Alternating Current: Question

SINGLE CORRECT ANSWER TYPE

LEVEL – I

Alternating Current

1. In an AC circuit, the value of AC is $I = 4\sin(100\pi t + \pi/6)$ A. The initial value of current is

   (a) 4 A (b) 3 A (c) 2 A (d) 1 A

2. A dynamo disspates 20 watt, when it supplies a current of 4 amp. through it. If the terminal potential difference is 220 V, the emf produced is

   (a) 220 V (b) 225 V (c) 215 V (d) 300 V

3. A generator develops an emf of 120 V and has a terminal potential difference of 115 volt, when armature current is 25 A. The resistance of the armature is

   (a) $2k\Omega$ (b) 2Ω (c) 0.2Ω (d) 20Ω

4. The initial phase angle for $i = 10\sin\omega t + 8\cos\omega t$ is

   (a) $\tan^{-1}\frac{4}{5}$ (b) $\tan^{-1}\frac{5}{4}$ (c) $\sin^{-1}\frac{4}{5}$ (d) 90°

5. The instantaneous value of current and emf in an AC circuit are $I = \frac{1}{\sqrt{2}}\sin 314t$ amp and $E = \sqrt{2}\sin\left(314t - \frac{\pi}{6}\right)V$, respectively. The phase difference between E and I (with respect to I) will be

   (a) $-\frac{\pi}{6}$ rad (b) $-\frac{\pi}{3}$ rad (c) $\frac{\pi}{6}$ rad (d) $\frac{\pi}{3}$ rad

RMS & Average value of Alternating current

6. A sinusoidal alternating current having peak value 14 A is used to heat a metal wire. To produce the same heating effect, a constant current i can be used where i is

   (a) 14 A (b) about 20 A (c) 7 A (d) about 10 A

7. The r.m.s. value of an ac of 50 Hz is 10 amp. The time taken by the alternating current in reaching from zero to maximum value and the peak value of current will be

   (a) 2×10^{-2} sec and 14.14 amp (b) 1×10^{-2} sec and 7.07 amp

   (c) 5×10^{-3} sec and 7.07 amp (d) 5×10^{-3} sec and 14.14 amp

8. The electric bulb is designed to operate at 12 V DC. It is connected to AC and gives same brightness then peak AC voltage is

   (a) 12 V (b) 24 V (c) $12\sqrt{2}$V (d) $\frac{12}{\sqrt{2}}$V

9. The electric current in a circuit is given by i = 3t Here, t is in second and i in ampere. The rms current for the peirod t = 0 to t = 1 s is

   (a) 3 A (b) 9 A (c) $\sqrt{3}$ A (d) $\sqrt[3]{3}$ A

Series A. C. Circuit

10. When 100 volt dc is applied across a coil, a current of 1 amp flows through it; when 100 V ac of 50 Hz is applied to the same coil, only 0.5 amp flows. Calculate the resistance and inductance of the coil.

(a) $200\Omega, 0.55H$ (b) $200\Omega, 0.75H$ (c) $100\Omega, 0.55H$ (d) $100\Omega, 0.75H$

11. When 100 volt DC is applied across a solenoid, a current of 1.0 amp flows in it. When 100 volt AC is applied across the same coil, the current drops to 0.5 amp. If the frequency of the AC source is 50 Hz, the impedance and inductance of the solenoid are

(a) 200 ohm and 0.55 henry (b) 100 ohm and 0.86 henry

(c) 100 ohm and 1.0 henry (d) 100 ohm and 0.93 henry.

12. A coil having an inductance of $1/\pi$ henry is connected in series with a resistance of 300 Ω. If 20 volt from a 200 cycle source are impressed across the combination, the value of the phase angle between the voltage and the current is :

(a) $\tan^{-1}\frac{5}{4}$ (b) $\tan^{-1}\frac{4}{5}$ (c) $\tan^{-1}\frac{3}{4}$ (d) $\tan^{-1}\frac{4}{3}$.

13. An alternating voltage E (in volt) = 200 $\sqrt{2}$ sin (100 t) is connected to a 1 μF capacitor through an ac ammeter. The reading of the ammeter shall be :

(a) 10 mA (b) 20 mA (c) 40 mA (d) 80 mA.

14. In a circuit containing an inductance of zero resistance, the current lags behind the applied alternating voltage by a phase angle

(a) 90° (b) 45° (c) 30° (d) 0°

15. In a series combination, $R = 300\Omega, L = 1.0\,H, C = 20\,\mu F$ and $\omega = 100\,rad/sec$. The impedance of the circuit will be

(a) 400Ω (b) 1300Ω (c) 500Ω (d) 900Ω

16. In a circuit containing an inductance of zero resistance, the current leads the applied a.c. voltage by a phase angle at

(a) 90^o (b) -90^o (c) 0^o (d) 180^o

17. In a series LCR the voltage across resistance, capacitance and inductance is 10 V each. If the capacitor is short circuited, the voltage across the inductance will be

(a) $\frac{10}{\sqrt{2}}V$ (b) 10 V (c) $10\sqrt{2}\,V$ (d) 20 V

18. If resistance of 100Ω, inductance of 0.5 henry and capacitance of 10×10^{-6} F are connected in series through 50 Hz ac supply, then impedance is

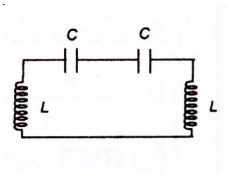
(a) 1.876 (b) 18.76 (c) 189.72 (d) 101.3

19. In RLC circuit, at a frequency ν, the potential difference across each device are $(\Delta V_R)_{max}$ = 8.8 V, $(\Delta V_L)_{max} = 2.6\,V$ and $(\Delta V_C)_{max} = 7.4\,V$. The composed potential difference $(\Delta V_C + \Delta V_L)_{max}$ across inductor and capacitor is

(a) 10 V (b) 7.8 V (c) 7.4 V (d) 4.8 V

20. A coil of resistance 200 ohms and self inductance 1.0 henry has been connected to an a.c. source of frequency $200/\pi$ Hz. The phase difference between voltage and current is :
(a) 30° (b) 63° (c) 45° (d)75°.

