inductor :

i) The instantaneous alternating current is given by $i = i_0 \sin(\omega t - \phi)$

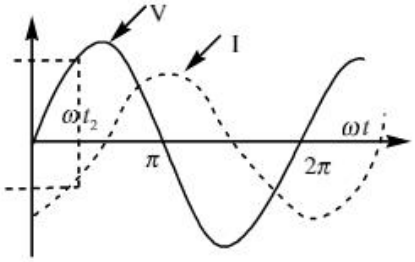


ii) The peak or maximum current is given by $i_0 = \frac{e_0}{z}$

iii) The impedance (inductive reactance X_L) is given by $Z = L\omega$

iv) The phase difference between emf and current is given by $\phi = \tan^{-1}\frac{\omega L}{0}$

$\phi = \frac{\pi}{2}$



Voltage leads current by $\frac{\pi}{2}$

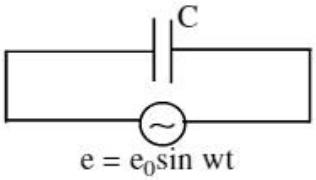
A.c voltage applied to Capacitor:

i) The instantaneous alternating current is given by $i = i_0 \sin(\omega t + \phi)$

ii) The peak or maximum current is given by $i_0 = \frac{e_0}{z}$

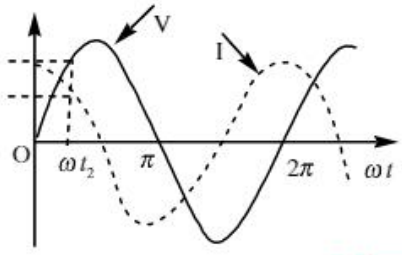
iii) The impedance is given by(capacitive reactance X_C)

$Z = \frac{1}{c\omega}$



iv) The phase difference between emf and current is given by $\phi = \tan^{-1}\frac{1/C\omega}{0}$

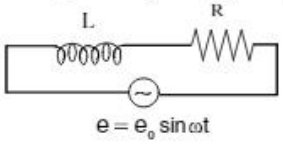
$\phi = \frac{\pi}{2}$



Current leads voltage by $\frac{\pi}{2}$

3. A.c voltage applied across L-R series combination

i) The instantaneous alternating current is given by $i = i_0 \sin(\omega t - \phi)$

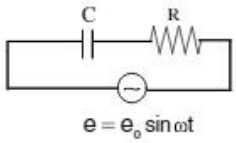


ii) The peak or maximum current is given by $i_0 = \frac{e_0}{z}$

iii) The impedance is given by $z = \sqrt{R^2 + L^2\omega^2}$

iv) The phase difference between emf and current is given by $\phi = \tan^{-1}\frac{L\omega}{R}$ (ϕ is positive Voltage leads current by ϕ)

A.c voltage applied across R-C series combination



i) The instantaneous alternating current is given by $i = i_0 \sin(\omega t + \phi)$

ii) The peak or maximum current is given by $i_0 = \frac{e_0}{z}$

iii) The impedance is given by $z = \sqrt{\frac{1}{C^2\omega^2} + R^2}$

iv) The phase difference between emf and current is given by $\phi = \tan^{-1}\left(\frac{1}{c\omega}\Big/R\right)$

ϕ is negative. Current leads voltage by ϕ

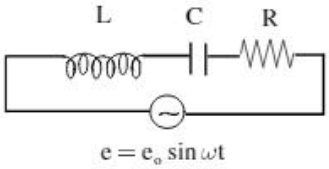
4. A.c voltage applied across L-C-R series combination

i) The instantaneous alternating current is given by $i = i_0 \sin(\omega t \pm \phi)$

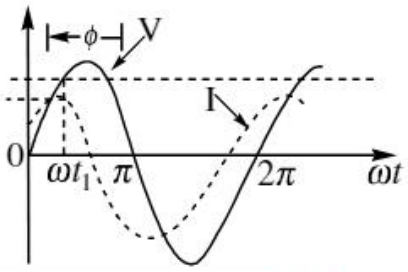
ii) The peak or maximum current is given by $i_0 = \frac{e_0}{z}$

iii) The impedance is given by

$$z = \sqrt{\left(L\omega - \frac{1}{\omega C}\right)^2 + R^2}$$



iv) The phase difference between emf and current is given by $\phi = \tan^{-1}\frac{\left(L\omega - \frac{1}{\omega C}\right)}{R}$



Case - i If $L\omega > \frac{1}{\omega C}$; ϕ is positive Voltage leads current by ϕ. Circuit is predominantly **Inductive**

Case - ii If $\frac{1}{\omega C} > L\omega$; ϕ is negative

Current leads voltage by ϕ ; Circuit is predominantly **capacitive**

Case-iii If $L\omega = \frac{1}{\omega c}$; ϕ is zero . Voltage and current are inphase. This condition is called **Resonance**

at resonance $\omega_0 = \frac{1}{\sqrt{LC}}$ $\boxed{n_0 = \frac{1}{2\pi\sqrt{LC}}}$

This frequency is called resonant frequency At resonant frequency, the current amplitude (i_0) is maximum $\boxed{i_0 = \frac{e_0}{R}}$

i) It is important to note that resonance phenomenon is exhibited by a circuit only if both L and C are present in the circuit. Only then the voltages across L and C cancel each other (both being 180^0 out of phase) and the current amplitude (i_0) is $\frac{e_0}{R}$, the total source voltage appears across R. This means **we cannot have resonance in a LR (or) CR circuits.**

ii) Resonant circuits are used in tuning mechanism of a radio (or) a TV set and musical instruments.

iii) In AC circuit, while adding voltages across different elements one should take care of their phases properly.

a) In R, C circuit $V_{RC} = \sqrt{V_R^2 + V_C^2}$ since V_C is $\frac{\pi}{2}$ out of phases of V_R

b) In L,R circuit $V_{LR} = \sqrt{V_L^2 + V_R^2}$ since V_L is $\frac{\pi}{2}$ out of phase of V_R

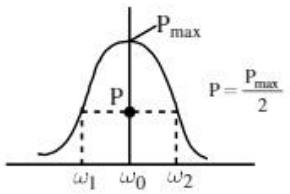
c) In L, C circuit $V_{LC} = V_L - V_C$. since V_L is π out of phase of V_C

d) In LCR circuit, the total applied voltage (V) across L, C, R is given by $V = \sqrt{(V_L - V_C)^2 + V_R^2}$

HALF POWER FREQUENCIES AND BAND WIDTH :

The frequencies at which the power in the circuit is half of the maximum power (The power at resonance), are called half power frequencies.

i) The current in the circuit at half power frequencies (HPF) is $\frac{1}{\sqrt{2}}$ or 0.707 or 70.7% of maximum current (current at resonance).



ii) There are two half power frequencies

(a) $\omega_1 \rightarrow$ called lower half power frequency. At this frequency, the circuit is capacitive.

(b) $\omega_2 \rightarrow$ called upper half power frequency. It is greater than ω_0. At this frequency, the circuit is inductive..

iii) Band width ($\Delta\omega$) : The difference of half power frequencies, ω_1 and ω_2 is called band width. $\therefore \Delta\omega = \omega_2 - \omega_1$.

QUALITY FACTOR (Q) OF SERIES RESONANT CIRCUIT :

i) The characteristic of a series resonant circuit is determined by the quality factor (Q - factor) of the circuit.

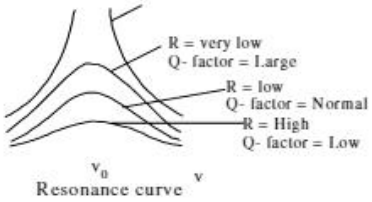
ii) It defines sharpness of i - v curve at resonance. When Q - factor is large, the sharpness of resonance curve is more and vice versa.

iii) $Q = \frac{\text{Resonant frequency}}{\text{Band width}} = \frac{\omega_0}{\Delta\omega}$

For series resonant circuit, it can be proved that, $\Delta\omega = \frac{R}{L}$.

$\therefore Q = \frac{\omega_0}{\Delta\omega} = \omega_0 \times \frac{L}{R}$

But at resonance, $\omega_0 = \frac{1}{\sqrt{LC}}$ $\therefore Q = \frac{1}{\sqrt{LC}} \times \frac{L}{R} = \frac{1}{R}\sqrt{\frac{L}{C}}$



iv) Q - Factor tells the relation between voltage across the inductor or capacitor and peak value of voltage.

The sharpness or selectivity of a resonance circuit is measured by Q-factor, called quality factor.

The Q-factor of series resonance circuit is defined as the ratio of voltage developed across the inductance or capacitance at resonance to the applied voltage (which is the voltage across R).

$$Q = \frac{\text{voltage across L or C}}{\text{Applied Voltage}(= \text{voltage across R})}$$

$$Q = \frac{IX_L}{IR} = \frac{X_L}{R} = \frac{\omega L}{R} = \frac{1}{\sqrt{LC}}\frac{L}{R} \quad Q = \frac{1}{R}\sqrt{\frac{L}{C}} \;;$$

$$Q \text{ - factor} = \frac{V_L}{V_R} or \frac{V_C}{V_R} = \frac{\omega_0 L}{R} or \frac{1}{\omega_0 CR}$$

v) The quality factor (Q) is also defined as 2π times the ratio of the energy stored in L (or C) to the average energy loss per period.

$$\therefore Q = 2\pi\left[\frac{\text{max}imum\ energy\ stored\ in\ circuit}{energy\ loss\ per\ period}\right]$$

The maximum energy stored in inductor, $U = \frac{1}{2}LI_0^2$

The energy dissipated per second, $U_R = I_{rms}^2.R = \frac{I_0^2R}{2}$

Energy dissipated per time period, $U_R = \frac{I_0^2R}{2}.T$

Substituting these values, we get $Q = 2\pi\left[\frac{\frac{1}{2}LI_0^2}{\left(\frac{I_0^2R}{2}\right)T}\right] = \frac{2\pi}{T}\times\frac{L}{R} = \omega_0\times\frac{L}{R} = \frac{1}{\sqrt{LC}}\times\frac{L}{R} = \frac{1}{R}\sqrt{\frac{L}{C}}$

WATTLES CURRENT OR IDLE CURRENT :

If the voltage and current differ in phase by $\pi/2$, then Power factor, $\cos\phi = \cos 90^0 = 0$.

In this case, as there is no resistance to the flow of current, the average power consumed by the current is zero. Such a current is, therefore, called wattles current. Since this current does not perform any work, therefore, this current may also be called idle current. Such a current flows only in purely inductive, purely capacitive or L–C circuits.

The average power consumed per cycle in a pure inductive or capacitive or L - C circuit is zero.

Such current for zero power consumption is called Wattles current.

5. TRANSFORMER :

a) Input power = Out put power

$$I_P V_P = I_S V_S \quad \boxed{\frac{I_P}{I_S} = \frac{V_S}{V_P} = \frac{N_S}{N_P}} \quad V_S = \left(\frac{N_S}{N_P}\right)V_P$$

b) If $N_S > N_P$ voltage is stepped up, then the transformer is called step - up transformer.

c) If $N_S < N_P$ voltage is stepped down, then the transformer is called step - down transformer.

d) In step - up transformer, $V_S > V_P$ and $I_S < I_P$

e) In step - down transformer, $V_S < V_P$ and $I_S > I_P$.

f) Frequency of input a.c is equal to frequency of output a.c.

g) Transformation of voltage is not possible with d.c

h) Efficiency = $\frac{\text{output power}}{\text{input power}}$

Percentage of efficiency = $\frac{output\ power}{Input\ power}\times 100$

Table for values of different parameters for different components applied to ac

parameter	R-L circuit	R-C circuit	L-C circuit	L-C-R circuit
1) Input emf	$E = E_0 \sin \omega t$	$E = E_0 \sin \omega t$	$E = E_0 \sin \omega t$	$E = E_0 \sin \omega t$
2) Resulting current	$I = I_0 \sin(\omega t - \phi)$	$I = I_0 \sin(\omega t + \phi)$	$I = I_0 \sin\left(\omega t \pm \frac{\pi}{2}\right)$	$I = I_0 \sin(\omega t \pm \phi)$
3) Resistance	R	R	0	R
4) Net reactance	$X = X_L = \omega L$	$X = X_C = \frac{-1}{\omega C}$	$X = \omega L - \frac{1}{\omega C}$	$X = \omega L - \frac{1}{\omega C}$
5) Impedance	$Z = \sqrt{R^2 + (\omega L)^2}$	$Z = \sqrt{R^2 + \left(\frac{1}{\omega C}\right)^2}$	$Z = \sqrt{\left(\omega L - \frac{1}{\omega C}\right)^2}$	$Z = \sqrt{R^2 + \left(\omega L - \frac{1}{\omega C}\right)^2}$
6) Peak value of current	$I_0 = \frac{E_0}{Z}$	$I_0 = \frac{E_0}{Z}$	$I_0 = \frac{E_0}{Z}$	$I_0 = \frac{E_0}{Z}$
7) Phase diff. between E & I	$\phi = \tan^{-1}\left(\frac{\omega L}{R}\right)$	$\phi = \tan^{-1}\left(\frac{-1}{\omega RC}\right)$	$\phi = 90°$	$\phi = \tan^{-1}\left(\frac{X_L - X_C}{R}\right)$
8) Lead / lag	I lags E by ϕ	I leads E by ϕ	If $X_L > X_C$, I lags E by 90^0 If $X_L < X_C$ I leads E by 90^0 If $X_L = X_C$ E and I are in phase	If $X_L > X_C$, I lags E by ϕ If $X_L > X_C$, I lags E by ϕ If $X_L > X_C$, I lags E by ϕ

LECTURE SHEET

EXERCISE-I

(Equations-Peak value, average value & rms value)

LEVEL-I (MAIN)

Straight Objective Type Questions

1. A 220 V main supply is connected to a resistance of 100k Ω. The rms current is
   1) 22 mA 2) 2.2mA 3) 220 mA 4) 10 mA

2. The peak value of an alternating emf is given by $E = E_0$ coswt is 10 volt and its frequency is 50Hz. At a time t = (1/600) second, the instantancous value of the emf is :
   1) 1V 2) 5V 3) $5\sqrt{3}$ V 4) 10V

3. The equation of an alternating voltage is $V = 100 \sin 100\pi t$ volt. Its peak value and frequency are
   1) 100V, 50 Hz 2) 50V, 100 Hz 3) 200V, 100 Hz 4) 100V, 200 Hz

4. An alternating current is given by $i = i_1 \cos\omega t + i_2 \sin\omega t$. The rms current is given by
   1) $\frac{i_1 + i_2}{\sqrt{2}}$ 2) $\frac{i_1 + i_2}{2}$ 3) $\frac{\sqrt{i_1^2 + i_2^2}}{2}$ 4) $\frac{\sqrt{i_1^2 + i_2^2}}{\sqrt{2}}$

5. Write the equation of an alternating emf of 120V, and its frequency 60Hz
   1) $e = (169.7\sin 120\pi t)volt$ 2) $e = (152.7\sin 110\pi t)volt$
   3) $e = (143.7\sin 150\pi t)volt$ 4) $e = (156.7\sin 130\pi t)volt$

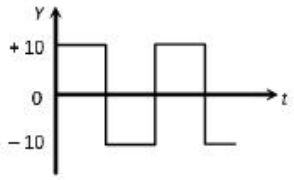
6. The time taken by an AC of frequency 50 Hz to complete one cycle will be
   1) 2 S 2) 0.2 S 3) 0.02 S 4) 0.002S

Numerical Value Type Questions

7. The rms value of an alternating current, which when passed through a resistor produces heat three times of that produced by a direct current of 2A in the same resistor, is

8. Calculate the reading which will be given by a hot-wire voltmeter if it is connected across the terminals of a generator whose voltage waveform is represented by
   $V = 200\sin\omega t + 100\sin 3\omega t + 50\sin 5\omega t$

