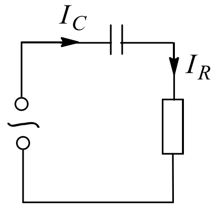
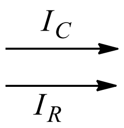
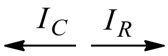
7.ALTERNATING CURRENT

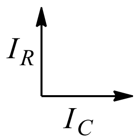
Single Correct Answer Type

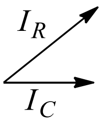
1. An inductive coil has resistance of 100 Ω. When an ac signal of frequency 1000 Hz is fed to the coil, the applied voltage leads the current by 45°. What is the inductance of the coil?
   a) 2 mH b) 3.3 mH c) 16 mH d) $\sqrt{5}$ mH
2. Fig shows a source of alternating voltage connected to a capacitor and a resistor. Which of the following phasor diagrams correctly describes the phase relationship between I_c, the current between the source and the capacitor, and I_R, the current in the resistor?



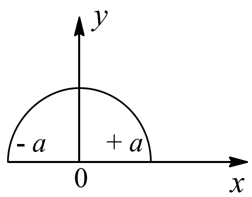
   a) 

   b) 

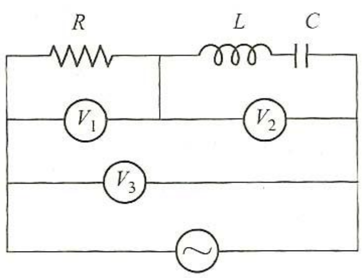
   c) 

   d) 

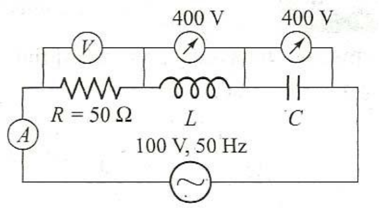
3. Determine the rms value of a semi-circular current wave which has a maximum value of a



   a) $(1/\sqrt{2})a$ b) $\sqrt{(3/2)}a$ c) $\sqrt{(2/3)}\ a$ d) $(1/\sqrt{3})a$
4. The value of current in two series LCR circuits at resonance is same. Then
   a) Both circuits must be having same value of capacitance and inductance
   b) In both circuits ratio of L and C will be same
   c) For both the circuits X_L/X_C must be same at that frequency
   d) Both circuits must have same impedance at all frequencies
5. AnLCR circuit contains resistance of 100 Ω and a supply of 200 V at 300 rad angular frequency. If only capacitance is taken out from the circuit and the rest of the circuit is joined, current lags behind the voltage by 60°. If, on the other hand, only inductor is taken out the current leads by 60° with the applied voltage. The current flowing in the circuit is
   a) 1 A b) 1.5 A c) 2 A d) 2.5 A
6. Which voltmeter will give zero reading at resonance?



   a) V_1 b) V_2 c) V_3 d) None
7. In the series LCR circuit, the voltmeter and ammeter readings are:



a) $V = 100$ V, $I = 2$ A b) $V = 100$ V, $I = 5$ A c) $V = 1000$ V, $I = 2$ A d) $V = 300$ V, $I = 1$ A

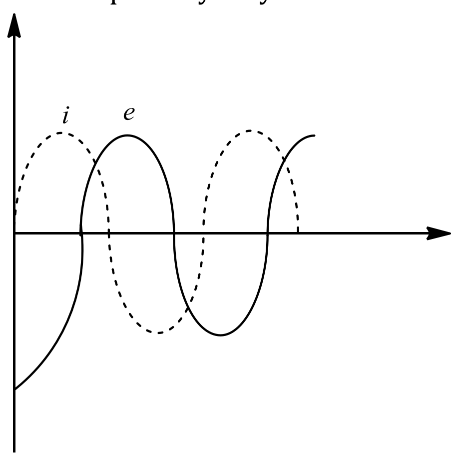
8. A capacitor of capacitance 1 μF is charged to a potential of 1V. It is connected in parallel to an inductor of inductance 10^{-3} H. The maximum current that will flow in the circuit has the value

a) $\sqrt{1000}$mA b) 1 mA c) 1 μA d) 1000 mA

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

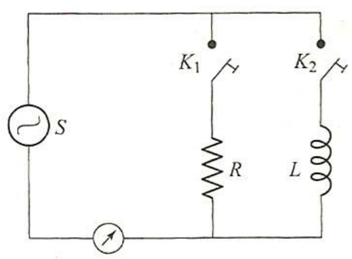
a) 100 Ω b) 25 Ω c) $\sqrt{125 \times 75}$ Ω d) 400 Ω