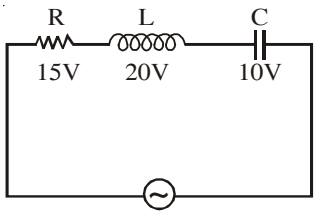
21. The natural frequency of the circuit shown in the figure is



(a) $\frac{1}{2\pi\sqrt{LC}}$ (b) $\frac{1}{\pi\sqrt{LC}}$ (c) $\frac{2}{\pi\sqrt{LC}}$ (d) none

22. If the phase difference between voltage and current is $\pi/6$ and the resistance in the circuit is $\sqrt{300}\,\Omega$, then the impedance of the circuit will be
(a) 40Ω (b) 20Ω (c) 50Ω (d) 13Ω

23. In the circuit as shown in the figure, if value of $R = 60\,\Omega$, then the current flowing through the condenser will be



(a) 0.5 A (b) 0.25 A (c) 0.75 A (d) 1.0 A

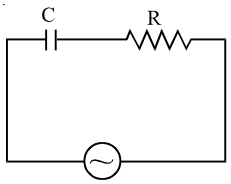
24. The power in ac circuit is given by $P = E_{rms} I_{rms} \cos\phi$. The vale of $\cos\phi$ in series LCR circuit at resonance is:

(a) zero (b) 1 (c) $\frac{1}{2}$ (d) $\frac{1}{\sqrt{2}}$

25. In ac circuit when ac ammeter is connected it reads i current if a student uses dc ammeter in place of ac ammeter the reading in the dc ammeter will be:

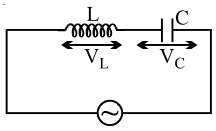
(a) $\frac{i}{\sqrt{2}}$ (b) $\sqrt{2}\,i$ (c) $0.637\,i$ (d) zero

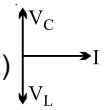
26. In the circuit shown if the emf of source at an instant is 5 V, the potential difference across capacitor at the same instant is 4 V. The potential difference across R at that instant may be

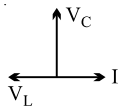


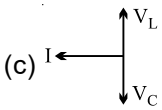
(a) 3V (b) 9V (c) $\frac{3}{\sqrt{2}}$ V (d) none

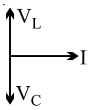
27. The current I, potential difference V_L across the inductor and potential difference V_C across the capacitor in circuit as shown in the figure are best represented vectorially as



(a) 

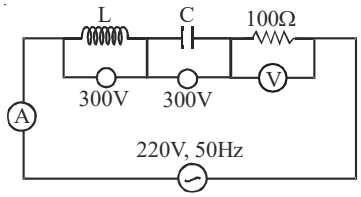
(b) 

(c) 

(d) 

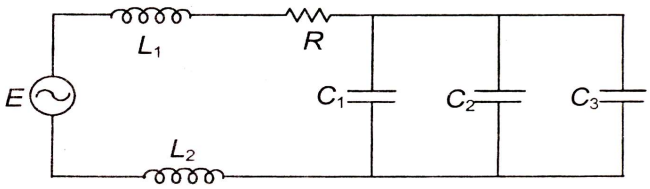
Resonance in R-L-C Series Circuit

28. In the circuit shown in figure, what will be the readings of voltmeter and ammeter ?



(a) 800 V, 2 A (b) 220 V, 2.2 A (c) 300 V, 2 A (d) 100 V, 2 A.

29. A generator with an adjustable frequency of oscillation is connected to resistance, R = $100\,\Omega$, inductances, L_1 = 1.7 mH and L_2 = 2.3 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

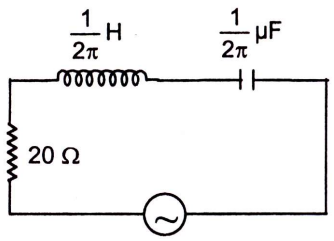


(a) 0.5 rad/s (b) 0.5×10^4 rad/s (c) 2 rad/s (d) 2×10^{-4} rad/s

30. The value of L, C and R in an LCR series circuit are 4 mH, 40 pF and $100\,\Omega$ respectively. The quality factor of the circuit is
(a) 10,000 (b) 100 (c) 1000 (d) 10

31. What is the nature of the graph between impedance and frequency of a.c. for series RLC circuit?
(a) straight line (b) parabola (c) hyperbola (d) bell shaped

32. In the a.c. circuit shown in figure, the supply voltage has a constant r.m.s. values but variable frequency f. Resonance frequency is



(a) 10 Hz (b) 100 Hz (c) 1000 Hz (d) 200 Hz

33. In a LCR circuit capacitance is changed from C to 2C. For the resonant frequency to remain unchanged, the inductance should be change from L to

(a) 4L (b) 2L (c) L/2 (d) L/4

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

(a) 10,000 (b) 100 (c) 1000 (d) 10

Power in A. C. circuit.

35. In an a.c. circuit V and i are given by V = $100\sin(100t)$ volts; $i = 100\sin\left(100t + \frac{\pi}{3}\right)$mA . The power dissipated in the circuit is

(a) 10^4 watt (b) 10 watt (c) 2.5 watt (d) 5 watt

36. A series combination of R, L, C is connected to an a.c. source. If the reistance is 3Ω and the reactance is $4\,\Omega$, the power factor of the circuit is

(a) 0.4 (b) 0.6 (c) 0.8 (d) 1.0

37. In a series RC circuit, $R = 500\,\Omega, C = 2\mu F, V = 282\sin(377t)$. The power consumed is

(a) 14100 W (b) 141 W (c) 10 W (d) 14.1 W

38. The p.d. across an instrument in an a.c. circuit of frequency f is V and the current flowing through it is I such that V = 5 cos ($2\pi ft$) volt and I = 2 sin ($2\pi ft$) amp. The power dissipate in the instrument is :

(a) zero (b)10 watt (c) 5 watt (d)2.5 watt.

39. If a current I given by $I_0\sin(\omega t - \pi/2)$ flows in an ac circuit across which an ac potential of $E_0\sin(\omega t)$ has been applied, then the power consumption P in the circuit will be

(a) $E_0I_0/\sqrt{2}$ (b) $E_0I_0/2$ (c) $EI/\sqrt{2}$ (d) Zero

40. In an a.c. circuit, V & I are given by V = 100 sin (100 t) volt. I = 100 sin (100 t + π/3) mA. The power dissipated in the circuit is :

(a) 10^4 watt (b) 10 watt (c)2.5 watt (d) 5 watt.

41. In an AC circuit, a resistance of 3Ω, an inductance coil of 4Ω and a condenser of 8Ω are connected in series with an AC source of 50 V (rms). The average power loss in the circuit will be

(a) 300 W (b) 600 W (c) 400 W (d) 500 W

LEVEL II

Alternating current

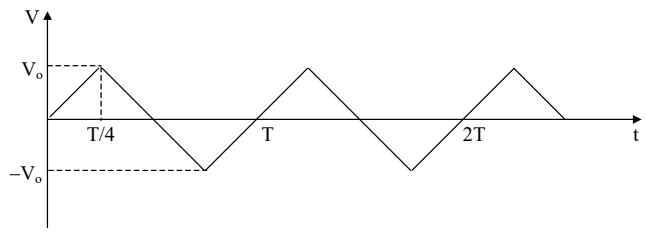
42. If $V_o = V_P\sin(\omega t + \pi/3)$ when will the voltage be maximum for the first time ?