9. The r.m.s. voltage of the wave form shown is



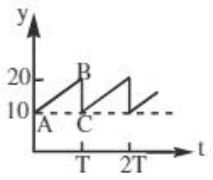
10. The *r.m.s.* current in an ac circuit is 2 *A*. If the wattless current be $\sqrt{3}$A, what is the power factor

11. In a certain circuit current changes with time according to $i = 2\sqrt{t}$ r.m.s. value of current between t = 2 to t = 4 will be

LEVEL-II (ADVANCED)

Straight Objective Type Questions

1. Find the rms and average value of the wave-form shown in figure.



a) 8.5, 10

b) 10.3, 20

c) 15.2, 15

d) 2.6, 5

2. Determine the rms value of a semi-circular current wave which has a maximum value of a.

a) 2.515a b) 1.815a c) 0.615a d) 0.816a

3. 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 $t = \tau$.

a) $\frac{i_0}{e}\sqrt{\frac{(e^2-1)}{2}}$ b) $\frac{i_0}{e}\sqrt{\frac{(e^{-2}+1)}{2}}$ c) $\frac{i_0}{e}\sqrt{\frac{(e+2)}{3}}$ d) $\frac{i_0}{e}\sqrt{\frac{(e^2-2)}{2}}$

More than One correct answer Type Questions

4. In which of the following electrical appliances will AC fail to function where DC in normally used ?

a) electric light b) voltmeter

c) solenoid for electromagnet d) a cathode ray tube

5. The voltage of an AC source varies with time according to the relation $E = 100\sin(100\pi t)\cos(100\pi t)$

a) the peak voltage of the source is 100 volt b) the peak voltage = 50 volt

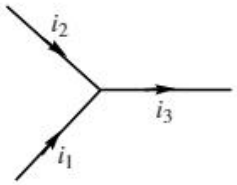
c) the peak voltage = $100\sqrt{2}$ volt d) the frequency of source voltage is 100 Hz

Linked Comprehension Type Questions

Passage :

The currents i_1 and i_2 in A.C circuit are given as (in amp):

$$i_1 = 4\sin\left(\omega t - \frac{\pi}{3}\right) \text{ and } i_2 = 4\sin\left(\omega t + \frac{\pi}{3}\right)$$



6. The current i_3 can be given as

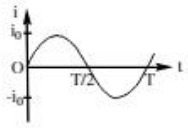
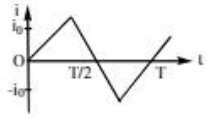
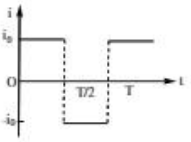
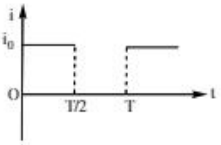
a) $4\sqrt{3}\sin(\omega t - 2\pi/3)$ b) $2\sqrt{3}\cos(\omega t + \pi/3)$ c) $4\sin\omega t$ d) 8

7. The r.m.s value of i_3 is :

a) $2\sqrt{6}$ b) $\sqrt{6}$ c) $3\sqrt{2}$ d) $2\sqrt{2}$

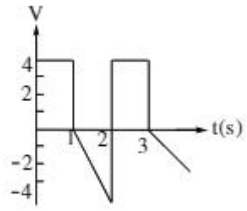
Matrix Matching Type Questions

8. In Column-I, variation of current I with time t is given in the figure. In Column-II, root mean square current I_{rms} and average current is given. Match the Column-I with corresponding quantities given in Column-II

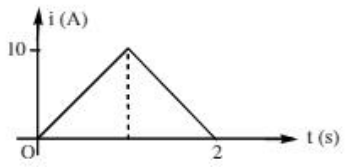
COLUMN - I	COLUMN - II
A) 	p) $I_{rms} = \frac{i_0}{\sqrt{3}}$
B) 	q) average current for positive half cycle is i_0
C) 	r) average current for positive half cycle is $\frac{i_0}{2}$
D) 	s) For full cycle average current is zero

Integer Type Questions

9. Calculate the average value of the voltage wave shown in Figure.



10. The average value of current shown graphically in Figure, from t = 0 to t = 2s is ____ amp.



11. An ac ammeter is used to measure current in a circuit. When a given direct current passes through the circuit, the ac ammeter reads 3A. When another alternating current passes through the circuit, the ac ammeter reads 4A. Then the reading of this ammeter, if dc and ac flows through the circuit simultaneously is

EXERCISE-II

(A.C through Pure indutor, Capacitor, resistor)

LEVEL-I (MAIN)

Straight Objective Type Questions

1. When a coil is connected to a D.C source of emf 12V, a current of 4 amp flows in it. If same coil is connected to 12V, 50Hz AC source, the current is 2.4 A. The self inductance of the coil is (in henry)

   1) $\frac{1}{20\pi}$ 2) $\frac{1}{10\pi}$ 3) $\frac{1}{25\pi}$ 4) $\frac{1}{5\pi}$

2. An electric bulb is designed to operate at 12 volts DC. If this bulb is connected to an AC source and gives normal brightness, what would be the peak voltage of the source ?

   1) 37V 2) 17V 3) 18V 4) 10V

3. A choke coil has

   1) high inductance and low resistance
   2) low inductance and high resistance
   3) high inductance and high resistance
   4) low inductance and low resistance

4. A capacitance of 0.4μF is connected to an alternating emf of 100 cycles/second. What is the capacitive reactance ?

   1) 3981Ω 2) 4687Ω 3) 5768Ω 4) 6843Ω

5. In a pure inductive circuit, the current

   1) Lags behind the applied emf by an angle π
   2) Lags behind the applied emf by an angle $\pi/2$
   3) Leads the applied emf by an angle $\pi/2$
   4) Applied emf are in same phase

6. When resistance is connected with AC source the emf.

   1) Leads current by $\pi/2$
   2) Leads current by $\pi/2$ radian
   3) Inphase with current
   4) Leads current

7. The phase difference between the alternating current and emf is $\pi/2$. Which of the following combination are used

   1) C alone 2) R, L 3) L, C 4) L alone

Numerical Value ype Questions

8. The magnetic field energy in an inductor changes from maximum value to minimum value in 5.0 ms when connected to an AC source. the frequency of the source is ___ Hz.

9. A 120 volt ac source is connected across a pure inductor of inductance 0.70 henry. If the frequency of the source is 60 Hz, the current passing through the inductor is ___ amps

LEVEL-II (ADVANCED)

Straight Objective Type Questions

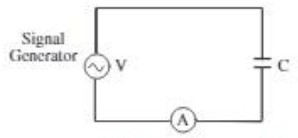
1. A resistor of resistance 100 Ω is connected to an AC source $\varepsilon = (12\,V)\sin(250\,\pi s^{-1})t$. Find the energy dissipated as heat during t=0 to t=1.0ms.

   a) $0.61\times10^{4}\,J$ b) $0.61\times10^{-4}\,J$ c) $2.61\times10^{-4}\,J$ d) $2.61\times10^{-6}\,J$

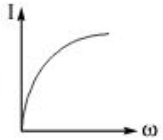
2. A lamp consumes only 50% of peak power in an a.c. circuit. What is the phase difference between the applied voltage and the circuit current

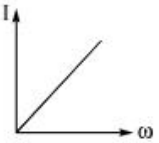
a) $\frac{\pi}{6}$ b) $\frac{\pi}{3}$ c) $\frac{\pi}{4}$ d) $\frac{\pi}{2}$

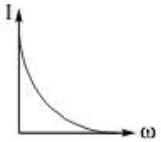
3. A constant voltage at different frequencies is applied across a capacitance C as shown in the figure. Which of the following graphs

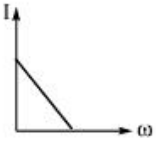


correctly depicts the variation of current with frequency ?

a) 

b) 

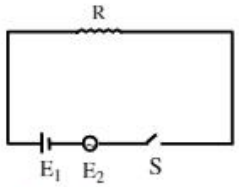
c) 

d) 

Linked Comprehension Type Questions

* *Passage :*

In the circuit shown in the figure $R = 50\,\Omega$, $E_1 = 25\sqrt{3}$ *volt and* $E_2 = 25\sqrt{6}\sin\omega t$ *volt where* $\omega = 100\pi s^{-1}$. *The switch s is closed at time t = 0, and remains closed for 14 minutes, then it is opened.*



4. Find the amount of heat produced in the resistor

a) 64000 J b) 56000 J c) 63000 J d) 75000 J

5. If total heat produced is used to raise the temperature of 3 kg of water at 20^0C, what would be the final temperature of water ?

a) 15^0C b) 25^0C c) 45^0C d) 75^0C

6. Find the value of the direct current that will produce same amount of heat in the resistor in same time as combination of DC source and AC source has produced Specific heat of water = 4200 J/kg-^{0} C.

a) 0.23A b) 1.22A c) 2.24A d) 3.25A

Matrix Matching Type Questions

7. Match the following

COLUMN - I	COLUMN - II
A) For square wave having peak value v_{max}	1) $v_{max} > v_{rms} > v_{av}$
B) For sinusoidal wave having peak value v_{max}	2) In a pure inductance.
C) Current leads the voltage by $\pi/2$	3) $v_{av} = v_{rms} = v_{max}$
D) Wattless current	4) In a pure capacitance

Integer Type Questions

8. In a region of uniform magnetic induction B = 10^{-2} tesla, a circular coil of radius 30cm and resistance π^2 ohm is rotated about an axis which is perpendicular to the direction of B and which forms a diameter of the coil. If the coil rotates at 200 rpm the amplitude of the alternating current induced in the coil is___mA

EXERCISE-III

(LR, CR, LC circuits)

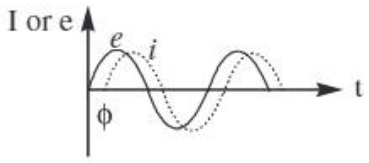
LEVEL-I (MAIN)

Straight Objective Type Questions

*1. Voltage and current for a circuit with two elements in series are expressed as follows :
$v(t) = 170\sin(6280t + \pi/3)$volts $i(t) = 8.5\sin(6280t + \pi/2)$amperes
What are the values of the elements ?

1) $R = 27.32\Omega, C = 25.92\mu F$ 2) $R = 17.32\Omega, C = 15.92\mu F$
3) $R = 7.32\Omega, C = 5.92\mu F$ 4) $R = 10.32\Omega, C = 5.92\mu F$

2. When an ac source of e.m.f. $e = E_0\sin(100t)$ is connected across a circuit, the phase difference between the e.m.f. e and the current i in the circuit is observed to be $\pi/4$, as shown in the diagram. If the circuit consists possibly only of RC or LC or LR in series, find the relationship between the two elements



1) $R = 1k\Omega, C = 10\mu F$ 2) $R = 1k\Omega, C = 1\mu F$ 3) $R = 1k\Omega, L = 10H$ 4) $R = 1k\Omega, L = 1H$

3. An ac source of angular frequency ω is fed across a resistor r and a capacitor C in series. The current registered is I. If now the frequency of source is changed to $\omega/3$ (but maintaining the same voltage), the current in then circuit is found to be halved. Calculate the ratio of reactance to resistance at the original frequency ω

1) $\sqrt{\frac{3}{5}}$ 2) $\sqrt{\frac{2}{5}}$ 3) $\sqrt{\frac{1}{5}}$ 4) $\sqrt{\frac{4}{5}}$

4. A bulb and a capacitor are connected in series to a source of alternating current. If its frequency is increased, while keeping the voltage of the source constant, then

1) Bulb will give more intense light
2) Bulb will give less intense light
3) Bulb will give light of same intensity as before
4) Bulb will stop radiating light

5. An e.m.f. $E = 4\cos(1000t)$ volt is applied to an LR-circuit of inductance 3mH and resistance 4 ohms. The amplitude of current in the circuit is

1) $\frac{4}{\sqrt{7}}$A 2) 1.0A 3) $\frac{4}{7}$A 4) 0.8A

6. An inductence of 0.2H and resistance 100 Ω are connected to an AC 180V - 50Hz. The current in the circuit is ———

1) 0.52A 2) 5.2 A 3) 1.52 A 4) 15.2A

7. An emf E = 4cos 1000t volt is applied to an L–R circuit of inductance 3mH and resistance 4Ω. The amplitude of the current in the circuit is :

1) 1.0A 2) 0.8A 3) $\frac{4}{\sqrt{7}}$A 4) $\frac{5}{7}$A

Numerical Value Type Questions

8. An e.m.f. E = 4cos(1000t) volt is applied to an LR-circuit of inductance 3 mH and resistance 4 ohms. The amplitude of current in the circuit is _____ A

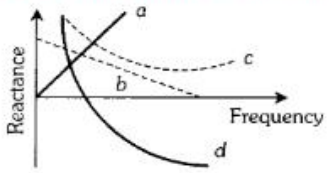
9. One 10 *V*, 60 *W*bulb is to be connected to 100 *V* line. The required induction coil has self inductance of value (in H) (f = 50 Hz)

LEVEL-II (ADVANCED)

Straight Objective Type Questions

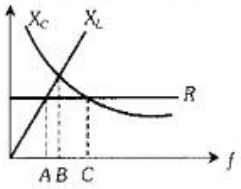
1. Which of the following plots may represent the reactance of a series LC combination

a) a
b) b
c) c
d) d



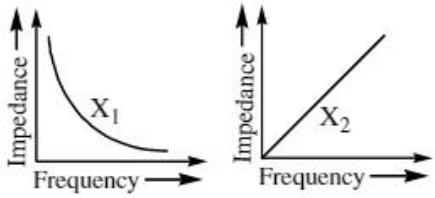
2. The figure shows variation of R,X_L and X_C with frequency f in a series L, C, R circuit. Then for what frequency point, the circuit is inductive

a) A
b) B
c) C
d) All points



3. The graphs given below depict the dependence of two reactive impedances X_1 and X_2 on the frequency of the alternating e.m.f. applied individually to them. We can then say that

a) X_1 is an inductor and X_2 is a capacitor
b) X_1 is a resistor and X_2 is a capacitor
c) X_1 is a capacitor and X_2 is an inductor
d) X_1 is an inductor and X_2 is a resistor



4. An inductor-coil, a capacitor and an AC source of rms voltage 24V are connected in series. When the frequency of the source is varied, a maximum rms current of 6.0A is observed. If this inductor coil is connected to a battery of emf 12V and internal resistance 4.0 Ω, what will be the current ?

a) 2A b) 1.5A c) 0.5A d) 2.5A

More than One correct answer Type Questions

5. In an AC circuit, the instantaneous voltage is zero when the instancoues current is maximum. Then AC circuit connected to the source may be a

a) pure inductor b) pure capacitor c) pure resistor

d) combination of inductor and a capacitor

6. In which of the following AC circuits, there occurs a phase difference of $\pi/2$ between voltage and current ?

a) circuit having pure inductance

b) circuit having pure capacitance

c) circuit having pure inductance and pure capacitance

d) none of the above

Linked Comprehension Type Questions

Passage :

A resistor and a capacitor are connected to an ac supply of 200V, 50Hz in series. The current in the circuit is 2A. If the power consumed in the circuit is 100 watt, then

7. The resistance in the circuit is

a) 100Ω b) 25Ω c) $\sqrt{125\times75}\,\Omega$ d) 400Ω

8. In the above problem, the capacitive reactance in the circuit is

a) 100Ω b) 25Ω c) $\sqrt{125\times75}\,\Omega$ d) 400Ω

9. In the above problem, the capacitance in the circuit is

a) $\frac{100}{100\pi}$F b) $\frac{25}{100\pi}$F c) $\frac{\sqrt{125\times75}}{100\pi}$F d) $\frac{1}{100\pi\sqrt{125\times75}}$F

Matrix Matching Type Questions

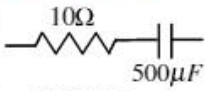
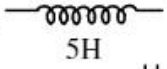
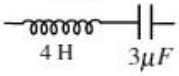
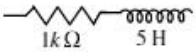
10.