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



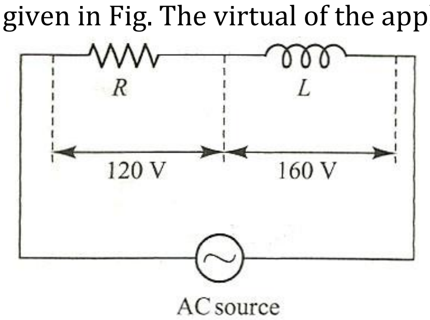
a) $R = 1\,\text{k}\,\Omega, C = 10\,\mu\text{F}$ b) $R = 1\,\text{k}\,\Omega, C = 1\,\mu\text{F}$ c) $R = 1\,\text{k}\,\Omega, L = 10$ H d) $R = 1\,\text{k}\,\Omega, L = 1$ H

11. In the circuit shown in Fig, R is a pure resistor, L is an inductor of negligible resistance (as compared to R), S is a 100 V, 50 Hz ac source of negligible resistance. With either key K_1 alone or K_2 alone closed, the current is I_0. If the source is changed to 100 V, 100 Hz the current with K_1 alone closed and with K_2 alone closed will be respectively



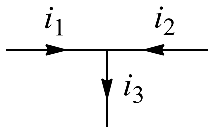
a) $I_0, \frac{I_0}{2}$ b) $I_0, 2I_0$ c) $2I_0, I_0$ d) $2I_0, \frac{I_0}{2}$

12. The circuit given in Fig has a resistanceless choke coil L and a resistance R. The voltage across R and L are given in Fig. The virtual of the applied voltage is



a) 100 V b) 200 V c) 300 V d) 400 V

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



a) $5\sin(\omega t + 53°)$ b) $5\sin(\omega t + 37°)$ c) $5\sin(\omega t + 45°)$ d) $5\sin(\omega t + 53°)$

14. A coil has an inductance of 0.7 H and is joined is series with a resistance of 220 Ω. When an alternating emf of 220 V at 50 cps is applied to it, then the wattles component of the current in the circuit is (take $0.7\pi = 2.2$)

a) 5 A b) 0.5 A c) 0.7 A d) 7 A

15. In the above question, the average value of voltage (V) in one time period will be

a) $\frac{V_0}{\sqrt{3}}$ b) $\frac{V_0}{2}$ c) $\frac{V_0}{\sqrt{2}}$ d) 0

16. A series R-C circuit is connected to AC Voltage source. Consider two cases: (A) when C is without a dielectric medium and (B) when C is filled with dielectric of constant 4. The current I_R through the resistor and voltage V_c across the capacitor are compared in the two cases. Which of the following is/are true?

a) $I_R^A > I_R^B$ b) $I_R^A < I_R^B$ c) $V_C^A > V_C^B$ d) $V_C^A < V_C^B$

17. A transmitter transmits at a wavelength of 300 m. A condenser of capacitance 2.4 μ F is being used. The value of the inductance for the resonant circuit is approximately

a) 10^{-4} H b) 10^{-6} H c) 10^{-8} H d) 10^{-10} H

18. If the total charge stored in the LC circuit is Q_0, then for $t \geq 0$

a) The charge on the capacitor is $Q = Q_0 \cos\left(\frac{\pi}{2} + \frac{t}{\sqrt{LC}}\right)$

b) The charge on the capacitor is $Q = Q_0 \cos\left(\frac{\pi}{2} - \frac{t}{\sqrt{LC}}\right)$