(a) T/6 (b) T/12 (c) T/3 (d) None of these

43. The phase difference between current and voltage in an AC circuit is p/4 radian. If the frequency of AC is 50 Hz, then the phase difference is equivalent to the time difference :
(a) 0.78 s (b) 15.7 ms (c) 0.25 s (d) 2.5 ms

RMS & Average value of Alternating current

44. The voltage time (V-t) graph for a triangular wave having peak value V_o is as shown in figure. The rms value of V is

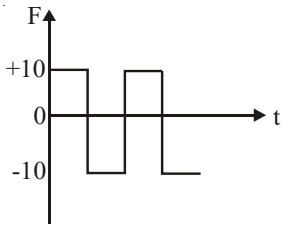


(a) $\frac{V_o}{3}$ (b) $\frac{V_o}{2}$ (c) $\frac{V_o}{\sqrt{2}}$ (d) $\frac{V_o}{\sqrt{3}}$

45. An alternating voltage is given by: $e = e_1 \sin \omega t + e_2 \cos \omega t$ Then the root mean square value of voltage is given by:

(a) $\sqrt{e_1^2 + e_2^2}$ (b) $\sqrt{e_1 e_2}$ (c) $\sqrt{\frac{e_1 e_2}{2}}$ (d) $\sqrt{\frac{e_1^2 + e_2^2}{2}}$

46. The rms voltage of the wave form shown is



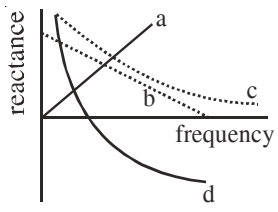
(a) 10 V (b) 7 V (c) 6.37 V (d) None of these

47. If $i = t^2, 0 < t < T$ then rms value of current is

(a) $\frac{T^2}{\sqrt{2}}$ (b) $\frac{T^2}{2}$ (c) $\frac{T^2}{\sqrt{5}}$ (d) None of these

Series A.C. Circuits

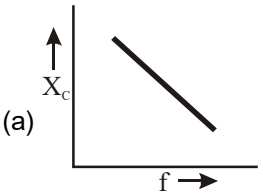
48. Which of the following plots may represent the reactance of a series LC combination ?

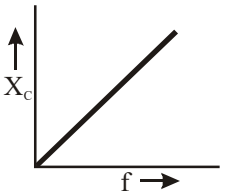


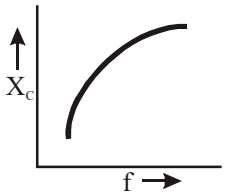
(a) a (b) b (c) c (d) d

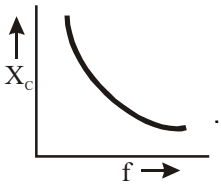
49. In an LR series AC circuit the angular frequency of applied emf is $2\times10^4\,\text{rads}^{-1}$ and the value of resistance is 20Ω. The instant at which the value of emf is maximum E_0, the value of current is $i_0/\sqrt{2}$. The inductance in the circuit will be
(a) 1 mH (b) 40 mH (c) 8 mH (d) cannot be predicted

50. The reactance of a capacitor X_C in an ac circuit varies with frequency f of the source voltage. Which one of the following represents this variation correctly ?

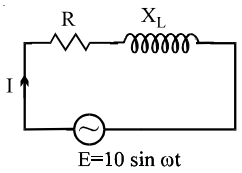
(a) 

(b) 

(c) 

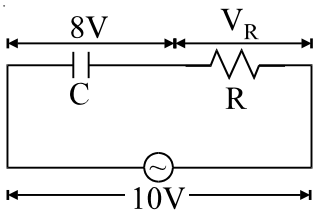
(d) 

51. An ac-circuit having supply voltage E consists of a resistor of resistance 3Ω and an inductor of reactance 4Ω as shown in the figure. The voltage across the inductor at $t = \pi/\omega$ is



(a) 2 volts (b) 10 volts (c) zero (d) 4.8 volts

52. In a series CR circuit shown in figure, the applied voltage is 10 V and the voltage across capacitor is found to be 8V. Then the voltage across R, and the phase difference between current and the applied voltage will respectively be

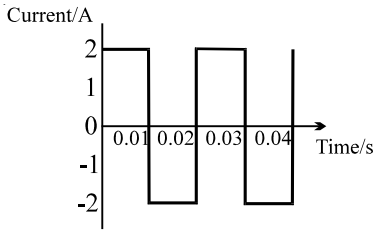


(a) 6V, $\tan^{-1}\left(\frac{4}{3}\right)$ (b) 3V, $\tan^{-1}\left(\frac{3}{4}\right)$ (c) 6V, $\tan^{-1}\left(\frac{5}{3}\right)$ (d) none

Resonance in R-L-C series circuit

53. The effective value of current $i = 2\sin 100\pi t + 2\sin(100\pi t + 30°)$ is :
(a) $\sqrt{2}$ A (b) $2\sqrt{2+\sqrt{3}}$ (c) 4 (d) $\sqrt{4+2\sqrt{3}}$

54. The direct current which would give the same heating effect in an equal constant resistance as the current shown in figure, i.e. the r.m.s. current,
is



(a) zero (b) $\sqrt{2}$ A (c) 2A (d) $2\sqrt{2}$ A

Power in an A.C. Circuit

55. An inductor of inductance L and resistor of resistance R are joined in series and connected by a source of emf V and frequency ω. Power dissipated in the circuit is

(a) $\frac{(R^2+\omega^2L^2)}{V}$ (b) $\frac{V^2R}{(R^2+\omega^2L^2)}$ (c) $\frac{V}{(R^2+\omega^2L^2)}$ (d) $\frac{\sqrt{R^2+\omega^2L^2}}{V^2}$

56. In series LR circuit $X_L = 3R$. Now a capacitor with $X_C = R$ is added in series. Ratio of new to old power factor is

(a) 1 (b) 2 (c) $\frac{1}{\sqrt{2}}$ (d) $\sqrt{2}$

57. The self inductance of the motor of an electric fan is 10 Henry. In order to impart maximum power at 50 Hz it should be connected to a capacitance of

(a) 3×10^{-6} Farad (b) 2×10^{-6} Farad (c) 10^{-6} Farad (d) 10^{-4} Farad

58. Power loss in AC circuit will be minimum when

(a) Inductance is high, resistance is high (b) Inductance is low, resistance is high

(c) Inductance is low, resistance is low (d) Inductance is high, resistance is low