COLUMN - I	COLUMN - II
A) To increase current in a series RL circuit	p) decrease R
B) To increase the phase angle in series RL circuit.	q) increase R
C) To decrease the phase angle in series RL circuit.	r) increase frequency
D) To decrease the current in series RL circuit.	s) connect a in a suitable value of C in

11.

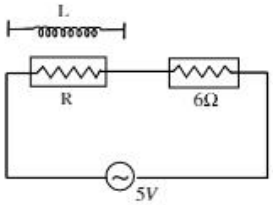
COLUMN - I	COLUMN - II
A) To increase current in a series RC circuit	p) increase C
B) To decrease phase angle in a series RC circuit	q) increase frequency
C) To decrease current in a series RC circuit	r) connecting a suitable L in series
D) To increase phase angle in a series RC circuit.	s) increase R

12. 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 $\omega = 200$ rad/s. The information of phase difference between the current and source voltage in each situation of Column-I is given in Column-II. Match the circuit components in Column-I with corresponding results in Column-II

COLUMN - I	COLUMN - II
A) 	p) The magnitude of required phase difference is $\pi/2$.
B) 	q) The magnitude of required phase difference is $\pi/4$.
C) 	r) The current leads in phase to source voltage
D) 	s) The current lags in phase to source voltage.

Integer Type Questions

13. Two resistors are connected in a series across 5V rms source of alternating potential. The potential difference across 6Ω resistor is 3V. If R is replaced by a pure inductor L of such magnitude that current remains same, then the potential difference across L is



14. An ideal choke takes a current of 10A when connected to an ac supply of 125V and 50Hz. A pure resistor under the same conditions take a current of 12.5A. If the two are connected to an ac supply of 100V and 40Hz, then the peak current in series combination of above resistor and inductor is 10^x what is the value of x

15. A coil has inductance 0.7H and is joined in series with a resistance of 220Ω. When A.C. emf of 220V at 50Hz is applied. Wattless component of current is 1/n, Find 'n'.

EXERCISE-IV

(LCR Circuits, Resonance)

LEVEL-I (MAIN)

Straight Objective Type Questions

1. A capacitor of capacitance 100μF and a coil of resistance 50Ω and inductance 0.5H are connected in series with a 110 V, 50 Hz AC source. Find the rms value of the current.

1) 0.12A 2) 0.82A 3) 0.53A 4) 0.22A

2. A series AC circuit contains an inductor (20mH), a capacitor (100μF), a resistor (50Ω) and an AC source of 12V, 50 Hz. Find the energy dissipated in the circuit in 1000 s.

1) 2.286 kJ 2) 22.86 kJ 3) 0.2286 kJ 4) 228.6 kJ

3. In a series LCR circit R = 10Ω and the impedance Z = 20Ω. Then the phase difference between the current and the voltage is

1) 60^0 2) 30^0 3) 45^0 4) 90^0

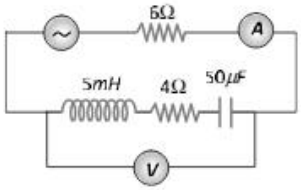
4. In a series circuit R= 300Ω, L= 0.9 H, C=2.0μF and ω= 1000 rad/sec. The impedance of the circuit is
   1) 1300Ω 2) 900Ω 3) 500Ω 4) 400Ω

Numerical Value Type Questions

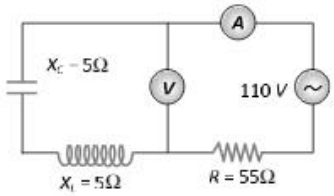
5. A circuit consisting of a capacitor and a coil in series is connected to the mains. Varying the capacitance of the capacitor, the horse power generated in the coil was increased n = 1.7 times. How much (in per cent) was the value of $\cos\phi$ changed in the process ?

6. In an ac circuit, the instantaneous values of e.m.f. and current are e = 200 sin 314 t volt and $i=\sin\left(314t+\frac{\pi}{3}\right)$ ampere. The average power consumed in watt is

7. In the circuit shown in the figure, the ac source gives a voltage $V=20\cos(2000t)$. Neglecting source resistance, the ammeter reading will be

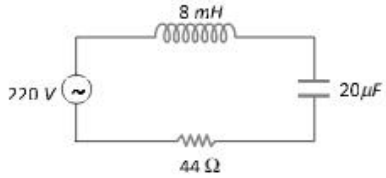


8. The reading of ammeter in the circuit shown will be



9. The impedance of a circuit consists of 3 *ohm* resistance and 4 *ohm* reactance. The power factor of the circuit is

10. For the series LCR circuit shown in the figure, what is the amplitude of the current at the resonating frequency in amp



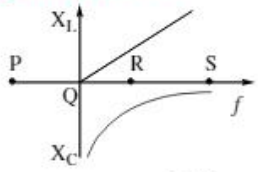
11. In a series circuit $C=2\mu F, L=1mH$ and $R=10\Omega$, when the current in the circuit is maximum, at that time the ratio of the energies stored in the capacitor and the inductor will be

12. In a series resonant circuit, the ac voltage across resistance *R*, inductance *L* and capacitance *C* are 5 *V*, 10 *V* and 10 *V* respectively. The ac voltage applied to the circuit will be __ V

LEVEL-II (ADVANCED)

Straight Objective Type Questions

1. The resonance point in X_L– f and X_C – f curves is

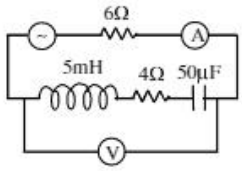


a) P b) Q c) R d) S

2. An inductance of 2.0H, a capacitance of 18 μF and a resistance of 10 kΩ are connected to an AC source of 20V with adjustable frequency. What frequency should be chosen to maximise the current in the circuit ?

a) 29Hz b) 25Hz c) 26.52Hz d) 30Hz

3. In the circuit shown in the figure, the ac source gives a voltage V=20cos(2000t). Neglecting source resistance, the voltmeter and ammeter reading will be



a) 0V, 0.47A b) 1.68V, 0.47A c) 0V, 1.4A d) 5.6V, 1.4A

4. An LCR series circuit with a resistance of 100 ohm is connected to an ac source of 200 V (r.m.s) and angular frequency 300 rad/s. When only the capacitor is removed, the current lags behind the voltage by 60^0. When only the inductor is removed the current leads the voltage by 60^0. The average power dissipated is

a) 50W b) 100W c) 200W d) 400W

5. Two impedances Z_1 and Z_2 when connected separately across a 230-V, 50-Hz supply consumed 100 W and 60 W at power factors of 0.5 lagging and 0.6 leading respectively. If these impedances are now connected in series across the same supply, find :

A) total power absorbed

B) the value of the impedance to be added in series so as to raise the overall power factor to unity.

a) 19 W, 295Ω b) 19 W, 95Ω c) 99 W, 195Ω d) 75 W, 195Ω

More than One correct answer Type Questions

6. An AC source rated 100 volts (rms) supplies a current of 10 amp (rms) to a circuit. The average power delivered by the source.

a) must be 1000W b) may be 1000W

c) may be greater than 1000W d) may be less than 1000W

7. In which of the following AC circuits, consumed power will be zero ?

a) circuit having pure inductance b) circuit having pure capacitance

c) circuit having a combination of pure inductance and pure capacitance

d) none of the above

8. A resistance $R = 12\Omega$, inductance L = 2H and capacitance C = 5 mF are connected inseries to an AC generator of frequency 50 Hz.

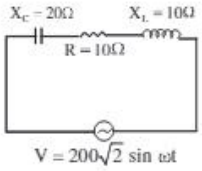
a) at resonance, the circuit impedance is zero

b) at resonance, the circuit impedance is 12 ohm

c) the resonance frequency of the circuit is $\frac{1}{0.2\pi}$

d) the inductive reactance is less than capacitive reactance

9. In the LCR circuit shown in figure



a) current will lead the voltage

b) rms value of current is 20A

c) power factor of the circuit is $\frac{1}{\sqrt{2}}$

d) voltage drop across resistance is 100V

10. In an L-R-C series circuit the current is given by $i = I\cos\omega t$ .The voltage amplitudes for the resistor, inductor and capacitor are V_R, V_L and V_C respectively.

a) The instantaneous power into the resistor is $p_R = V_R I\cos^2\omega t$.

b) The value of instantaneous power into the inductor is $p_L = V_L I\sin\omega t\cos\omega t$.

c) The instantaneous power into the capacitor is $p_C = V_C I\sin\omega t\cos\omega t$.

d) $p_R + p_L + p_C$ equals total power p supplied by the source at each instant of time.

11. An alternating e.m.f. of frequency $\upsilon\left(=\frac{1}{2\pi\sqrt{LC}}\right)$ is applied to a series LCR circuit. For this frequency of the applied e.m.f.

a) The circuit is at resonance and its impedance is made up only of a reactive part

b) The current in the circuit is in phase with the applied e.m.f. and the voltage across R equals this applied emf

c) The sum of the p.d's across the inductance and capacitance equals the applied e.m.f. which is 180^0 ahead of phase of the current in the circuit

d) The quality factor of the circuit is $\omega L/R$ or $1/\omega CR$ and this is a measure of the voltage magni fication (produced by the circuit at resonance) as well as the sharpness of resonance of the circuit.

12. A choke coil of resistance 5Ω and inductance 0.6H is inseries with a capacitance of $10\mu F$. If a voltage of 200 V is applied and the frequency is adjusted to resonance, the current and voltage across the inductance and capacitor are I_0, V_0, I_1 and V_1 respectively. We have

a) $I_0 = 40A$ b) $V_0 = 9.8$ kV c) $V_1 = 9.8$ kV d) $V_1 = 19.6$ kV

Linked Comprehension Type Questions

Passage - I :

A series LCR circuit containing a resistance of 120 Ω has angular resonace frequency 4×10^5 rads^{-1}. At resonance the voltages across resistance and inductance are 60V and 40V respectively.

13. Find the value of L ?

a) 0.1mH b) 0.2mH c) 0.3mH d) 0.4mH

14. Find the value of C ?

a) $\frac{1}{12}\mu F$ b) $\frac{1}{22}\mu F$ c) $\frac{1}{32}\mu F$ d) $\frac{1}{42}\mu F$

15. Angle between voltage and current is 45^0 then find angular frequency

a) $8\times10^5\ \frac{rad}{s}$ b) $9\times10^5\ \frac{rad}{s}$ c) $9\times10^4\ \frac{rad}{s}$ d) $9\times20^4\ \frac{rad}{s}$

Passage - II :

An LCR circuit has L=10mH, R= 3Ω and C = 1μF connected in series to a source of 15 cos ωt V. The frequency is 10% lower than the resonance frequency

16. Impedance of circuit ?

a) 21.32Ω b) 31.32Ω c) 41.32Ω d) 61.32Ω

17. Calculate the current amplitude

a) 0.704A b) $\frac{2}{10}$A c) 0.504A d) 0.404A

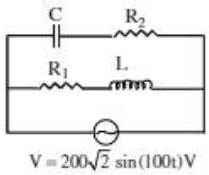
18. Average power dissipated per cycle

a) $5.16\times10^{-4}\ \frac{J}{cycle}$ b) $5.18\times10^{-4}\ \frac{J}{cycle}$ c) $5.18\times10^{-2}\ \frac{J}{cycle}$ d) $5.18\times20^{-2}\ \frac{J}{cycle}$

Passage -III :

In the circuit shown in figure :

$R_1 = 10\Omega, L = \frac{\sqrt{3}}{10}H$, $R_2 = 20\Omega$ *and* $C = \frac{\sqrt{3}}{2}$ *mF. Current in L–R_1 circuit is I_1 in C–R_2 circuit is I_2 and the main current is I*



19. Phase different between I_1 and I_2 is

a) 0^0 b) 90^0 c) 180^0 d) 60^0

20. At some instant current in L–R_1 circuit is 10A. At the same instant current in C–R_2 branch will be

a) 5 A b) $5\sqrt{2}$A c) $5\sqrt{6}$A d) $5\sqrt{3}$A

21. At some instant I_1 in the circuit is $10\sqrt{2}$A, then at this instant current I will be

a) 26.5 A b) $10\sqrt{2}$A c) $20\sqrt{2}$A d) 25 A

Passage - IV :

An inductor 20×10^{-3} henry, a capacitor 100μF and a resistor 50Ω are connected in series across a source of emf V=10sin (314t).

22. Find the impedence in the circuit

a) 56 ohm b) 40 ohm c) 36 ohm d) 60 ohm

23. Find the energy dissipated in the circuit in 20 minutes.
a) 615 J b) 750 J c) 951 J d) 250 J

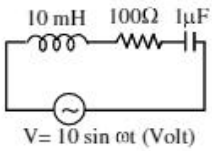
24. If resistance is removed from the circuit and the value of indutance is doubled, then find the variation of current with time in the new circuit.
a) 0.43 cos 314 t b) 0.52 cos 214 t c) 0.25 cos 114 t d) 0.52 cos 314 t

Matrix Matching Type Questions

25. An alternating source $V = V_0 \sin\omega t$ is connected in a series LCR circuit $\omega_0 = \frac{1}{\sqrt{LC}}$. Then,

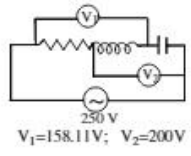
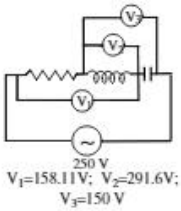
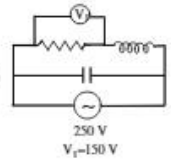
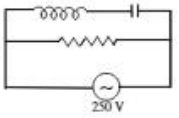
COLUMN - I	COLUMN - II
A) $\omega < \omega_0$	p) current leads voltage
B) $\omega > \omega_0$	q) $X_C > X_L$
C) $\omega = \omega_0$	r) current lags voltage
D) $\omega = \frac{\omega_0}{2}$	s) $X_C = X_L$

26. Referring to the given circuit, match Column-I with Column-II



COLUMN - I	COLUMN - II
A) For $\omega = 8000$ rad/s	p) Peak current in the circuit is less than 0.1A
B) For $\omega = 10000$ rad/s	q) Voltage across the combination and the current are in same phase
C) For $\omega = 10500$ rad/s	r) Voltage across the combination leads the current
D) For $\omega = 12500$ rad/s	s) Current through the circuit leads the voltage across it

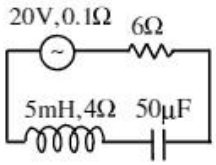
27. In Column-I some ac circuits with meter reading are given and in Column-II some circuit quantities are given. Match the entries of Column-I with the entries of Column-II

COLUMN - I	COLUMN - II	COLUMN - I	COLUMN - II
A) 	p) $V_R = 150$ V	C) 	r) $V_C = 250$V
B) 	q) $V_L = 50$V	D) 	s) Power factor of the circuit 3/5

Integer Type Questions

28. In LCR circuit current resonant frequency is 600 Hz and half power points are at 650 and 550 Hz. The quality factor is

29. In the resonance of circuit $\omega = 2000$ rad/s. The amplitude of the current will be nearest to



EXERCISE-V

(Transformers)

LEVEL-I (MAIN)

Straight Objective Type Questions

1. In a step up transformer, the ratio of turns of primary to secondary is 1:10 and primary voltage is 230V. If the load current is 2A, then current in the primary is

   1) 20A 2) 10A 3) 2A 4) 1A

2. In a transformer, number of turns in the primary are 140 and that in the secondary are 280. If current in primary is 4A then that in the secondary is

   1) 4A 2) 2A 3) 6A 4) 10A

3. In a transformer, the number of turns in the primary and secondary coils are 1000 and 3000 respectively. If the primary is connected across 80V AC, the potential difference across each turn of the secondary will be

   1) 240V 2) 0.24V 3) 0.8V 4) 0.08V

4. A transformer is based on the principle of

   1) Mutual inductance 2) Self inductance 3) Ampere's law 4) Lenz's law

Numerical Value Type Questions

5. The number of turns in primary and secondary windings of a transformer are 1000 and 100 respectively. If 200V dc voltage is impressed across the primary terminals, the voltage across secondary terminals is

LEVEL-II (ADVANCED)

Straight Objective Type Questions

1. A step up transformer works on 220V and gives 2A to an external resistor. The turn ratio between the primary and secondary coils is 2:25. Assuming 100% efficiency, find the secondary voltage. Primary current and power delivered.

   a) 2750V, 25A, 5500W b) 5500V, 0.16A, 2750W

   c) 1600V, 1A, 5000W d) 4000V, 1A, 5500W

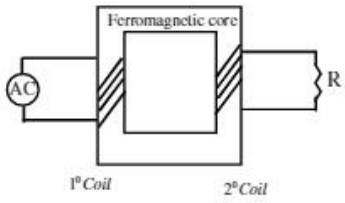
2. A step down transformer has primary voltage 1100V. The transformer ratio is 1 : 5. If the primary current is 10A find the secondary voltage, secondary current assuming the transformer to be an ideal transformer.

   a) 1100V, 10A b) 2200V, 20A c) 3300V, 30A d) 220V, 50A

Linked Comprehension Type Questions

Passage :

A physics lab is designed to study the transfer of electrial energy from one circuit to another by means of a magnetic field using simple transformers. Each transformer has two coils of wire electrically insulated from each other but wound around a common core of ferromagnetic material. The two wires are close together but do not touch each other



The primary (1st) coil is connected to a sorce of alternating (AC) current. The secondary (2nd) coil is connected to resistor such as a light bulb. The AC source produces an oscillating voltage and current in the primary coil that produces an oscillating magnetic field in the core material. This in turn induces an oscillating voltage and AC current in the secondary coil

Students collected the following data comparing the number of turns per coil (N) , the voltage (V) and the current (I) in the coils of three transformers.