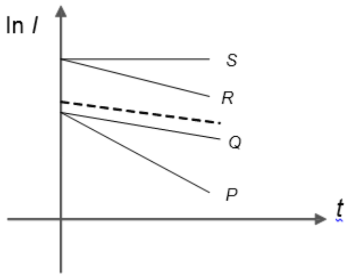
c) The charge on the capacitor is $Q = -LC\frac{d^2Q}{dt^2}$

d) The charge on the capacitor is $Q = \frac{1}{\sqrt{LC}}\frac{d^2Q}{dt^2}$

19. A 4μF capacitor, a resistance of 2.5 mΩ is in series with 12 V battery. Find the the time after which the potential difference across the capacitor is 3 times the potential difference across the resistor. [Given ln (2)=0.693]

a) 13.86 s b) 6.93 s c) 7 s d) 14 s

20. In an R-C circuit while charging, the graph of ln$I$ *versus* time is as shown by the dotted line in the adjoining diagram where I is the current. When the value of the resistance is doubled, which of the solid curves best represents the variation of ln I *versus* time?



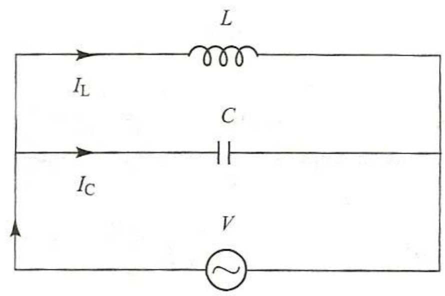
a) P b) Q c) R d) S

21. Two alternating voltage generators produce emfs of the same amplitude E_0 but with a phase difference of $\pi/3$. The resultant emf is

a) $E_0\sin[\omega t + (\pi/3)]$ b) $E_0\sin[\omega t + (\pi/6)]$

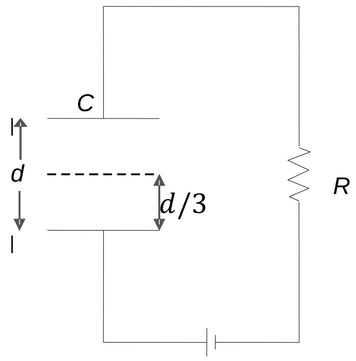
c) $\sqrt{3}E_0\sin[\omega t + (\pi/6)]$ d) $\sqrt{3}E_0\sin[\omega t + (\pi/2)]$

22. For the circuit shown in Fig, current in inductance is 0.8 A while that in capacitance is 0.6 A. What is the current drawn from the source?



a) 0.1 A b) 0.3 A c) 0.6 A d) 0.2 A

23. A parallel plate capacitor C with plates of unit area and separation d is filled with a liquid of dielectric constant $K=2$. The level of liquid is $\frac{d}{3}$ initially. Suppose the liquid level decreases at a constant speed v, the time constant as a function of time t is.



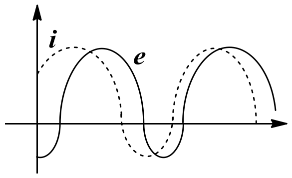
a) $\frac{6\varepsilon_0 R}{5d+3vt}$ b) $\frac{(15d+9vt)\varepsilon_0 R}{2d^2-3dvt-9v^2t^2}$ c) $\frac{6\varepsilon_0 R}{5d-3vt}$ d) $\frac{(15d-9vt)\varepsilon_0 R}{2d^2+3dvt-9v^2t^2}$

24. For an LCR series circuit with an ac source of angular frequency ω,
a) Circuit will be capacitor if $\omega > \frac{1}{\sqrt{LC}}$
b) Circuit will be inductive if $\omega = \frac{1}{\sqrt{LC}}$
c) Power factor of circuit will be unity if capacitive reactance equals inductive reactance
d) Current will be leading voltage if $\omega > \frac{1}{\sqrt{LC}}$

25. A dc ammeter and a hot wire ammeter are connected to a circuit in series. When a direct current is passed through circuit, the dc ammeter shows 6 A. When ac current flows through circuit, the ac ammeter shows 8 A. What will be reading of each ammeter, if dc and ac currents flow simultaneously through the circuit?
a) dc = 6 A, ac = 10 A b) dc = 3 A, ac = 5 A c) dc = 5 A, ac = 8 A d) dc = 2 A, ac = 3 A