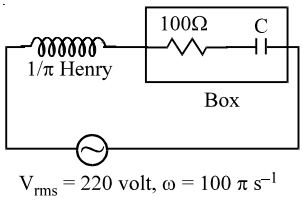
59. The average power dissipation in pure inductance is

(a) $\frac{1}{2}Li^2$ (b) $2Li^2$ (c) Zero (d) $\frac{Li^2}{4}$

60. An alternating current of frequency f is flowing in a circuit containing only choke coil of resistance R and inductance L, V_0 and I_0 represent peak value of the voltage and the current respectively, the average power given by source is equal to

(a) $\frac{V_0I_0}{2}$ (b) $\frac{V_0^2}{(2\pi f)L}$ (c) $\frac{I_0^2R}{2}$ (d) Zero

61. In the circuit, as shown in the figure, if the value of R.M.S current is 2.2 ampere, the power factor of the box is

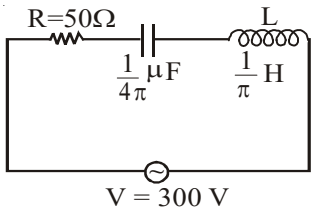


(a) $\frac{1}{\sqrt{2}}$ (b) 1 (c) $\frac{\sqrt{3}}{2}$ (d) $\frac{1}{2}$

62. A capacitor C = 2mF and an inductor with L = 10 H and coil resistance 5 W are in series in a circuit. When an alternating current of r.m.s. value 2A flows in the circuit, the average power in watts in the circuit is
(a) 100 (b) 50 (c) 20 (d) 10

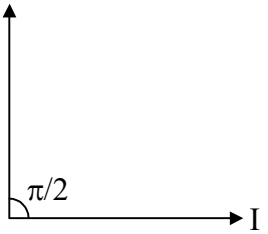
LEVEL III

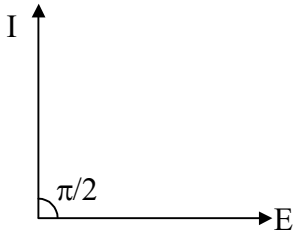
63. In the a.c. circuit shown in the figure. The supply voltage has a constant r.m.s, value V, but variable frequency f. Resonance frequency is

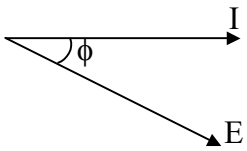


(a) 10 (b) 100 (c) 1000 (d) 200

64. The phase diagram for an LR circuit is

(a)


(b)


(c)


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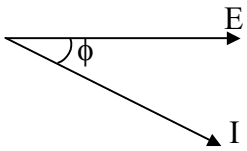


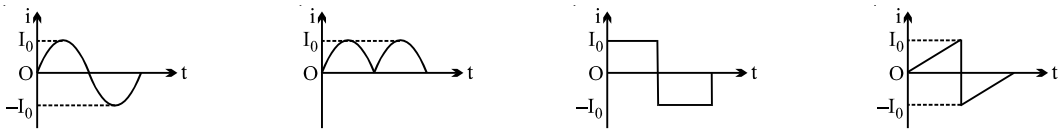
65. If the power factor is 1/2 in a series RL circuit with R = 100Ω. If AC mains, 50 Hz is used, then L is

(a) $\frac{\sqrt{3}}{\pi}$ Henry (b) π Henry (c) $\sqrt{3}$ Henry (d) none of the above

66. An AC current is given by $I = I_0 + I_1 \sin wt$ then its rms value will be

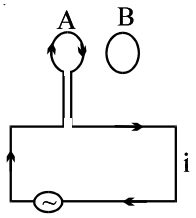
(a) $\sqrt{I_0^2 + 0.5 I_1^2}$ (b) $\sqrt{I_0^2 + 0.5 I_0^2}$ (c) 0 (d) $I_0/\sqrt{2}$

67. If I_1, I_2, I_3 and I_4 are the respective r.m.s. values of the time varying currents as shown in the four cases I, II, III and IV. Then identify the correct relations.



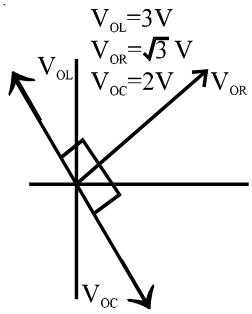
(a) $I_1 = I_2 = I_3 = I_4$ (b) $I_3 > I_1 = I_2 > I_4$ (c) $I_3 > I_4 > I_2 = I_1$ (d) $I_3 > I_2 > I_1 > I_4$

68. Two circular coils A and B are facing each other as shown in figure.
The current i through A can be altered



(a) there will be repulsion between A and B if i is increased
(b) there will be attraction between A and B if i is increased
(c) there will be neither attraction nor repulsion when i is changed
(d) attraction or repulsion between A and B depends on the direction of current. It does not depend whether the current is increased or decreased.

69. The given figure represents the phasor diagram of a series LCR circuit connected to an ac source. At the instant t¢ when the source voltage is given by $V = V_0 \cos wt¢$, the current in the circuit will be



(a) $I = I_0 \cos(wt¢ + p/6)$ (b) $I = I_0 \cos(wt¢ – p/6)$
(c) $I = I_0 \cos(wt¢ + p/3)$ (d) $I = I_0 \cos(wt¢ – p/3)$

70. Power factor of an L-R series circuit is 0.6 and that of a C–R series circuit is 0.5. If the element (L, C, and R) of the two circuits are joined in series the power factor of this circuit is found to be 1. The ratio of the resistance in the L-R circuit to the resistance in the C–R circuit is

(a) 6/5 (b) 5/6 (c) $\frac{4}{3\sqrt{3}}$ (d) $\frac{3\sqrt{3}}{4}$

MULTIPLE CORRECT ANSWER TYPE

LEVEL – I

1. In an AC series circuit, the instantaneous current is zero when the instantaneous voltage is maximum. Connected to the source may be
(a) pure inductor
(b) pure capacitors
(c) pure resistor
(d) combination of an inductor and a capacitor

2. An alternating voltage (in volts) varies with time t (in seconds) as V = 200 sin (100 πt)
(a) The peak value of the voltage is 200 V
(b) The rms value of the voltage is 220 V
(c) The rms value of the voltage is $100\sqrt{2}$ V
(d) The frequency of the voltage is 50 Hz

3. An inductor-coil having some resistance is connected to an AC source. Which of the following quantities have zero average value over a cycle?
(a) current (b) induced emf in the inductor
(c) joule heat (d) magnetic energy stored in the inductor

4. The magnitude of the emf across the secondary of a transformer does not depend upon
(a) The magnitude of the emf across the primary (b) Turn ratio
(c) The resistance of the primary coil (d) The resistance of the secondary coil.