	Primary Coil	Secondary Coil
Transformer-1	100 10V	10A 200 20V 5A
Transformer-2	100 10V	10A 50 5V 20A
Transformer-3	100 10V	10A 100 5V 20A

3. The primary coil of a transformer has 100 turns and is connected to a 120V AC source. How many turns are in the secondary coil if there's a 2400V acorss it

a) 5 b) 50 c) 200 d) 2000

4. A transformer with 40 turns in its primary coil is connected to a 120V AC source. If 20W of power is supplied to the primary coil, how much power is developed in the secondary coil?

a) 10W b) 20 W c) 80W d) 160W

5. Which of the following is a correct expression for R, the resistance of the load connected to the secondary coil ?

a) $\left(\frac{V_1}{I_1}\right)\left(\frac{N_2}{N_1}\right)$ b) $\left(\frac{V_1}{I_1}\right)\left(\frac{N_2}{N_1}\right)^2$ c) $\left(\frac{V_1}{I_1}\right)\left(\frac{N_1}{N_2}\right)$ d) $\left(\frac{V_1}{I_1}\right)\left(\frac{N_1}{N_2}\right)^2$

6. A 12V battery is used to supply 2.0 mA of current to the 300 turns in the primary coil of a given transformer. What is the current in the secondary coil of $N_2 = 150$ turns ?

a) zero b) 1. 0mA c) 2.0mA d) 4.0mA

KEY SHEET (LECTURE SHEET)

EXERCISE-I

LEVEL-I

1) **2** 2) **3** 3) **1** 4) **4** 5) **1** 6) **3** 7) **3.46** 8) **162**
9) **10** 10) **0.5** 11) **3.46**

LEVEL-II

1) **c** 2) **d** 3) **a** 4) **b,c,d** 5) **b,d** 6) **c** 7) **d**
8) **A-s; B-p,s,r; C-s,q; D-q** 9) **1** 10) **5** 11) **5**

EXERCISE-II

LEVEL-I

1) **3** 2) **2** 3) **1** 4) **1** 5) **2** 6) **3** 7) **2**
8) **50** 9) **0.455**

LEVEL-II

1) **c** 2) **b** 3) **b** 4) **c** 5) **b** 6) **b**
7) **A-r; B-p; C-s; D-q** 8) **6**

EXERCISE-III

LEVEL-I

1) **2** 2) **3** 3) **1** 4) **1** 5) **4** 6) **3** 7) **2** 8) **0.8**
9) **0.052**

LEVEL-II

1) **d** 2) **c** 3) **c** 4) **b** 5) **a,b,d** 6) **a,b,c** 7) **b** 8) **c**
9) **d** 10) **A-p,s ; B-p,r ; C-q,s; D-q,r**
11) **A-p,q,r ; B-p,q,s ; C-s ; D-r** 12) **A-q,r ; B-p,s ; C-p,r ; D-q,s**
13) **4** 14) **1** 15) **2**

EXERCISE-IV

LEVEL-I

1) **2** 2) **1** 3) **1** 4) **3** 5) **30%** 6) **50** 7) **1.4A** 8) **0**
9) **0.6** 10) **7.07** 11) **0.2** 12) **5**

LEVEL-II

1) **c** 2) **c** 3) **d** 4) **d** 5) **c** 6) **bd** 7) **abc** 8) **bc**
9) **a,c** 10) **a,b,c,d** 11) **b,d** 12) **a,b,c** 13) **b** 14) **c** 15) **a**
16) **a** 17) **a** 18) **a** 19) **b** 20) **d** 21) **b** 22) **a** 23) **c**
24) **d** 25) **A-p,r,t ; B-p,r,t ; C-q,s;D-p,r,t** 26) **A-p,s ; B-q ; C-p,r; D-p,r**
27) **A-p,q,r,s ; B-p,r ; C-p,q,r,s ; D-r** 28) **6** 29) **2**

EXERCISE-V

LEVEL-I

1) **1** 2) **2** 4) **4** 4) **1** 5) **0**

LEVEL-II

1) **a** 2) **d** 3) **d** 4) **b** 5) **b** 6) **d**

PRACTICE SHEET

EXERCISE-I

(Equations-rms value, average value)

LEVEL-I (MAIN)

Straight Objective Type Questions

1. The equation of the alternating voltage applied to our houses is $e = (311\sin 100\pi t)$ volt. A hot wire instrument is used to measure the alternating voltage. The rms value of emf is

   1) 219.9V 2) 329.1V 3) 543.7V 4) 432.7V

2. The heat produced in a given resistor in a given time by the sinusoidal current $Io \sin\omega t$ will be the same as that by a steady current of magnitude

   1) $\frac{I_0}{\sqrt{2}}$ 2) I_0 3) $\sqrt{2}I_0$ 4) $\frac{I_0}{2}$

3. A generator produces a voltage that is given by V = 240 sin 120t volt, where time t is in seconds. The frequency and rms voltage are

   1) 60 Hz and 240 volt 2) 19 Hz and 20 volt
   3) 19 Hz and 170 volt 4) 754 Hz and 170 volt

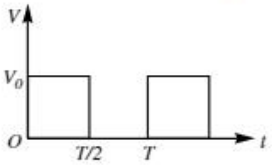
4. In an ac circuit I = 100 sin 200 πt. The time required for the current to achieve its peak value will be

   1) $\frac{1}{100}$sec 2) $\frac{1}{200}$sec 3) $\frac{1}{300}$sec 4) $\frac{1}{400}$sec

5. Voltage and current in an ac circuit are given by V=5 sin $\left(100\pi t - \frac{\pi}{6}\right)$ and I = 4sin $\left(100\pi t + \frac{\pi}{6}\right)$

   1) voltage leads the current by 30° 2) current leads the voltage by 30°
   3) current leads the voltage by 60° 4) current are voltage are in phase

6. The rms value of potential difference *V* shown in the figure is



   1) V_0 2) $\frac{V_0}{\sqrt{2}}$ 3) $\frac{V_0}{2}$ 4) $\frac{V_0}{\sqrt{3}}$

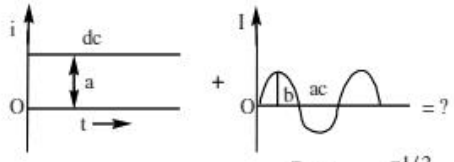
LEVEL-II (ADVANCED)

Straight Objective Type Questions

1. Alternating current can not be measured by dc ammeter because

   a) ac cannot pass through d c ammeter b) Average value of complete cycle is zero
   c) ac is virtual d) ac changes its direction

*2. If a direct current of value *a* ampere is superimposed on an alternative current $I = b\sin\omega t$ flowing through a wire, what is the effective value of the resulting current in the circuit ?



a) $\left[a^2 - \frac{1}{2}b^2\right]^{1/2}$ b) $\left[a^2 + b^2\right]^{1/2}$ c) $\left[\frac{a^2}{2} + b^2\right]^{1/2}$ d) $\left[a^2 + \frac{1}{2}b^2\right]^{1/2}$

More than One correct answer Type Questions

3. Which of the following statements are true ? Heat produced in a current carrying conductor depends upon

a) time for which true current flows in true conductor b) the resistsdance of the conductor

c) the nature of conductor d) the nature of current (AC or DC)

4. The voltage of an AC source varies with time according to the relation $E = 6\sin(200\pi t)$

a) the peak voltage of the source is 120V b) the peak voltage is 6V

c) the peak voltage $\frac{120}{\sqrt{2}}$ V d) the frequency of source voltage is 100 Hz

Linked Comprehension Type Questions

Passage :

If the voltage in an ac circuit is represented by the equation, $V = 220\sqrt{2}\sin(314t - \phi)$, calculate

5. rms value of the voltage

a) 220V b) 314V c) $220\sqrt{2}$ V d) $200/\sqrt{2}$ V

6. average voltage

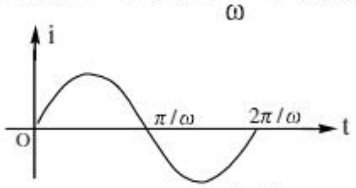
a) 220V b) $622/\pi$V c) $220/\sqrt{2}$ V d) $220\sqrt{2}$ V

7. frequency of ac

a) 50Hz b) $50\sqrt{2}$ Hz c) $50/\sqrt{2}$ Hz d) 75Hz

Integer Type Questions

8. Find the average value of current from t = 0 to $t = \frac{2\pi}{\omega}$ if the current varies as $i = I_m \sin\omega t$.



9. The electric current in a circuit is given by $I = I_0\left(\frac{t}{T}\right)^2$ for some time. The r.m.s current for the period t=0 to t=T is $\frac{I_0}{\sqrt{x}}$. Find the value of x.

EXERCISE-II

(A.C through Pure inductor, Capacitor, resistor)

LEVEL-I (MAIN)

Straight Objective Type Questions

1. An alternating emf of $e = 200\sin 100\pi t$ is applied across a capacitor of capacitance $2\mu F$. the capacitive reactance and the peak current is

   1) $\frac{5\times10^{3}}{\pi}\Omega,\ 4\times10^{-2}\pi A$ 2) $4\times10^{-2}\pi\Omega,\ \frac{5\times10^{3}}{\pi}A$

   3) $\frac{4\times10^{-2}}{\pi}\Omega,\ 5\times10^{3}A$ 4) $4\Omega,\ 5\times10^{-3}A$

2. An inductance 1 H is connected in series with an A.C source of 200 V and 50 Hz. The inductive reactance in (ohms) is

   1) 2π 2) 5π 3) 100π 4) 1000π

3. The resistance of a coil for dc is 5Ω. In case of ac, the resistance :

   1) will remain 5Ω 2) will decrease 3) will increase 4) will be zero

4. A coil of self-inductance L is connected in series with a bulb B and an AC source. Brightness of the bulb decreases when

   1) Frequency of the AC source is decreased
   2) Number of turns, in the coil is reduced
   3) A capacitance of reactance $X_c = X_L$ is included in the same circuit
   4) An iron rod is inserted in the coil

5. An ac source is connected to a capacitor. The current in the circuit is I. Now, a dielectric slab is inserted into the capacitor, then the new current is :

   1) equal to I 2) more than I 3) less than I
   4) sometimes more and sometimes less than I

Numerical Value Type Questions

6. A series AC circuit has a resistance of 4Ω and a reactance of 3Ω. The impedance of the circuit is

LEVEL-II (ADVANCED)

Straight Objective Type Questions

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

   a) Induced emf in the inductor b) Current
   c) Both (a) and (b) d) Neither (a) nor (b)

2. A capacitor of capacitance $12.0\mu F$ is joined to an AC source of frequency 200Hz. The rms current in the circuit is 2.00 A. Find the rms voltage across the capacitor.

   a) 90V b) 111.6V c) 132.6V d) 192.1V

3. 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.
   a) 212V b) 105V c) 315V d) 505V

4. Capacitor of capacitance $10\mu F$ is connected to an oscillator giving an output voltage $\varepsilon=(10V)\sin\omega t$. Find the peak currents in the circuit of $\omega=100s^{-1},500s^{-1}$
   a) 0.01 A, 0.05 A b) 0.1 A, 0.001 A c) 0.2 A, 0.2 A d) 0.05 A, 0.01 A

Linked Comprehension Type Questions

Passage :

A 20 volts 5 watt lamp is used in ac main 220 volts and 50 c.p.s.

5. Capacitance of capacitor, to be put in series to run the lamp at the given rated voltage.
   a) $2\mu F$ b) $3.63\mu F$ c) $6\mu F$ d) $8\mu F$

6. Inductance of inductor, to be put in series to run the lamp at the given rated voltage.
   a) 2.79H b) 5H c) 7.5H d) 9H

7. What pure resistance should be included in place of the above passive elements so that the lamp can run on its rated voltage ?
   a) $120\,\Omega$ b) $240\,\Omega$ c) $480\,\Omega$ d) $800\,\Omega$

EXERCISE-III

(L-R, C-R, L-C circuits)

LEVEL-I (MAIN)

Straight Objective Type Questions

1. An inductance of 1mH and a charged capacitor of capacitance $10\mu F$ are connected across each other. The resonating angular frequency of circuit is
   1) 10^5 rad/s 2) 10^4 rad/s 3) 10^3 rad/s 4) 10^2 rad/s

2. An inductor of inductance 100mH is connected in series with a resistance, a variable capacitance and an AC source of frequency 2.0 kHz. the value of the capacitance so that maximum current may be drawn into the circuit.
   1) 50nF 2) 60nF 3) 63nF 4) 79nF

3. When an L – R combination is connected in series with 12V - 50Hz supply, a current of 0.5A flows through the combination. The current differs in phase from applied voltage by $\pi/3$ rad. Then resistance is
   1) 24Ω 2) 12Ω 3) 6Ω 4) 3Ω

4. A pure resistive circuit element X when connected to an AC supply of peak voltage 200V gives a peak current of 5A which is in phase with the voltage. A second circuit element Y, when connected to the same AC supply also gives the same value of peak current but the current lags behind by 90^0. If the series combination of X and Y is connected to the same supply, the rms value of current is
   1) $\frac{10}{\sqrt{2}}$A 2) $\frac{5}{\sqrt{2}}$A 3) $\frac{5}{2}$A 4) 5A

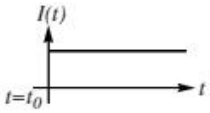
5. A radio tuner has a frequency range from 500kHz to 5MHz. If its LC circuit has an effective inductance of $200\mu H$, what is the range of its variable capacitor ? (Take $\pi^2 = 10$).