26. When 100 V dc is applied across a solenoid, a current of 1.0 A flows in it. When 100 V ac is applied across the same coil, the current drops to 0.5 A. If the frequency of the ac source is 50 Hz, the impedance and inductance of the solenoid are
a) 200 Ω and 0.55 H b) 100 Ω and 0.86 H c) 200 Ω and 1.0 H d) 100 Ω and 0.93 H

27. When an ac source of emf $e = E_0 \sin(100\ t)$ is connected across a circuit, the phase difference between emf e and current i in the circuit is observed to be $\pi/4$ as shown in Fig. If the circuit consists possibly only of $R-C$ or $R-C$ or $L-R$ series, find the relationship between the two elements



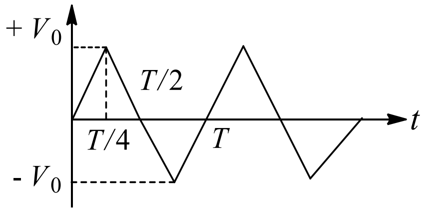
a) $R = 1\ \mathrm{k\Omega}, C = 10\ \mu\mathrm{F}$ b) $R = 1\ \mathrm{k\Omega}, C = 1\ \mu\mathrm{F}$ c) $R = 1\ \mathrm{k\Omega}, L = 10\ \mathrm{H}$ d) $R = 1\ \mathrm{k\Omega}, L = 1\ \mathrm{H}$

28. In an ac circuit the potential differences across an inductance and resistance joined in series are respectively 16 V and 20 V. The total potential difference across the circuit is
a) 20 V b) 25.6 V c) 31.9 V d) 53.5 V

29. A resistor and an inductor are connected to an ac supply of 120 V and 50 Hz. The current in the circuit is 3A. If the power consumed in the circuit is 108 W, then the resistance in the circuit is

a) 12 Ω   b) 40 Ω   c) $\sqrt{(52 \times 28)}\Omega$ d) 360 Ω

30. The voltage time $(V - t)$ graph for triangular wave having peak value V_0 is as shown in Fig



The rms value of V in time interval from $t = 0$ to $T/4$ is

a) $\frac{V_0}{\sqrt{3}}$ b) $\frac{V_0}{2}$ c) $\frac{V_0}{\sqrt{2}}$ d) None of these

31. The peak value of an alternating emf$E$ given by $E = E_0 \cos \omega t$
is 10 V and frequency is 50 Hz. At time $t = (1/600)$ s, the instantaneous value of emf is

a) 10 V   b) $5\sqrt{3}$ V   c) 5 V   d) 1 V

32. An inductor and a resistor are connected in series with an ac source. In this circuit

a) The current and the p.d. across the resistance lead the p.d. across the inductance
b) The current and the p.d. across the resistance lag behind the p.d. across the inductance by an angle $\pi/2$
c) The current and the p.d. across the resistance lag behind the p.d. across the inductance by an angle π
d) The p.d. across the resistance lags behind the p.d. across the inductance by an angle $\pi/2$ but the current in resistance lead the p.d. across the inductance by $\pi/2$

33. An ac voltage is represented by
$E = 220\sqrt{2}\cos(50\,\pi)\,t$
How many times will the current become zero in 1 s?

a) 50 times   b) 100 times   c) 30 times   d) 25 times

34. In series LCR circuit voltage drop across resistance is 8 V, across inductor is 6 V and across capacitor is 12 V. Then

a) Voltage of the source will be leading current in the circuit
b) Voltage drop across each element will be less than the applied voltage
c) Power factor of circuit will be 4/3
d) None of these

35. Using an ac voltmeter, the potential difference in the electrical line in a house is read to be 234 V. If the line frequency is known to be 50 cycles/second, the equation for the line voltage is

a) $V = 165\sin(100\,\pi t)$ b) $V = 331\sin(100\,\pi t)$ c) $V = 220\sin(100\,\pi t)$ d) $V = 440\sin(100\,\pi t)$