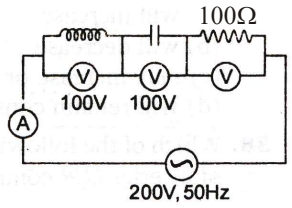
5. To convert mechanical energy into electrical energy, one can use
(a) DC dynamo (b) AC dynamo (c) motor (d) transformer

6. An AC source rated 100 V (rms) supplies a current of 10 A (rms) to a circuit. The average power delivered by the source
(a) must be 1000 W (b) may be 1000 W
(c) may be greater than 1000 W (d) may be less than 1000 W

7. In a series R-L-C circuit, the frequency of the source is half of the resonance frequency. The nature of the circuit will be
(A) capacitive (B) inductive (C) purely resistive (D) data insufficient

8. 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 of the circuit and current will be :
(a) 50 ohm (b) 60 ohm
(c) 2 ampere (d) 4 ampere.

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



(a) 200 V (b) 300 V (c) 3 A (d) 2 A

LEVEL – II

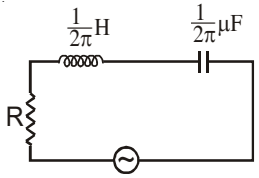
10. The reactance of a circuit is zero. It is possible that the circuit contains
(a) an inductor and a capacitor (b) an inductor but no capacitor
(c) a capacitor but no inductor (d) neither an inductor nor a capacitor

11. A $50\ \Omega$ electric heater is connected to 100 V, 60 Hz ac supply.
(a) The peak value of the voltatge is 100 V
(b) The peak value of the current in the circuit is $2\sqrt{2}$ A
(c) The rms value of the voltage is 100 V
(d) The rms value of the current is 2 A

12. L, C and R respectively represent inductance, capacitance and resistance. Which of the following combinations have the dimensions of frequency ?

(a) R/L (b) 1/RC (c) $R/\sqrt{LC}$ (d) $1/\sqrt{LC}$

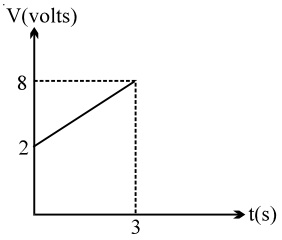
13. In a series LCR circuit



(a) the voltage V_L across the inductance leads the current in the circuit by a phase angle of $\pi/2$
(b) the voltage V_C across the capacitance lags behind the current by a phase angle of $\pi/2$
(c) the voltage V_R across the resistance is in phase with the current
(d) the votage across the series combination of L, C and R is $V = V_L + V_C + V_R$.

14. Which statement(s) is False for the series resonant condition
(a) current maximum and phase difference between E and *i* is $\pi/2$
(b) current maximum and phase difference between E and *i* is zero
(c) voltage maximum and phase difference between E and *i* is zero
(d) voltage maximum and phase difference between E and *i* is $\pi/2$

15. A circuit element is placed in a closed box. At time t=0, constant current generator supplying a current of 1 amp, is connected across the box. Potential difference across the box varies according to graph shown in figure. The element in the box is :



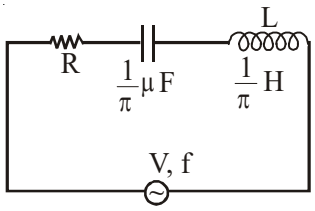
(a) resistance of 2W (b) battery of emf 6V
(c) inductance of 2H (d) capacitance of 0.5F

16. A circuit has three elements, a resistance of 11W, a coil of inductive reactance 120W and a capacitive reactance of 120 W in series and connected to an A.C. source of 110 V, 60 Hz. Which of the three elements have minimum potential difference?
(a) Resistance (b) Capacitance
(c) Inductor (d) All will have equal potential difference

17. An a.c. source of voltage V and of frequency 50 Hz is connected to an inductor of 2H and negligible resistance. A current of r.m.s. value *I* flows in the coil. When the frequency of the voltage is changed to 400 Hz keeping the magnitude of V the same, the current is now
(a) 8*I* in phase with V (b) 4*I* and leading by 90° from V
(c) *I*/4 and lagging by 90° from V (d) *I*/8 and lagging by 90° from V

LEVEL – III

18. In the AC circuit shown below, the supply voltage has constant rms value V but variable frequency f. At resonance, the circuit



(a) has a current I given by $I = \frac{V}{R}$
(b) has a resonance frequency 500 Hz
(c) has a voltage across the capcitor which is 180° out of phase with that across the inductor
(d) has a current given by $I = \frac{V}{\sqrt{R^2 + \left(\frac{1}{\pi} + \frac{1}{\pi}\right)^2}}$.

19. In a series RC circuit with an AC source (peak voltage E_o = 50 V and f = $50/\pi$ Hz), R = 300Ω, $C = 25\mu F$. Then
(a) the peak current is 0.1 A (b) the peak current is 0.7 A
(c) the average power disspated is 1.5 W (d) the average power dissipated is 3 W

20. In a series LCR circuit with an AC source (E_{rms} = 50 V and v = $50/\pi$ Hz), R = $300\,\Omega$, $C = 0.02\,mF$, $L = 1.0\,H$. Which of the following is correct?
(a) the rms current in the circuit is 0.1 A
(b) the rms potential difference across the capacitor is 50 V
(c) the rms potential difference across the capacitor is 14.1 V
(d) the rms current in the circuit is 0.14 A

21. A circuit is set up by connecting L = 100 mH, C = $5\,\mu F$ and R = $100\,\Omega$ in series. An alternating emf of $\left(150\sqrt{2}\right)$ volt, $\frac{500}{\pi}$ Hz is applied across this series combination. Which of the following is correct?
(a) the impedance of the circuit is 141.4 Ω
(b) the average power dissipated across resistance 225 W
(c) the average power dissipated across inductor is zero.
(d) the average power dissipated across capacitor is zero.

22. A coil of inductance 5.0 mH and negligible resistance is connected to an oscillator giving an output voltage E = (10 V) sin ωt. Which of the following is correct?
(a) for $\omega = 100\,s^{-1}$ peak current is 20 A
(b) for $\omega = 500\,s^{-1}$ peak current is 4 A
(c) for $\omega = 1000\,s^{-1}$ peak current is 2 A
(d) for $\omega = 1000\,s^{-1}$ peak current is 4 A

23. A pure inductance of 1 henry is connected across a 110 V, 70 Hz source. Then correct option are (Use $\pi = 22/7$)
(a) reactance of the circuit is $440\,\Omega$
(b) current of the circuit is 0.25 A
(c) reactance of the circuit is 880 Ω
(d) current of the circuit is 0.5 A

COMPREHENSIONS

Comprehensive type questions:-(1 to 3)

A $100\,\Omega$ resistance is connected in series with a 4H inductor. The voltage across the resistor is, V_R = (2.0V) sin (10^3t).