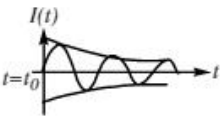
1) 2.5 pF to 250 pF 2) 5.0 pF to 500 pF 3) 7.5 pF to 750 pF 4) 10 pF to 1000 pF

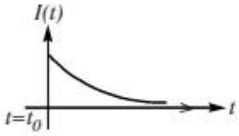
6. An electric lamp designed for operation on 110V AC is connected to a220V AC supply, through a choke coil of inductance 2H, for proper operation. The angular frequency of the AC is $100\sqrt{10}$ rad / s. If a capacitor is to be used in the place of the choke coil, its capacitance must be

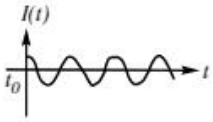
1) $1\mu F$ 2) $2\mu F$ 3) $5\mu F$ 4) $10\mu F$

7. A series L R circuit is connected to a voltage source with $V(t) = V_0 \sin\Omega t$. After very large time, current I(t) behave as $\left(t_0 >> \frac{L}{R}\right)$:

1) 

2) 

3) 

4) 

8. An L-C circuit has a natural frequency f. If the capacitance and inductance are both doubled, the frequency would become :

1) f/2 2) 2f 3) f/4 4) none of these

9. What is the mechanical equivalent of spring constant *k* in *LC* oscillating circuit?

1) $\frac{1}{L}$ 2) $\frac{1}{C}$ 3) $\frac{L}{C}$ 4) $\frac{1}{LC}$

10. A resistance *R* draws power *P* when connected to an AC source. If an inductance is now placed in series with the resistance, such that the imped-ance of the circuit becomes *Z*, the power drawn will be

1) $P\left(\frac{R}{Z}\right)^2$ 2) $P\sqrt{\frac{R}{Z}}$ 3) $P\left(\frac{R}{Z}\right)$ 4) P

11. A series *R-C* circuit is connected to an alternating voltage source. Consider two situations

a) When capacitor is air filled.

b) When capacitor is mica filled

Current through resistor is i and voltage across capacitor is V then

1) $V_a = V_b$ 2) $V_a < V_b$ 3) $V_a > V_b$ 4) $i_a = i_b$

Numerical ValueType Questions

12. An ideal inductor takes a current of 10A when connected to a 125V, 50 Hz ac supply. A pure resistor across the same source takes 12.5A. If the two are connected in series across a 100V, 40Hz supply, the current through the circuit will be ___ A.

13. The natural frequency of an LC - circuit is 125KHz. Then the capacitor C is replaced by another capacitor with a dielectric medium of dielectric contant k. In this case, the frequency decreases by 25kHz. The value of k is

LEVEL-II (ADVANCED)

Straight Objective Type Questions

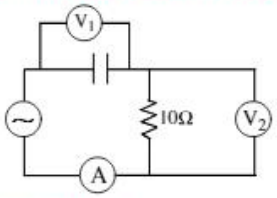
*1. A solenoid with inductance L = 7 mH and active resistance R = 44Ω is first connected to a source of direct voltage V_0 and then to a source of sinusiodal voltage with effective value $V = V_0$. At what freuency of the oscillator will the power consumed by the solenoid be $\eta = 5.0$ times less than in the former case ?

a) 3KHz b) 2KHz c) 5KHz d) 8KHz

*2. An inductor 20×10^{-3} henry, a capacitor 100μF and a resistor 50Ω are connected in series across a source of emf V = 10 sin 314t. Find the energy dissipated in the circuit in 20 minutes. If resistance is removed from the circuit and the value of inductance is doubled, then find the variation of current with time in the new circuit.

a) 951 J, 0.52 cos 314 t b) 951 J, 1.52 cos 315 t c) 851 J, 2.52 cos 412 t d) 751 J, 2.55 cos 215 t

3. The diagram shows a capacitor C and a resistor R connected in series to an ac source. V_1 and V_2 are voltameters and A is an ammeter consider now the following statements



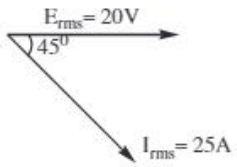
I) Readings in A and V_2 are always in phase

II) Reading in V_2 is ahead in phase with reading in V_1

III) Readings in A and V_1 are always in phase which of these statements are/is correct

a) I only b) II only c) I and II only d) II and III only

4. The vector diagram of current and voltage for a circuit is as shown. The components of the circuit will be



a) LCR b) LR c) LCR or LR d) None of these

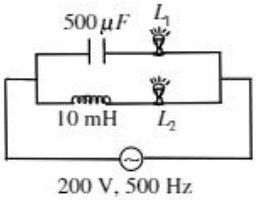
5. In the circuit shown in fig. If both the lamps L_1 and L_2 are identical.

a) their brightness will be same

b) L_1 will be brighter than L_2

c) as the frequency of supply voltage is increased, brightnessof L_1 will increase and that of L_2 will decrease

d) only L_2 will glow because the capacitor has infinite resistance



Linked Comprehension Type Questions

Passage - I :

A circuit takes a current of 3 A at a power factor of 0.6 lagging when connected to a 115 V-50 Hz supply. Another circuit takes a current of 5A at a power factor of 0.707 leading when connected to the same supply. If the two circuits are connected in series across a 230 V, 50 Hz supply.

6. Find the current

a) 3.2A b) 6.2A c) 5.5A d) 7.2A

7. Find the power consumed

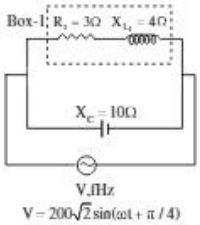
a) 2.88KW b) 4.88KW c) 1.8KW d) 1.188KW

8. Find the power factor

a) 0.939 b) 2.939 c) 3.239 d) 1.693

Passage - II :

As shown in figure (given $\tan^{-1}(4/3) = 53^0$)



9. Instantaneous current in branch having capacitor C will be :

a) $20\sqrt{2}\sin(\omega t + 3\pi/4)$ b) $40\sqrt{2}\sin(\omega t + \pi/4)$ c) $60\sqrt{2}\sin(\omega t - \pi/4)$ d) None of above

10. Angle between current through inductor and capacitor will be

a) 143^0 b) 90^0 c) 53^0 d) None

11. Potential drop across X_L will be

a) 160 volt b) 120 volt c) 200 volt d) 160 $\sqrt{2}$ volt

Matrix Matching Type Questions

12. Some electric circuits containing any two of the components –a resistor, an inductor, and/or a capacitor –supplied with either a variable DC source or an AC source of frequency 50 Hz, are shown in Column-II below. When a current I (steady state for DC or rms for AC) flows through the circuit, let the corresponding potential difference V_1 and V_2 across the components be related as shown in Column-I. Match the items in Column-I with those in Column-II.

COLUMN - I

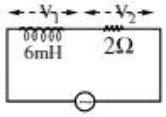
A) $I \neq 0, V_1$ is proportional to I

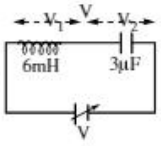
B) $I \neq 0, V_2 > V_1$

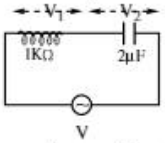
C) $V_1 = 0, V_2 = V$

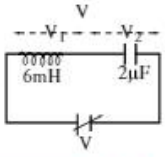
D) $I \neq 0, V_2$ is proportional to I

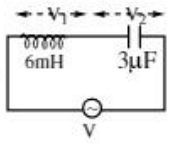
COLUMN - II

p) 

q) 

r) 

s) 

t) 

Integer Type Questions

13. A transmitter transmits at a wavelength of 300m. A condenser of capacitance $2.4\mu F$ is being used. The value of the inductance for the resonant circuit is 10^{-x} find value of x approximately

EXERCISE-IV

(LCR Circuits, Resonance)

LEVEL-I (MAIN)

Straight Objective Type Questions

1. In an LCR series circuit, the voltages across R, L and C at resonance are 40V, 60V and 60V respectively. The applied voltage is

1) 60V 2) 40V 3) 160V 4) $\sqrt{(40)^2+(120)^2}$ V

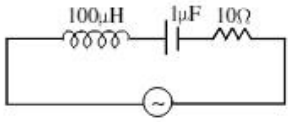
2. The following series L – C– R circuit, when driven by an e.m.f. source of angular frequency 70 kilo - radians per second, the circuit effectively behaves like

1) purely resistive circuit

2) series R – L circuit

3) series R – C circuit

4) series L– C circuit with R = 0



3. An A.C. circuit contains a resistor 'R', an inductor 'L' and a capacitor 'C' connected in series. When it is connected to an A.C. generator of fixed output voltage and variable frequency, the current in the circuit is found to be leading the applied voltage $\pi/4$ rad,when the frequency is f_1. When the frequency of the generator increased to 'f_2' the current is found to be lagging behind the applied voltage by $\pi/4$ rad. The resonant frequency of the circuit is

1) $\frac{f_1f_2}{f_1+f_2}$ 2) $\frac{f_1+f_2}{2}$ 3) $\frac{2f_1f_2}{f_1+f_2}$ 4) $\sqrt{f_1f_2}$

4. In a series LCR circuit the frequency of a 10V, AC voltage source is adjusted in such a fashion that the reactanace of the inductor measures 15Ω and that of the capacitor 11Ω. If R= 3Ω, the potential difference across the series combination of L and C will be:

1) 8V 2) 10V 3) 22V 4) 52V

5. In an L-C-R series AC circuit the voltage across L,C and R is 10 V each. If the inductor is short circuited, the voltage across the capacitor would become :

1) 10 V 2) $\frac{20}{\sqrt{2}}$ V 3) $20\sqrt{2}$V 4) $\frac{10}{\sqrt{2}}$ V

Numerical Value Type Questions

6. An LCR series circuit consists of a resistance of 10Ω, a capacitor of reactance 60Ω and an inductor coil. The circuit is found to resonate when put across a 300V, 100Hz supply. The inductance of the coil is ___ H (take $\pi = 3$)

7. An L-C-R series circuit with 100Ω resistance is connected to an A.C source of 200V and angular frequency 300 rads^{-1}. When only the capacitor is removed, the current lags behind the voltage by 60^0. When only inductor is removed, the current leads the voltage by 60^0. If all elements are connected, the current in the circuit is ___ A.

LEVEL-II (ADVANCED)

Straight Objective Type Questions

1. In a series circuit R= 300 Ω, L= 0.9 H, C=2.0 μF and ω = 1000 rad/sec. The impendence of the circuit is

   a) 1300 Ω b) 900 Ω c) 500 Ω d) 400 Ω

2. A resistance of 10 Ω, a capacitance of $0.1\mu F$ and an inductance of 2mH are connected in series across a source of alternating emf of variable frequency. At what frequency does maximum current flow ?

   a) 11.25 kHz b) 23.76 kHz c) 35.46 kHz d) 46.72 kHz

3. The potential differences across the resistance, capacitance and inductance are 80V, 40V and 100V respectively in an L-C-R circuit. The power factor of this circuit is

   a) 0.4 b) 0.5 c) 0.8 d) 1.0

4. An inductance of 1 mH and a charged capacitor of capacitance of 10μF are connected across each other. The resonating angular frequency of circuit is

   a) 10^5 rad/s b) 10^4 rad/s c) 10^3 rad/s d) 10^2 rad/s

5. A series LCR circuit is connected to a source of alternating emf 50 V and if the potential differences across inductor and capacitor are 90 V and 60 V respectively, the potential difference across resistor is :

   a) 400 V b) 40 V c) 80 V d) 160 V

6. In a circuit, *L*, *C* and *R* are connected in series with an alternating voltage source of frequency *f* The current leads the voltage by 45°. The value of C is

   a) $\frac{1}{2\pi f(2\pi f L+R)}$ b) $\frac{1}{\pi f(2\pi f L+R)}$ c) $\frac{1}{2\pi f(2\pi f L-R)}$ d) $\frac{1}{\pi f(2\pi f L-R)}$

7. An inductance, a capacitance and a resistance are connected in series across a source of alternating voltage. At resonance, the applied voltage and the current flowing through the circuit wil have a phase difference of

   a) $\pi/4$ b) zero c) π d) $\pi/2$

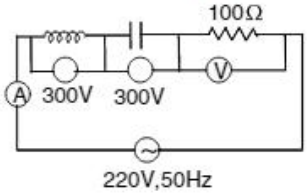
8. A L–C–R series combination is connected to an AC source. If voltages across the inductor, capacitor, resistor are 40V, 80V and 40V respectively. Then the voltage across the AC source is

   a) $100\sqrt{2}$ V b) $80\sqrt{2}$ V c) 80 V d) $40\sqrt{2}$ V

9. In an LRC circuit L, C and R values are respectively 8 henry, 0.5μF and 100 Ω are arranged in series. The resonating frequency is

   a) 900 rad/s b) 500 Hz c) 500 rad/s d) 300 Hz

10. In the circuit shown below what will be the reading of the voltmeter and ammeter ?



   a) 200V, 1A b) 800V, 2A c) 100V, 2A d) 220V, 2.2A

11. A 0.03H inductor, a 10Ω resistor and a 3μF capacitor are connected in series. At what frequency will they resonate ? What will be the phase difference between the emf and current at resonance ?

a) $\frac{1}{6\pi}\times10^4$Hz, 0 b) $6\pi\times10^4$Hz, 0 c) $3\pi\times10^4$Hz, 30° d) $\pi\times10^4$Hz, 45°

12. An inductance L, a capacitance C and a resistance R may be connected to an ac source of angular frequency ω, in three different combinations of RC, RL and LC in series. Assume that $\omega L = \frac{1}{\omega C}$. The power drawn by the three combinations are P_1, P_2, P_3 respectively. Then

a) $P_1 > P_2 > P_3$ b) $P_1 = P_2 < P_3$ c) $P_1 = P_2 > P_3$ d) $P_1 = P_2 = P_3$

13. If LCR - circuit if resistance increases, quality factor.

a) increases finitely b) decreases fainitely c) remains constant d) non of these

14. To reduce the resonant frequency in an LCR series circuit with a generator

a) the generator frequency should be reduced

b) another capacitor should be added in parallel to the first

c) the iron core of the inductor should be removed

d) dielectric in the capacitor should be removed

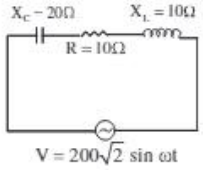
15. In the LCR circuit shown in figure

a) current will lead the voltage

b) rms value of current is 20A

c) power factor of the circuit is $\frac{1}{\sqrt{2}}$

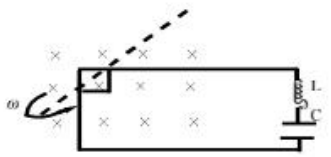
d) voltage drop across resistance is 100V



Linked Comprehe nsion Type Questions

Passage - I :

In the given arrangement, the square loop of area 10 cm^2 rotates with an angular velocity ω about its diagonal. The loop is connected to a inductance of $L = 100\,mH$ and a capacitance of 10 mF in series. The lead wires have a net resistance of $10\,\Omega$. Given that B = 0.1 T and $\omega = 63$ rad/s,



16. Find the rms current

a) 6×10^5A b) 5×10^{-5}A c) 4×10^{-4}A d) 7×10^{-5}A

17. Find the energy dissipated in 50 sec.

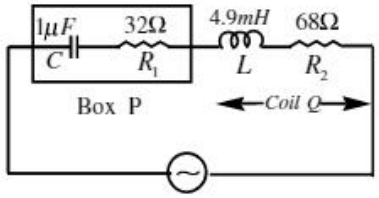
a) 6.12×10^{6}J b) 8×10^{-5} J c) 5.12×10^{5}J d) 8.12×10^{6}J

18. If the current is in phase with voltage, what should be the angular frequency of rotation of the coil.

a) 31.6 rad/s b) 29.5 rad/s c) 25.6 rad/s d) 20.5 rad/s

Passage - II :

A box P and a coil Q are connected in series with an ac source of variable frequency. The rms value of emf of source is constant at 10 V. Box P contains a capacitance of **1μF** *in series with a resistance of* **32Ω**. *Coil Q has a self-inductance 4.9 mH and a resistance of* **68Ω** *in series. The frequency is adjusted so that the maximum current flows in P and Q.*



19. Impedance of p at this frequency is.

a) 77 ohm b) 87 ohm c) 67 ohm d) 57 ohm

20. Maximum current through circuit is.

a) 5/20A b) $\frac{2}{10}$A c) 3/10A d) 1/10A

21. Voltage across Q is.

a) 3.45V b) 7.75V c) 9.76V d) 8.76V

Passage - III :

An inductor 20 × 10^{-3} henry, a capacitor **100μF** *and a resistor* **50Ω** *are connected in series across a source of emf V=10sin (314t).*

22. Find the impedence in the circuit

a) 56 ohm b) 40 ohm c) 36 ohm d) 60 ohm

23. Find the energy dissipated in the circuit in 20 minutes.

a) 615 J b) 750 J c) 951 J d) 250 J

24. If resistance is removed from the circuit and the value of indutance is doubled, then find the variation of current with time in the new circuit.