1. Find the expression of circuit current
(a) $\left(2\times10^{-2}\,A\right)\sin\left(10^3 t\right)$
(b) $\left(2\times10^{-3}\,A\right)\sin\left(10^2 t\right)$
(c) $\left(2\times10^{-3}\,A\right)\sin\left(10^3 t\right)$
(d) None of these

2. Find the inductive reactance
(a) 2 × 10^3 ohm (b) 3 × 10^3 ohm (c) 4 × 10^3 ohm (d) 5 × 10^3 ohm

3. Find amplitude of the voltage across the inductor.
(a) 40 V (b) 60 V (c) 80 V (d) 90 V

Comprehensive Type Questions :- 4 to 6

If various elements, i.e., resistance, capcitance and inductance which are in series and having values 1000 Ω, $1\,\mu F$ and 2.0 H respectively. Given emf as, $V = 100\sqrt{2}\sin 1000\,t$ volts

4. Voltage across the resistor is
(a) 70.7 Volts (b) 100 Volts (c) 141.4 Volts (d) 270.7 Volts

5. Voltage across the inductor is
(a) 70.7 Volts (b) 100 Volts (c) 141.4 Volts (d) 270.7 Volts

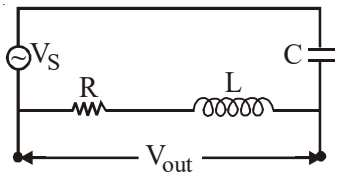
6. Voltage across the capacitor is
(a) 70.7 Volts (b) 100 volts (c) 141.4 Volts (d) 270.7 Volts

Comprehensive type (7 to 9)

One application of L-R-C series circuits is to high pass or low pass filters, which filter out either the low or high frequency components of a signal. A high pass filter is shown in figure

Where the output voltage is taken across the L-R

where L-R combination represents and inductive coil that also has resistance due to the large length of the wire in the coil.



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

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

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

8. Which of the following statement is correct when ω is small in the case of V_{out}/V_s

(a) ωRC (b) $\dfrac{\omega R}{L}$ (c) ωRL (d) $\dfrac{\omega R}{C}$

9. Which statement is correct in the limit of large frequency is reached ? (for V_{out}/V_s)

(a) 1 (b) ωRC (c) ωRL (d) $\dfrac{\omega R}{L}$

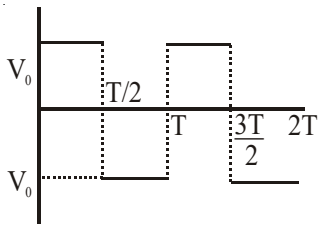
Comprehensive type: (10 to 12)

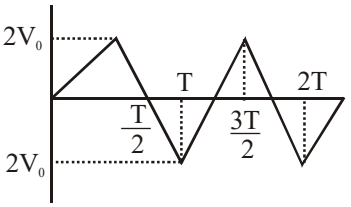
In A.C. source peak value of A.C. is the maximum value of current in either direction of the cycle. Root moon square (RMS) is also defined as the direct current which produces the some heating effect in a resistor as the actual A.C.

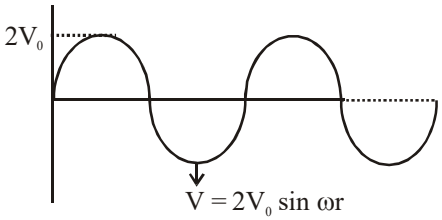
10. A.C. measuring instrument measures its

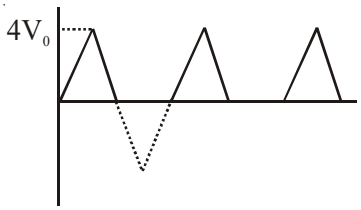
(a) rms value (b) Peak value (c) Average value (d) Square of current

11. Current time graph of different source is given which one will have R.M.S. value V_0

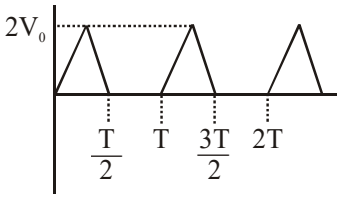
(a) 

(b) 

(c) 

(d) 

12. Average voltage for the given source is



(a) V_0 (b) $2V_0$ (c) $\frac{V_0}{2}$ (d) $\frac{3V_0}{2}$

MATRIX MATCH TYPE

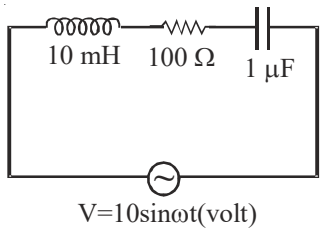
1.

	Column I	Column II
A.	In case of series L-C-R circuit, at resonance.	P. Current in the circuit has same frequency.
B.	Only resistor in an a.c. circuit.	Q. Voltage lags the current by $\pi/2$.
C.	Only inductor in an a.c. circuit.	R. Current lags the voltage by $\pi/2$.
D.	Only capacitor in an a.c. circuit.	S. Reactance of the circuit is zero.
		T. Current is in phase with applied voltage.

2.

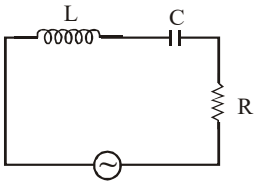
	Column I	Column II
A.	For square wave having peak value v_0.	P. $v_0 > v_{rms} > v_{av}$.
B.	For sinusoidal wave having peak value v_0.	Q. In a pure inductance.
C.	Current leads the voltage by $\pi/2$.	R. $v_{av} = v_{rms} = v_0$.
D.	Wattless current.	S. In a pure capacitance.

3. Refering to the given circuit, match the following.



	Column I		**Column II**
A.	For $\omega = 8000\,rad/s$	P.	Peak current in the circuit is less than 0.1 A
B.	For $\omega = 10000\,rad/s$	Q.	Voltage across the combination and the current are in same phase.
C.	$\omega = 10500\,rad/s$	R.	Voltage across the combination leads the current.
D.	$\omega = 1000\,rad/s$. If R = $50\,\Omega$ instead of $100\,\Omega$	S.	Current through the circuit leads the voltage across it.

4. Figure shows a series LCR circuit connected to a variable frequency 200 V source. L = 5 H, $C = 80\,\mu F$ and $R = 40\,\Omega$.