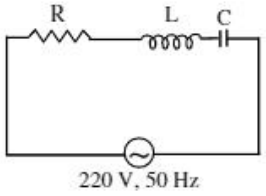
a) 0.43 cos 314 t b) 0.52 cos 214 t c) 0.25 cos 114 t d) 0.52 cos 314 t

Matrix Matching Type Questions

25. In L-C-R series circuit suppose ω_r is the resonance frequency, then match the following tables. (ω is frequency of applied A.C)

COLUMN - I	COLUMN - II
A) If $\omega > \omega_r$	p) current will lead the voltage
B) If $\omega = \omega_r$	q) voltage will lead thecurrent
C) If $\omega = 2\omega_r$	r) $X_L = 2X_C$
D) If $\omega < \omega_r$	s) Current and voltage are in phase

26. In series R–L–C circuit, $R = 100\Omega$, $C = \frac{100}{\pi}\mu F$, and $\frac{100}{\pi}$mH, is connected to an ac source as shown in Figure.

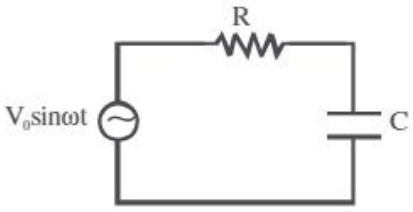


The rms value of ac voltage is 220V and its frequency is 50Hz. In Column-I some physical quantities are mentioned while in Column-II information about quantities are provide. Match the entries of Column-I with the entries of Column-II.

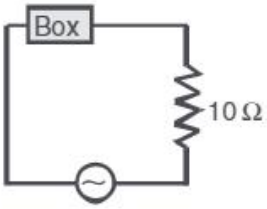
COLUMN - I	COLUMN - II
A) Average power dissipated in the resistor is	p) zero
B) Average power dissipated in the inductor is	q) non-zero
C) Average power dissipated in the capacitor is	r) 160
D) RMS voltage across the capacitor is	s) 260

Integer Type Questions

27. An ac voltage source $V = V_0 \sin\omega t$ is connected across resistance R and capacitance C as shown in figure. It is given that $R = \frac{1}{\omega C}$. The peak current is I_0. If the angular frequency of the voltage source is changed to $\frac{\omega}{\sqrt{3}}$ keeping R and C fixed, then the new peak current in the circuit is : $\frac{I_0}{\sqrt{x}}$ where x =



28. In the circuit shown in figure power factor of box is 0.5 and power factor of circuit is $\sqrt{3}/2$. Current is leading the voltage. The effective resistance of the box is $R\Omega$. Find R



EXERCISE-V

(Transformers)

LEVEL-I (MAIN)

Straight Objective Type Questions

1. The core of transformer is laminated to reduce energy losses due to
   1) Eddy currents 2) Hysteresis
   3) Resistance in winding 4) Non of these

2. The long distance transmission of electrical energy is done at
   1) High potential and low current 2) low potential and high current
   3) high potential and low current 4) low potential and low current

3. Statement (A): In a step up transformer primary is made of thick insulated copper wire and the secondary is made of thin wire.
   Statement (B) : A step up transformer converts large current at low voltage to a low current at high voltage.
   1) A is true, B is false 2) Both A and B are true
   3) A is false , B is true 4) Both A and B are false

4. A 50Hz, A.C. current of crest value 1A, flows through the primary of transformer. If mutual inductance between the primary and secondary is 0.5H, then crest voltage induced in the secondary is
   1) 157 V 2) 150 V 3) 75 V 4) 50 V

KEY SHEET (PRACTICE SHEET)

EXERCISE-I

LEVEL-I	1) 1	2) 1	3) 3	4) 4	5) 3	6) 2		
LEVEL-II	1) d	2) d	3) abc	4) bd	5) a	6) b	7) a	8) 0
	9) 5							

EXERCISE-II

LEVEL- I	1) 1	2) 3	3) 3	4) 4	5) 2	6) 5 Ω	
LEVEL-II	1) c	2) c	3) a	4) a	5) b	6) a	7) d

EXERCISE-III

LEVEL-I	1) 2	2) 3	3) 2	4) 3	5) 2	6) 3	7) 4	8) 1
	9) 2	10) 1	11) 3	12) 7	13) 1.56			
LEVEL-II	1) b	2) a	3) c	4) c	5) b, c	6) c	7) d	8) a
	9) a	10) a	11) a	12) A-p,r,t ; B-p,t ; C-q,s ; D-p,r,t				13) 8

EXERCISE - IV

LEVEL-I	1) 2	2) 3	3) 4	4) 1	5) 4	6) 0.01	7) 2

LEVEL-II

1) c 2) a 3) c 4) b 5) b 6) a 7) b 8) d
9) c 10) d 11) a 12) c 13) b 14) b 15) a,c 16) c
17) b 18) a 19) a 20) d 21) c 22) a 23) c 24) d
25) A-q ; B-s ; C-q ; D-p 26) A-q,s ; B-p ; C-p ; D-q,r 27) 2 28) 5

EXERCISE-V

LEVEL-I

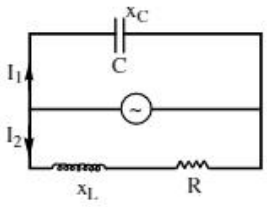
1) 1 2) 1 3) 2 4) 1

ADDITIONAL PRACTICE EXERCISE

LEVEL-I (MAIN)

Straight Objective Type Questions

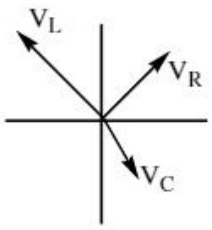
1. In the shown AC circuit phase different between currents I_1 and I_2 is

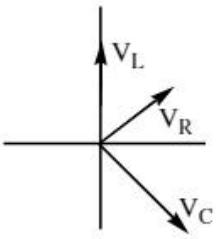


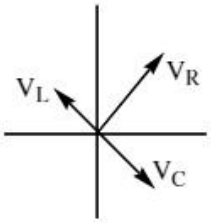
1) $\frac{\pi}{2}-\tan^{-1}\frac{X_L}{R}$ 2) $\tan^{-1}\left(\frac{X_L-X_C}{R}\right)$

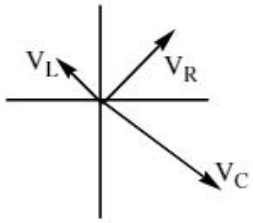
3) $\frac{\pi}{2}+\tan^{-1}\frac{X_L}{R}$ 4) $\tan^{-1}\left(\frac{X_L+X_C}{R}\right)+\frac{\pi}{2}$

2. In the figure, which of the phasor diagram represents RLC circuit driven at resonance ?

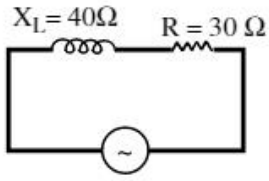
1) 

2) 

3) 

4) 

3. In the circuit current through source will be [Given $(\cos^{-1}(0.6) = 53°)$]

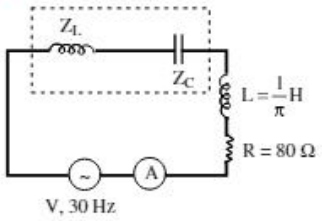


$V = 10 + 10\sqrt{2}\sin(100\pi t + 45°)$

1) $\frac{1}{3}+\frac{\sqrt{2}}{5}\sin(100\pi t-8°)$ 2) $\frac{1}{5}+\frac{\sqrt{2}}{5}\sin(100\pi t-8°)$

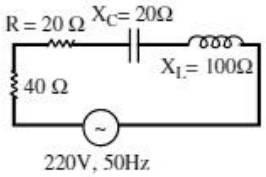
3) $\frac{1}{3}+\frac{\sqrt{2}}{5}\sin(100\pi t-98°)$ 4) $\frac{1}{5}+\frac{\sqrt{2}}{5}\sin(100\pi t+98°)$

4. In figure below if $Z_L = Z_C$ and reading of ammeter is 1 A. Find value of source voltage V.



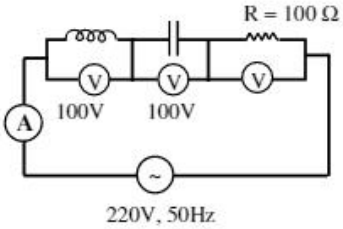
1) 80 Volt 2) 60 Volt 3) 100 Volt 4) None of these

5. The power factor of the circuit shown in the figure is



1) 0.4 2) 0.2 3) 0.8 4) 0.6

6. What will be the reading of the voltmeter across the resistance and ammeter in the circuit shown in the figure?



1) 300 V, 2A 2) 800 V, 2A 3) 100 V, 2A 4) 220 V, 2.2A

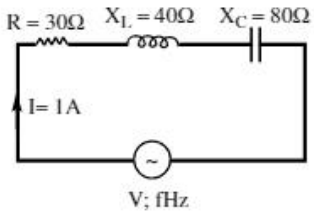
7. The value of L, C and R in an LCR series circuit are 4 mH, 40 pF and 100 respectively. The quality factor of the circuit is

1) 10,000 2) 100 3) 1000 4) 10

8. In an LR series AC circuit the angular frequency of applied emf is 2×10^4 rads^{-1} and the value of resistance is 20Ω. The instant at which the value of emf is maximum E_0, the value of current is $i_0/\sqrt{2}$. The inductance in the circuit will be

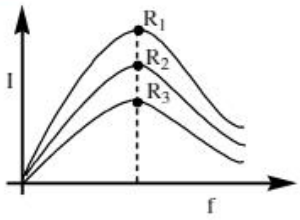
1) 1 mH 2) 40 mH 3) 8 mH 4) cannot be predicted

9. In series LCR circuit as shown in figure. Value of V will be



1) 50 V 2) 100 V 3) 30 V 4) None

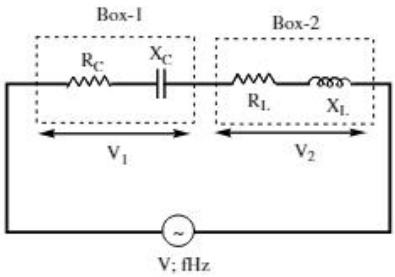
10. In series L, C, R circuit at resonance current versus frequency graph is shown below for different resistances choose correct alternative



1) $R_1 > R_2 > R_3$ 2) $R_1 < R_2 < R_3$ 3) $R_1 = R_2 = R_3$
4) impedance of circuit will be same for any value of R

11. In a series RC circuit $R = 500\Omega, C = 2\mu F$, $V = 282 \sin(377t)$. The power consumed is
1) 14100 W 2) 141 W 3) 10 W 4) 14.1 W

12. As shown in figure below :
V_1 voltage drop across box – 1 V_2 voltage drop across box -2
If Only f is variable $0 < f < f_C$ and $R_C = R_L$
where f_c frequency at resonance then



1) $V_1 > V_2$ 2) $V_1 < V_2$ 3) $V_1 = V_2$ 4) Cannot say

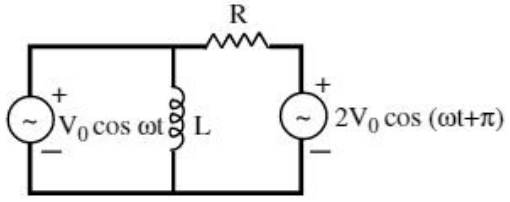
13. An AC voltage source of variable angular frequency ω and fixed amplitude v_0 is connected in series with a capacitance C and an electric bulb of resistance R (inductance zero). When ω is increased
1) The bulb glows dimmer
2) The bulb glows brighter
3) Total impedance of the circuit is unchanged
4) Total impendence of the circuit increases

14. A current is made of two components, a DC component of $I_1 = 3$ amp and an AC component given by $I_2 = 4\sqrt{2}\sin\omega t$ amp; then the reading of the hot-wire ammeter is:
1) 3 amp 2) $4\sqrt{2}$ amp 3) $(3+4\sqrt{2})$ amp 4) 5 amp

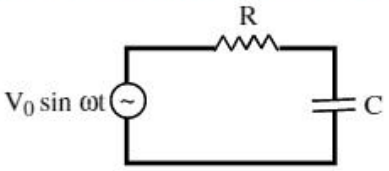
15. The diagram shows an AC circuit with two voltage sources of same frequency. Find out the value of current I shown in the fig.

1) $I = \frac{V_0 \sin(\omega t)}{R}$ 2) $I = \frac{V_0 \cos(\omega t + \pi/2)}{R}$

3) $I = \frac{V_0 \cos\omega t}{R}$ 4) $I = \frac{-3V_0 \cos\omega t}{R}$



16. An ac voltage source $V = V_0 \sin \omega t$ is connected across resistance R and capacitance C as shown in figure. It is given that $R = \frac{1}{\omega C}$. The peack currents is I_0. If the angular frequency of the voltage source is changed to $\frac{\omega}{\sqrt{3}}$ keeping R and C fixed then the new peak current in the circuit is

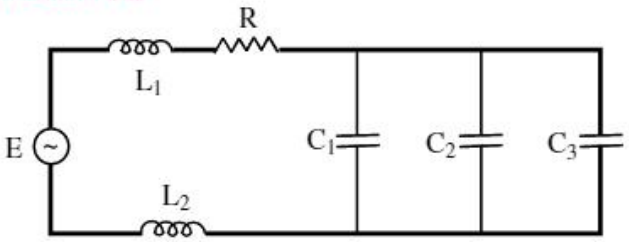


1) $\frac{I_0}{2}$ 2) $\frac{I_0}{\sqrt{2}}$ 3) $\frac{I_0}{\sqrt{3}}$ 4) $\frac{I_0}{3}$

17. 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 amplitude at resonance are separated by frequency interval

1) R/L 2) $2\pi\sqrt{LC}$ 3) $\sqrt{LC}$ 4) RC

18. A generator with an adjustable frequency of oscillation is connected to resistance, R inductances, $L_1 = 1.7$mH and $L_2 = 23$mH and capacitances, $C_1 = 4\mu F$, $C_2 = 2.5\mu F$ and $C_3 = 3.5\mu F$. The resonant angular frequency of the circuit is

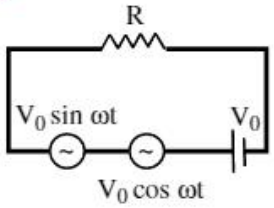


1) 0.5 rad/s 2) 0.5×10^4 rad/s 3) 2 rad/s 4) 2×10^{-4} rad/s

19. Three sources of emf, $V_0 \sin \omega t$, $V_0 \cos \omega t$ and V_0 are connected in series as shown. RMS value of current in the circuit is

1) $\frac{V_0}{R\sqrt{2}}$ 2) $\frac{V_0}{R}$

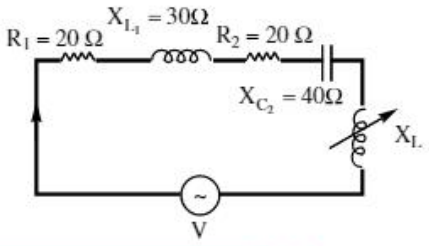
3) $\frac{V_0\sqrt{2}}{R}$ 4) $\frac{2V_0}{R}$



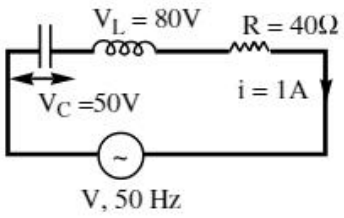
Numerical Value Type Questions

20. In an a.c. circuit, V & I are given by V = 100 sin (100 t) volt ; I = 100 sin (100 t + $\pi/3$) mA. The power dissipated in the circuit is ____ watt.

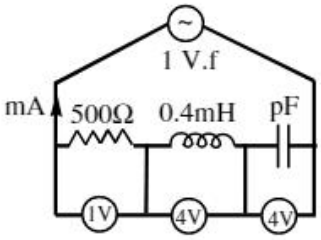
21. As shown in figure value of inductive reactance X_L (in ohms) will be if source voltage is 100 volt



22. Power factor of the A.C. circuit as shown in the figure is



23. A series LRC circuit is connected to an a.c. source (1V, f). The voltage drop across R, L and C respectively are 1V, 4 V and 4V. Find the readng shown in a.c. milliammeter.



LEVEL-II

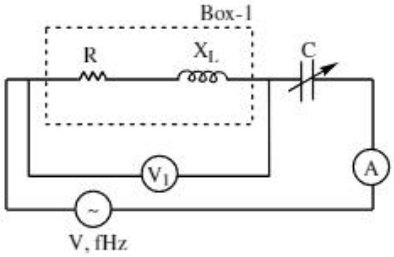
LECTURE SHEET (ADVANCED)

More than One correct answer Type Questions

1. A current of 4A flows in a coil when connected to 12V dc source. If the same coil is connected to a 12V, 50 rad/s source, a current of 2.4 A flows in the circuit. Then

a) $R = 4\Omega$ b) $R = 3\Omega$ c) L = 4H d) 0.08 H

2. Choose correct statement of capacitance increases from zero (0) to infinity (∞)



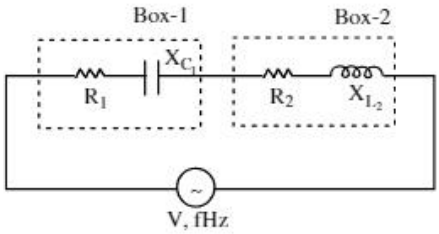
a) Current increases from 0 (Zero) to maximum then decreases to zero

b) Reading of voltmeter first increases and it will be maximum when $X_L = X_C$

c) Power factor of circuit first increases then decreases

d) V_1 may be greater than V, V_1 may be equal V, V_1 may be less than V, where V_1 is reading of voltmeter and V is source voltage.

3. If $X_{L_2} > X_{C_1}$ and $R_1 = R_2$ then. Choose the correct alternative

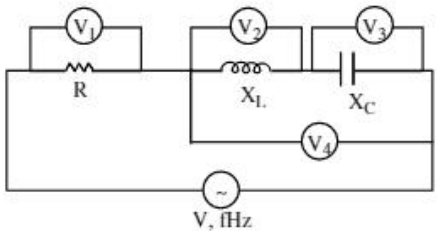


a) Source voltage v will lead the current
b) Power factor of box 1 will be greater than power factor of box – 2
c) Power factor of box 1 is less than power factor of circuit
d) Voltage across box-1 will lag current

4. Choose the correct alternative

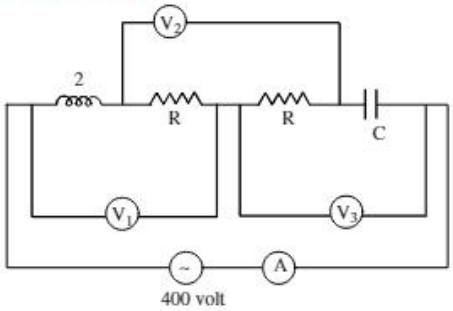
a) Inductive reactance of choke coil is much lesser
b) Power factor of ideal choke coil is nearly zero
c) Choke coil is connected in parallel across tube light.
d) In tube light initial induced voltage across choke coil is greater than supply voltage

5. In series LCR circuit. Choose correct option



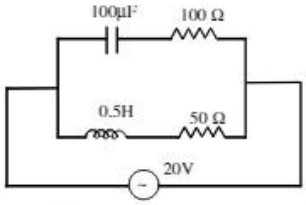
a) Reading of voltmeter V_2 may be greater than V (source voltage)
b) Reading of voltmeter V_4 may be equal to V_1
c) Reading of V_4 may be equal to V (source voltage)
d) Reading of V_1, V_2 and V_3 may be equal

6. In the shown circuit reading of ideal AC voltmeter V_1 and V_3 are 300 volt each then choose correct option/options if reading of ammeter is 10A:



a) $V_2 = 300$ V b) $V_2 = 400$ V c) $R = 10\Omega$ d) $R = 20\Omega$

7. In the given circuit, the AC source has ω=100 rad/s. Considering the inductor and capacitor to be ideal, the correct choice(s) is (are)



a) The current through the circuit, I is 0.3A

b) The current through the circuit, I is $0.3\sqrt{2}$A

c) The voltage across 100 Ω resistor =$10\sqrt{2}$A

d) The voltage across 50 Ω resistor =10V

8. A resistance of $10^3\,\Omega$, a capacitance of 10^{-6}F and an inductance of 2 Henry are connected in series with a source of 200 sin (1000t)volt. Which of the following are correct ?

a) RMS current = 0.1A b) Impedance = 1414 Ω

c) The voltage leads the current by 45° d) Power factor = 0.707

9. A current of 4 A flows in a coil when connected to a 12 V dc supply. If the same coil is connected to a 12 V, 50 rad/s ac source a current of 2.4 A flows in the circuit.

a) Inductance of the coil is 0.08 H b) Resistance of the coil is 3 ohm

c) Reactance of the coil is 5 ohm d) Inductance of the coil is 0.16 H

10. In an L-R circuit, the value of L is $(0.4/\pi)$henry and the value of R is 30 ohm. If in the circuit, an alternating emf of 200 volt at 50 cycles per second is connected, the impedance (Z) of the circuit and current (I) will be :

a) Z = 50 ohm b) Z = 60 ohm c) I = 2 ampere d) I = 4 ampere

Linked Comprehension Type Questions

Passage - I :

A series LCR circuit containing a resistance of 120Ω has an angular resonance frequency 4×10^5 rad/sec. At resonance, voltage across resistance and inductance are 60 V and 40 V.

11. Value of inductance is

a) 100 H b) 200 H c) 100 μ H d) 200 μ H

12. The value of capacitance is

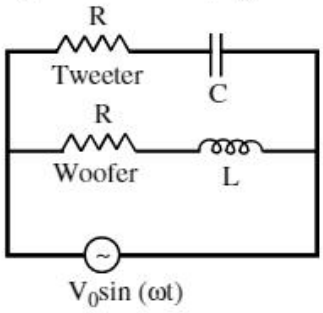
a) 32 μ F b) 16 μ F c) 1/32 μ F d) 1/16 μ F

13. The value of $X_L - X_C$, when the current lags behind the voltage by 45° is

a) 60Ω b) 120Ω c) 180Ω d) 240Ω

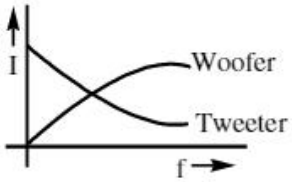
Passage - II :

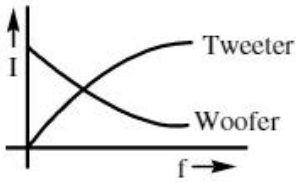
A loudspeaker system uses alternating current to amplify sound of certain frequencies. It consists of 2 speakers.

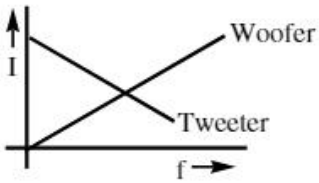


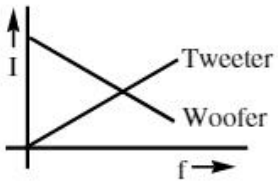
Tweeter-which has smaller diameter produces high frequency sounds. Woofer-which has larger diameter produces low frequency sound. For purpose of circuit analysis, we can take both speakers to be of equal resistance R. The equivalent circuit is shown in the figure. The 2 speakers are connected to the amplifier via capacitance and inductance respectively. The capacitor in tweeter branch blocks the low frequency sound but passes the high frequency. The inductor in woofer branch does the opposite.

14. Which plot ocrrectly represents rms current against frequency.

a) 

b) 

c) 

d) 

15. What is the frequency which is sounded equally loudly by both speakers

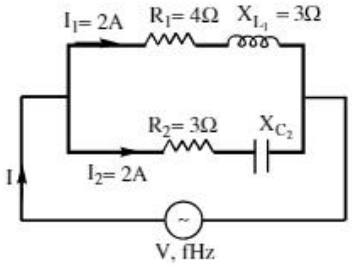
a) $\frac{1}{2\pi}\sqrt{\frac{R^2}{L^2}-\frac{1}{LC}}$ b) $\frac{1}{2\pi}\sqrt{\frac{4R^2}{L^2}-\frac{1}{LC}}$ c) $\frac{1}{2\pi}\sqrt{\frac{1}{LC}-\frac{R^2}{4L^2}}$ d) $\frac{1}{2\pi\sqrt{LC}}$

16. For a combination of L, R & C the current in woofer & tweeter are always found to have a phase difference of . What is the relation between L, R & C.

a) $L = 2R^2C$ b) $L = \sqrt{2}R^2C$ c) $L = R^2C$ d) $L = \frac{R^2C}{\sqrt{2}}$

Passage - III :

As shown in figure



17. Value of X_{C_2} will be

a) 3Ω b) 4Ω c) 5Ω d) None

18. Current through voltage source (I) will lie in interval

a) $2 < 1 < 4$ b) $0 < 1 < 2$ c) 4A d) $1 > 4$

19. Source voltage V will be

a) 10 volt b) Data in sufficient c) 20 volt d) 14 volt

Passage - IV :

A constant voltage at a frequency of 1 MHz is applied to an inductor in series with variable capacitor.; when capacitor is 500 pF, the current has its maximum value, while it is reduced to half when capacitance is 600 pF . Find

20. Resistance (R)

a) 30Ω b) 20Ω c) 40Ω d) 50Ω

21. The inductance L

a) 0.05 mH b) 0.5 mH c) 0.005 mH d) None

22. Q factor of an inductor

a) 10.4 b) 20.8 c) 5.2 d) None

Passage - V :

When 1 A passed through three coil A,B, C in series the voltage drops are respectively 6, 3, and 8 volt, on Direct current source and 7, 5 and 10 volt on Alternating current source

23. Power factor of coil B, will be

a) 0.6 b) 0.8 c) 0.7 d) None

24. Power dissipated in coil C

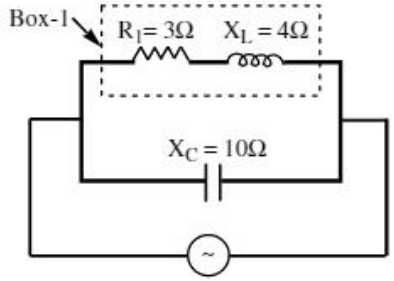
a) 10 watt b) 6 watt c) 5 watt d) 8 watt

25. Power factor of whole circuit when alternating current flow

a) 0.6 b) 0.8 c) 0.78 d) 1

Passage - VI :

As shown in figure (given $\tan^{-1}(4/3) = 53°$)



$V = 200\sqrt{2}\sin(\omega t + \pi/4)$

26. Instantaneous current in branch having capacitor C will be :

a) $20\sqrt{2}\sin(\omega t + 3\pi/4)$ b) $40\sqrt{2}\sin(\omega t + \pi/4)$

c) $60\sqrt{2}\sin(\omega t - \pi/4)$ d) None of above

27. Angle between current through inductor and capacitor will be

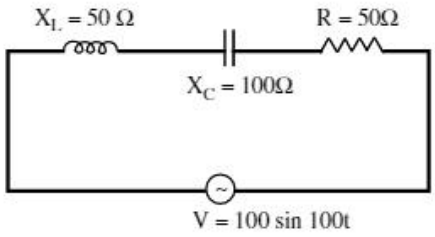
a) 143° b) 90° c) 53° d) None

28. Potential drop across X_L will be

a) 160 volt b) 120 volt c) 200 volt d) $160\sqrt{2}$ volt

Passage - VII :

In the LCR series AC circuit shown, the source voltage is given by v = (100 sin 100t)V. The inductive reactance, capacitive reactance and resistance in the circuit are $X_L = 50\Omega$; $X_C = 100\Omega$ and $R = 50\Omega$ respectively at the frequency of the source.



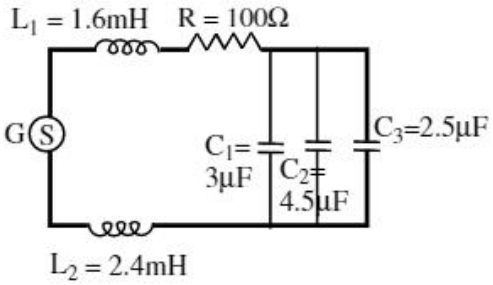
29. Choose the correct statement (V_R,V_L,V_C are the voltages across resistor, inductor and capacitor respectively)
    a) For the resistor the relation $V_R = IR$ can be applied for the instantaneous, RMS and also peak values of voltages and currents.
    b) For the inductor the relation $V_L = IX_L$ can be applied for the instantaneous, RMS and also peak values of voltages and currents.
    c) For the capacitor the relation $V_C = IX_C$ can be applied for the instantaneous, RMS and also peak values of voltages and currents.
    d) For the LCR combination the relation V= IZ can be applied for the instantaneous, RMS and also peak values of voltages and currents

30. At the instant the source voltage is zero, the voltage across the inductor is
    a) 50V b) 100V c) 150V d) 200V

31. At the instant the source voltage is zero, the voltage across the inductor, capacitor combination is
    a) 50V b) 100V c) 150V d) 200V

Passage -VIII :

An ac generator G with an adjustable frequency of oscillation is used in the circuit, as shown.



32. Current drawn from the ac source will be maximum if its angular frequency is
    a) 10^5 rad/s b) 10^4 rad/s c) 5000 rad/s d) 500 rad/s

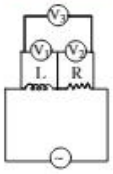
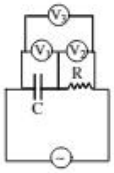
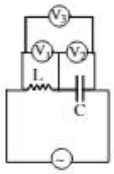
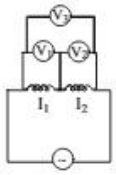
33. To increase resonant frequency of the circuit, some of the changes in the circuit are carried out. Which change(s) would certainly result in the increase inresonant frequency?
    a) R is increased
    b) L_1 is increased and C_1 is decreased
    c) L_2 is decreased and C_2 is increased
    d) C_3 is removed from the circuit.

34. If the ac source G is of 100 V rating at resonant frequency of the circuit, then average power supplied by the source is

a) 50 W b) 100 W c) 500 W d) 1000 W

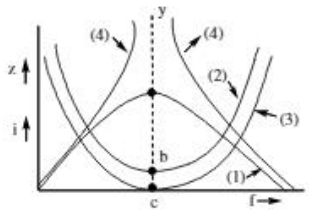
Matrix Matching Type Questions

35. All voltmeters are ideal and reading of voltmeters V_1 and V_2 are given by $V_1 = 3$ volt and $V_2 = 4$volt in all cases. Match the following.