Column I	**Column II**
(A) The impedance of the circuit at resonance (in ohm)	(P) 1250 V
(B) The current amplitude at resonance (in A)	(Q) 200 V
(C) The rms potential drop across the inductor at resonance (in volt)	(R) 40 V
(D) The rms potential drop across the resistor at resonance (in V)	(S) $5\sqrt{2}$ A

5. In L-C-R series circuit suppose ω_r is the resonance frequency, then match the following columns:

Column I		**Column II**
(A)	If $\omega > \omega_r$	(P) current will lead the voltage
(B)	If $\omega = \omega_r$	(Q) voltage will lead the current
(C)	If $\omega = 2\omega_r$	(R) $X_L = 2X_C$
(D)	If $\omega < \omega_r$	(S) current and voltage are in phase
		(T) None

6. Four different circuit components are given in each situation of column-I and all the components are connected across an ac source of same angular frequency $\omega = 200\,rad/s$. 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.

(A) 

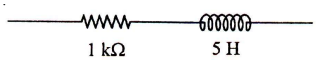
(P) The magnitude of required phase difference is $\frac{\pi}{2}$

(B) 

(Q) The magnitude of required phase difference is $\frac{\pi}{4}$

(C) 

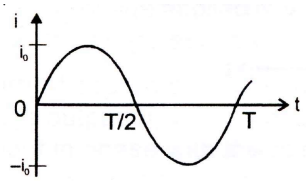
(R) The current leads in phase to source voltage.

(D) 

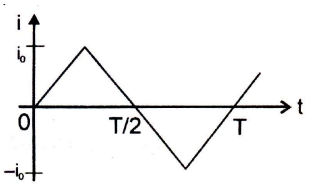
(S) The current lags in phase to source voltage.

7. In column I, variation of current with time t is given in figures. 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.

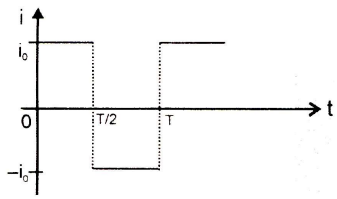
Column I **Column II**

(A) 

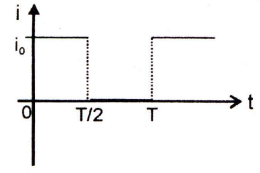
(P) $i_{rms} = \frac{i_o}{\sqrt{3}}$

(B) 

(Q) Average current for positive half cycle is i_o

(C) 

(R) Avreage current for positve half cycle is $\frac{i_o}{2}$

(D) 

(S) Full cycle averge current is zero.

(T) $i_{rms} = i_o$

ASSERTION-REASONING TYPE

CODE:

(A) Statement – 1 is True, Statement – 2 is True; Statement – 2 **is** a correct explanation for Statement – 1.
(B) Statement – 1 is True, Statement – 2 is True; Statement – 2 **is NOT** a correct explanation for Statement – 1.
(C) Statement – 1 is True, Statement – 2 is False.
(D) Statement – 1 is False, Statement – 2 is True.

1. **STATEMENT – 1 :** The r.m.s. value of alternating current is defined as the square root of the average of I^2 during a complete cycle.

   STATEMENT – 2 : For sinusoidal a.c. ($I = I_0 \sin wt$) $I_{rms} = \frac{I_0}{\sqrt{2}}$.

2. **STATEMENT – 1 :** Average value of a.c. over a complete cycle is always zero.
   STATEMENT – 2 : Average value of a.c. is always defined over half cycle.

3. **STATEMENT – 1 :** In series LCR circuit resonance can take place.
   STATEMENT – 2 : Resonance takes if inductive reactance and capacitive reactance are equal and opposite.

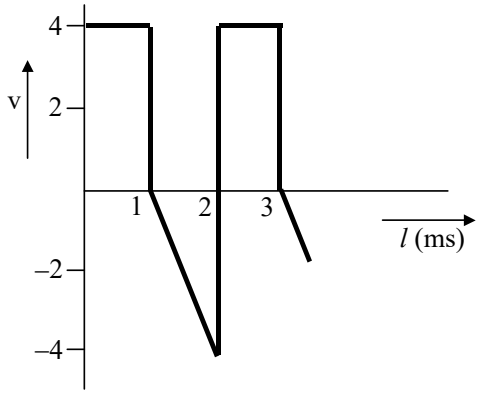
4. **STATEMENT – 1 :** The divisions marked on the scale of an a.c. ammeter are not equally spaced.
   STATEMENT – 2 : AC ammeter is based on heating effect of current.

5. **STATEMENT – 1 :** In series LCR resonance circuit, the impedance is equal to the ohmic resistance.
   STATEMENT – 2 : At resonance, the inductive reactance is equal and opposite to the capacitive reactance.

6. **STATEMENT – 1 :** In series LCR circuit, the resonance occurs at one frequency only.
   STATEMENT – 2 : At this frequency, inductive reactance is equal to capacitive reactance.

INTEGER TYPE

1. 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 by 60°. Calculate the power (in kW) disspated in the LCR circuit.
2. Calculate the average value of the voltage wave shown in figure (in volt).



3. A solenoid with inductance L = 7 mH and active resistance $R = 44\,\Omega$ is first connected to a source of direct voltage V_o and then to a source of sinusoidal voltage with effective value $V = V_o$. At what frequency (in KHz) of teh oscillator will the power consumed by the solenoid be $\eta = 5.0$ times less than in the former case?

4. A series LCR circuit containing a resistance of $120\,\Omega$ has angular resonance frequency 4×10^5 rad / sec. At resonance the voltage across resistance and inductance are 60 V and 40 V respectively. At what frequency (in 10^5) the current in the circuit lags the voltage by 45°?

5. An LCR circuit has L = 10 mH, R = $3\,\Omega$ and C = $1\mu F$ connected in series to a source of $(15\cos\omega t)$ volt. Compute the average energy dissipated per cycle (in 10^{-4}) at a frequency that is 10% lower than the resonance frequency. Give the answer in nearest integer.

6. A series LCR circuit with R = 20 Ω, L = 1.5 H and C = 35 μF is connected to a variable-frequency 200 V ac supply. When the frequency of the supply equals the natural frequency of the circuit, what is the average power in Kw transferred to the circuit in one complete cycle ?

7. Find the value of an inductance which should be connected in series with a capacitor of $5\,\mu F$, a resistance of 10 Ω and an ac source of 50 Hz so that the power factor of the circuit is unity.

8. A sinusoidal voltage of peak value 283 V and frequency 50 Hz is applied to a series LCR circuit in which $R = 3\Omega$, L = 25.48 mH, and C = 796 μF. Find the impedance of the circuit.