COLUMN - I	COLUMN - II
A) 	p) $V_3 = 5$ volt
B) 	q) $V_3 = 1$ volt
C) 	r) $V_3 = 7$ volt
D) 	s) Current is lagging in phase from applied voltage
	t) Applied voltage is lagging in phase from current

36. In series R,L,C circuit frequency of voltage source is variable as shown in graph match Column I and Column II.

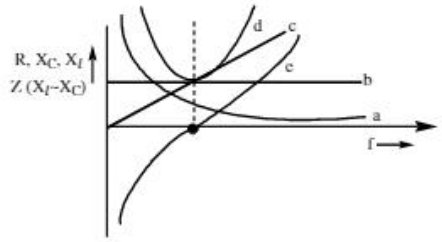
COLUMN - I	COLUMN - II
A) Impedance (Z) vs frequency if $R \neq 0$	p) Graph (4)
B) Current (I) vs frequency if $R \neq 0$	q) Graph (3)
C) Impedance vs frequency if $R = 0$	r) Graph (1)
D) Current (I) vs frequency if $R = 0$	s) Graph (2)



37. In series L, C, R circuit, if it is connected by voltage source vs and frequency f, condition is given in column I its result is at column II. Match the following

COLUMN - I	COLUMN - II
A) If $X_L > X_C$ and $R \neq 0$	p) Power factor of circuit will be unity.
B) If $X_L = X_C$ and $R \neq 0$	q) Source voltage will be in phase with current
C) If $X_L < X_C$ and $R = 0$	r) Power factor of circuit will be zero
D) If $X_L = X_C = R$	s) Source voltage will lead current.

38. In series L,C,R circuit only frequency of source voltage is variable. Graph show reactance, resistance and impedance as function of frequency



COLUMN - I	COLUMN - II
A) Inductive reactance vs frequency	p) Graph (d)
B) Impedance vs frequency	q) Graph (e)
C) $(X_L - X_C)$ difference of inductive reactance and capacitive reactance vs frequency	r) Graph (a)
D) Capacitive reactance vs frequency	s) Graph (c)

Integer Type Questions

39. An LCR series circuit with 100Ω resistance is connected to an ac source of 200V and angular frequency 300rad/sec. When only the capacitance is removed, the current lags behind the voltage by 60°, when only the inductance is removed the current leads the voltage by 60°. Calculate the current in LCR circuit in ampere

40. A circuit draws a power 550watt from a source of 220 volt, 50 Hz. The power factor of the circuit is 0.8 and the current lags in phase behing the potential difference. To make the power factor of the circuit as 1.0 capacitance of $1.5n\mu F$ will have be connected with it. Find the value of 'n'

41. A current of 4A flows in a coil when connected to a 12V. dc source. If the same coil is connected to a 12V, $50/\pi$ Hz ac source a current 2.4A flows in the circuit. If the inductance of the coil is $\pi \times 10^{-2}$ H. Find 'x' value.

42. An LCR series circuit with 10Ω resistance is connected to an AC source of 200 V and angular frequency 300 rad/s. When only the capacitance is removed, the current lags behind the voltage by 60°. When only the inductance is removed, the current leads the voltage by60°. Calculate the power (in kW) dissipated in the LCR circuit.

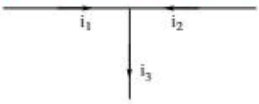
PRACTICE SHEET (ADVANCED)

Straight Objective Type Questions

1. An oscillating circuit consists of a capacitor with capacitance C, a coil of inductance L with negligible resistance, and a switch. With the switch disconnected the capacitor was charged to a voltage V_m and then at the moment t = 0, the switch was closed. The current I in the circuit as a function of time is represented as

a) $V_m\sqrt{\frac{L}{c}}\sin(\omega t)$ b) $V_m\sqrt{\frac{c}{L}}\sin(\omega t)$ c) $V_m\sqrt{\frac{L}{c}}\cos(\omega t)$ d) $V_m\sqrt{\frac{c}{L}}\cos(\omega t)$

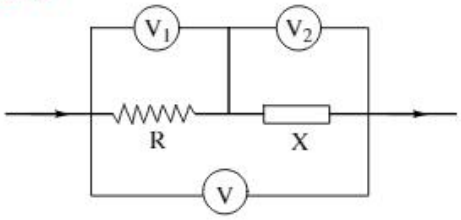
2. If $i_1 = 3\sin\omega t$ and $i_2 = 4\cos\omega t$ then i_3 is(i_1, i_2 and i_3 represents alternating current)



a) $5\sin(\omega t + 53^0)$ b) $5\sin(\omega t + 37^0)$

c) $5\sin(\omega t + 45^0)$ d) $5\sin(\omega t - 53^0)$

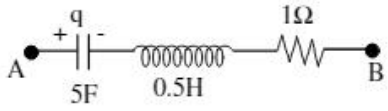
3. If the reading of the voltmeters vary with time as $V_1 = 20\sin\omega t$ and $V_2 = 20\cos(\omega t + \pi/6)$, then the unknown circuit element X is a



a) Pure (or ideal) inductor b) practical inductor

c) Pure (or ideal) capacitor d) practical capacitor

4. In the circuit as shown, charge varies with time t as $q = (t^2 - 4)$ where q is in coulombs and time t is in seconds. Find V_B at time t = 3sec (Given V_A = 10V)



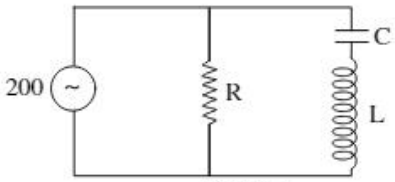
a) 4V b) 8V c) 6V d) 2V

5. An AC voltage source of variable angular frequency ω and amplitude V_0 is connected in series with a capacitance C and an electric bulb of resistance R (inductance zero). When ω is increased

a) The bulb glows dimmer b) The bulb glows brighter

c) Total impedance of the circuit is unchanged d) Total impendence of the circuit increases

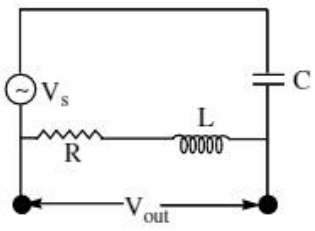
6. In the circuit diagram shown, $X_C = 100\,\Omega$, $X_L = 200\,\Omega$ & $R = 100\,\Omega$. The effective current through the source is :



a) 2A b) $2\sqrt{2}$ c) 0.5 A d) $\sqrt{0.4}$ A

7. Find the ratio for V_{out} / V_s as function of the angular frequency ω of the source

a) $\sqrt{\dfrac{R^2 + \left(\dfrac{1}{\omega C}\right)^2}{R^2 + \left(\omega L - \dfrac{1}{\omega C}\right)^2}}$ b) $\sqrt{\dfrac{R^2 + (\omega L)^2}{R^2 + \left(\omega L - \dfrac{1}{\omega C}\right)^2}}$



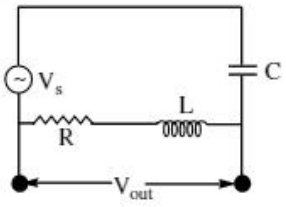
c) $\dfrac{R}{\sqrt{R^2 + \left(\omega L - \dfrac{1}{\omega C}\right)^2}}$ d) 1

8. Which of the following statement is correct (best approximation) when ω is very small in the case of V_{out}/V_s?

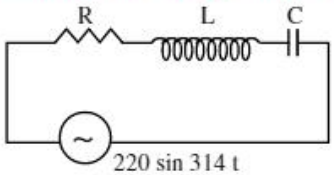
a) ωRC b) $\frac{\omega R^2}{L}$

c) ωRL

d) $\frac{\omega R}{C}$



9. In the circuit shown, the value of L is 5H and the power factor of the circuit is 0.8. It is also given that the voltage drop across capacitor is 2/5 times the voltage drop across the inductor. The impedence is



a) 471Ω b) 271Ω c) 442Ω d) 1570Ω

10. An electric bulb rated 100 W- 300 V D.C. is connected with an A.C. supply of 500 V and $\frac{150}{\pi}$ Hz. The required inductance to be connected in series to the bulb so that the bulb works at the rated power is

a) 2H b) H c) 4H d) 8H

More than One correct answer Type Questions

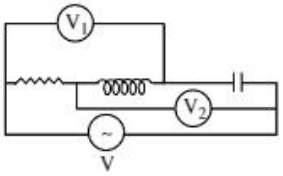
11. In an AC series circuit given that, R = 10Ω, X_L = 20Ω and X_C = 10Ω. Then choose the correct options

a) Voltage function will lead the current function b) Total impedance of the circuit is $10\sqrt{2}\Omega$

c) Phase angle between voltage function and current function is 45°

d) Power factor of circuit is $\frac{1}{\sqrt{2}}$

12. In the LCR series A.C circuit shown, the r.m.s. readings of voltmeters are V_1 = 150V, V_2 = 50V and the r.m.s. voltage of the source is 130 V. Then



a) r.m.s. Voltage across inductor must be 90V

b) r.m.s. Voltage across capacitor must be 40V

c) r.m.s. Voltage across resistor must be 120V

d) The power factor of the circuit $\frac{5}{13}$

13. In a certain series LCR circuit, it is found that $X_L = 2X_C$ and phase difference between current and voltage of source is $\frac{\pi}{4}$. If now, capacitance is made four times initial value and the inductance and resistance are doubled then

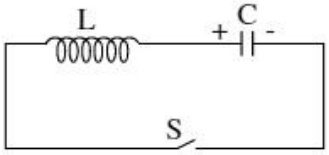
a) The new circuit is in resonance

b) Average power in the circuit is maximum

c) The impedance in the new circuit versus angular frequency of the source is a straight line

d) The rms voltage across the resistance is equal to the rms voltage across the source

14. A capacitor is charged to a potential of V_0. It is connected with an inductor through a switch S. The switch is closed at time t = 0. Which of the following statement(s) is/are correct?



a) The maximum current in the circuit is $V_0\sqrt{\frac{C}{L}}$.

b) Potential difference across the capacitor becomes zero for the first time at $t = \pi\sqrt{LC}$.

c) Energy stored in the inductor at $t = \frac{\pi}{2}\sqrt{LC}$ is $\frac{1}{4}CV_0^2$

d) Maximum energy stored in the inductor is $\frac{1}{2}CV_0^2$.

15. Parallel combination of a choke coil and a resistor of resistance 60Ω is connected to an AC source. The currents through the coil, the resistor and the source are I_{ch} = 3A, I_R = 2.5A and I_s = 4.5A respectively. Therefore,

a) Impedance of the coil is 50Ω

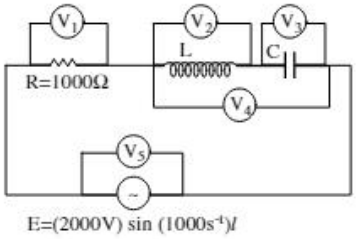
b) Impedance of the coil is 150Ω

c) Impedance of the circuit is $\frac{100}{3}\Omega$

d) Heat dissipated in the resistor is 375 W

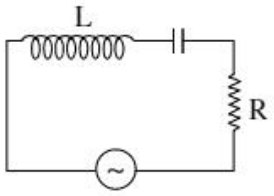
Matrix Matching Type Questions

16. In the circuit shown in figure, V_1, V_2, V_3, V_4 and V_5 are ideal ac voltmeters. The column - I gives a condition and the column - II gives the corresponding value, match the following :



COLUMN - I	COLUMN - II
A) When L = 1 H and $C = 1\mu F$, reading is approximately 1414V for	p) V_1
B) When L = 2 H and $C = 1\mu F$, reading is 1000 V for	q) V_2
C) When L = 1 H and $C = 0.5\mu F$ reading is 1000 V for	r) V_3
D) When L = 2 H and $C = 0.5\mu F$ reading is non zero for	s) V_4
	t) V_5

17. Match the following :
Figure shows a series LCR circuit connected to a variable frequency 200 V source. L=5H, C = 80μF and R = 40Ω



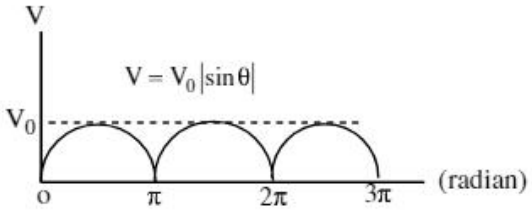
COLUMN - I	COLUMN - II
A) The impedance of the circuit at resonance (in ohm)	1) 1250 V
B) The current amplitude at resonance (in A)	2) 200 V
C) The rms potential drop across the inductor at resonance (in volt)	3) 40Ω
D) The rms potential drop across the resistor at resonance (in V)	4) $5\sqrt{2}$A

Integer Type Questions

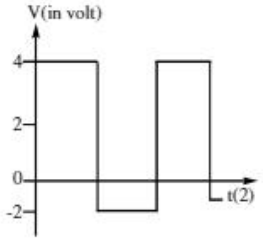
18. The current in a circuit is given as $I|\sin\omega t|$ and its mean value is I_0. If the effective value is $\frac{\pi I_0}{\sqrt{x}}$, find x.

19. It takes time "t_0" for a direct current I_0 to charge a storage battery. Now an a.c.source whose effective current is I_0 is connected along with half wave rectifier takes time $\frac{\pi t_0}{\sqrt{x}}$ time to charge the same battery. Find x. ($t_0 \times f = n$, where f is frequency of source and n is a positive integer)

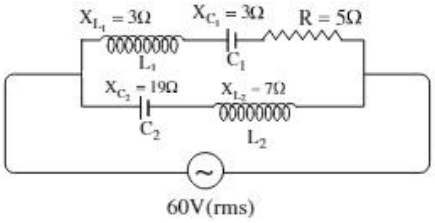
20. The average and rms values for the shape shown are V_1 and V_2. Then $\frac{V_1^2}{V_2^2} = \frac{k}{\pi}$ where k = ___



21. A 20Ω resistor is connected to an AC power supply of frequency 50Hz with a voltage output that varies from 4V to -2V at equal time intervals as shown in the figure.
If the average heating power dissipated in the resistor is (x/2) W. Find the value of x.



22. In the given A.C circuit the r.m.s voltage of the source is 60V then the r.m.s current passing through the source is (10+x)A then the value of x is



KEY SHEET (ADDITIONAL PRACTICE EXERCISE)

LEVEL-I (MAIN)

1) **3** 2) **3** 3) **2** 4) **3** 5) **4** 6) **4** 7) **2** 8) **1** 9) **1** 10) **2**

11) **3** 12) **1** 13) **2** 14) **4** 15) **4** 16) **2** 17) **1** 18) **2** 19) **3** 20) **2.5**

21) **50 ohms** 22) **0.8** 23) **2**

LEVEL-II

LECTURE SHEET (ADVANCED)

1) **bd** 2) **acd** 3) **abd** 4) **bd** 5) **abd** 6) **bd** 7) **ac** 8) **abcd** 9) **ab** 10) **ad**

11) **d** 12) **c** 13) **b** 14) **b** 15) **d** 16) **c** 17) **b** 18) **b** 19) **a** 20) **a**

21) **a** 22) **a** 23) **a** 24) **d** 25) **c** 26) **a** 27) **a** 28) **a** 29) **a** 30) **a**

31) **a** 32) **c** 33) **d** 34) **b** 35) **A-p,s ; B-p,t ; C-q,t ; D-r,s**

36) **A-s; B-r ; C-q ; D-p** 37) **A-s; B-p,q; C-r; D-p,q** 38) **A-s; B-p ; C-q ; D-r**

39) **2** 40) **5** 41) **4** 42) **4**

PRACTICE SHEET (ADVANCED)

1) **b** 2) **a** 3) **b** 4) **d** 5) **b** 6) **b** 7) **b** 8) **a** 9) **d** 10) **a**

11) **abcd** 12) **ac** 13) **abcd** 14) **ad** 15) **acd** 16) **A-p,q,r,t ; B-p,r,s ; C-q,s ; D-p,q,r,t**

17) **A-r ; B-s ; C-p ; D-q** 18) **8** 19) **2** 20) **4** 21) **1** 22) **3**