SUBJECTIVE TYPE

1. A circuit containing a 80 mH inductor and a 60 μF capacitor in series is connected to a 230 V, 50 Hz supply. The resistance of the circuit is negligible.
   (a) Obtain the rms values of current.
   (b) Obtain the rms values of potential drops across each element.
   (c) What is the average power transferred to the inductor ?
   (d) What is the average power transferred to the capacitor?
   (e) What is the total average power absorbed by the circuit ? ['Average implies 'averaged over one cycle']

2. A series LCR circuit with L = 0.12H, C = 480 nF, R = 23 Ω is connected to a 230 V variable frequency supply.
   (a) What is the source frequency for which current amplitude is maximum. Obtain this maximum value.
   (b) What is the source frequency for which average power absorbed by the circuit is maximum. Obtain the value of this maximum power.
   (c) For which frequencies of the source is the power transferred to the circuit half the power at resonant frequency ? What is the current amplitude at these frequencies?
   (d) What is the Q-factor of the given circuit ?

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 the circuit is found to be halved. Calculate the ratio of reactance to resistance at the original frequency ω.

4. An alternating emf of frequency 50 Hz is applied to a series circuit of resistance 20 ohm, an inductance of 100 mH and a capacitor of 30 μF . Does the current lag or lead the applied emf and by what angle ?

5. A circuit has a coil of resistance 60 ohm and inductance 3 henry. It is connected in series with a capacitor of 4 μF and A.C. supply voltage of 200 V and 50 cycle/sec. Calculate
   (i) the impedance of the coil (ii) the p.d. across inductor coil and capacitor.

6. A circuit contains a resistance of 4 ohm and inductance of 0.68 henry and an alternating effective emf of 500 volt at a frequency of 120 cycles per second applied it. Find the value of effective current in the circuit and power factor.

7. A circuit consists of a non inductive resistor of 50 Ω , a coil of inductance 0.3 H and resistance 2Ω , and a capacitor of $40\mu F$ in series and is supplied with 200 volts rms at 50 cycles/sec. Find the current lag or lead and the power in the circuit.

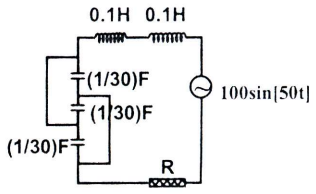
8. An LC circuit contains a 20 mH inductor and a 50 μF capacitor with an initial charge of 10 mC. The resistance of the circuit is negligible. Let the circuit be closed at t = 0.
   (a) What is the total energy stored initially ? Is it conserved during LC oscillations ?
   (b) What is the natural angular frequency of the circuit ?
   (c) At what time is the energy stored
      (i) Completely electrical (i.e., stored in the capacitor) ?
      (ii) Completely magnetic (i.e., stored in the inductor) ?
   (d) At what times is the total energy shared equally between the inductor and the capacitor ?
   (e) If a resistor is inserted in the circuit, how much energy is eventually dissipated as heat ?

9. A 20 volts, 5 watt lamp is used on a.c. mains of 200 volts 50 cps. Calculate the value of
   (i) Capacitance.
   (ii) Inductance to be pur in series to run the lamp.
   (iii) How much pure resistance should be included in place of the above device so that the lamp can run on its voltage.

10. When a 15 V dc source is applied across a choke coil, then a current of 5 Amp flows in it. If the same connected to a 15 V, 50 rad/s ac source, a current of 3 Amp flows in the circuit. Determine the inductance of the coil. Also find the power developed in the circuit and its resonance frequency if a 2500 μf capacitor is connected in series with the coil.

11. A circuit working at a frequency of 50 Hz consists of an inductive reactance (X_L) of $250\,\Omega$, a capacitive reactance (X_C) of $400\,\Omega$ and an ohmic resistance R = $400\,\Omega$ connected in series. An a.c. source of emf 200 V, and frequency 100 Hz is now applied across it. Find the power factor and average power developed in the circuit.

12. Find the value of the resistance R so that the power factor of the given circuit is $\frac{1}{\sqrt{2}}$. Also find the peak current in this case.



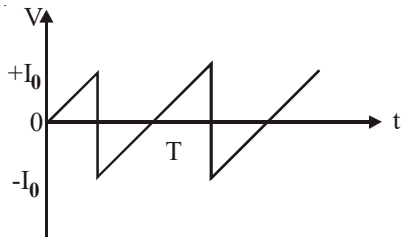
13. A coil of resistance $300\,\Omega$ and inductance 1.0 henry is connected across an voltage source of frequency $300/2\pi$ Hz. Calculate the phase difference between the voltage and current in the circuit.

14. A radio tuner has a frequency range from 500 kHz to 5 MHz. If its LC circuit has an effective inductance of $400\,\mu$ H, what is the range of its variable capcitor ? Take $\pi^2 = 10$.

15. A bulb is rated 55 W/110 V. It is to be connected to a 220 V/50 Hz with inductor in series. What should be the value of inductance so that bulb gets correct voltage.

16 A circuit draws a power of 550 watt from a source of 220 volt, 50 Hz. The power factor of the circuit is 0.8 and the current lags in phase behind the potential difference. To make the power factor of the circuit as 1.0, what capacitance will have to be connected with it.

17. Find the rms value of current in terms of I_0 for the waveform shown.

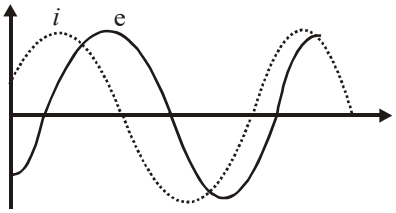


PREVIOUS YEARS IIT QUESTIONS

1. An inductor of inductance 2.0 mH is connected across a charged capacitor of capacitance 5.0 μF and the resulting *L-C* circuit is set oscillating at its natural frequency. Let *Q* denote the instantaneous charge on the capacitor and *I* the current in the circuit. It is found that the maximum value of *Q* is 200 μC. **(1998)**

(a) When *Q* = 100 μC, what is the value of |*dI*/*dt*| ?
(b) When *Q* = 200 μC, what is the value of *I* ?
(c) Find the maximum value of *I*.
(d) when *I* is equal to one-half its maximum value, what is the value of |*Q*| ?

2. When an AC source of emf e = E_0 sin (100 t) is connected across a circuit, the phase difference between emf e and the current *i* in the circuit is observed to be $\frac{\pi}{4}$, as shown in the diagram. If the current consists possibly only of R–C or R–L or L–C in series, find the relationship between the two elements.



(a) $R = 1k\Omega, C = 10\mu F$ (b) $R = 1k\Omega, C = 1\mu F$ (c) $R = 1k\Omega, L = 10H$ (d) $R = 1k\Omega, L = 1H$

(2003)

3. In an *L*-*R* series circuit, a sinusoidal voltage $V = V_0 \sin \omega t$ is applied. It is given that L = 35 mH, $R = 11\ \Omega$, V_{rms} = 220 *V*, $\omega/2\pi$ = 50 Hz and π = 22/7. Find the amplitude of current in the steady state and obtain the phase difference between the current and the voltage. Also plot the variation of current for one cycle on the given graph.

(2004)