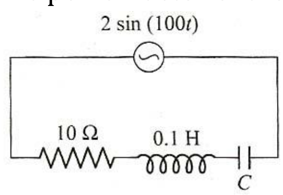
36. An alternating voltage $E = 50\sqrt{2}\sin(100\,t)$ V is connected to a 1 μ F capacitor through an ac ammeter. What will be the reading of the ammeter?

a) 10 mA   b) 5 mA   c) $5\sqrt{2}$mA   d) $10\sqrt{2}$mA

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

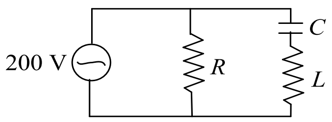
a) $\frac{1}{6}$ b) $\frac{1}{3}$ c) 6   d) 3

38. The power factor of the circuit in Fig is $1/\sqrt{2}$. The capacitance of the circuit is equal to



a) 400 μF   b) 300 μF   c) 500 μF   d) 200 μF

39. In the circuit shown in Fig, $X_C = 100\ \Omega, X_L = 200\ \Omega$and $R = 100\ \Omega$. The effective current through the source is

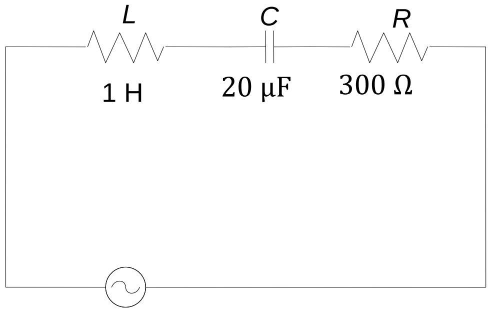


a) 2 A b) $2\sqrt{2}$ A c) 0.5 A d) $\sqrt{0.4}$A

40. A 220-V, 50 Hz ac generator is connected to an inductor and a 50 Ω resistance in series. The current in the circuit is 1.0 A. What is the pd across inductor?

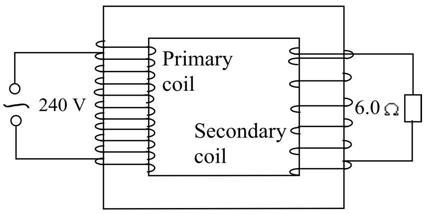
a) 102.2 V b) 186.4 V c) 214 V d) 170 V

41. In the *L*-*C*-*R* circuit shown, the impedance is



a) 500 Ω b) 300 Ω c) 100 Ω d) 200 Ω

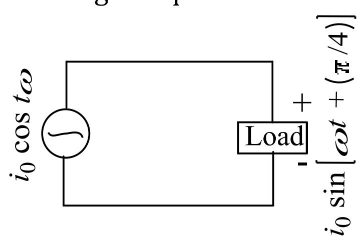
42. Figure shows an iron-cored transformer assumed to be 100% efficient. The ratio of the secondary turns to the primary turns is 1:20



A 240 V ac supply is connected to the primary coil and a 6.0 Ω resistor is connected to the secondary coil. What is the current in the primary coil?

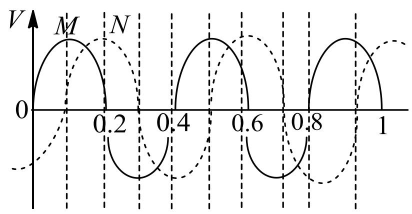
a) 0.10 A b) 0.14 A c) 2.0 A d) 40 A

43. A current source sends a current $I = i_0 \cos(\omega t)$. When connected across an unknown load, it gives a voltage output of $v = v_0 \sin[\omega t + (\pi/4)]$ across the load. Then the voltage across the current source may be brought in phase with the current through it by



a) Connecting an inductor in series with the load
b) Connecting a capacitor in series with the load
c) Connecting an inductor in parallel with the load
d) Connecting a capacitor in parallel with the load

44. Two sinusoidal voltages of same frequency are shown in Fig



What is the frequency and the phase relationship between the voltages?

frequency/Hz phase lead of
N over *M* in rad/s

a) 0.4 $-\frac{\pi}{4}$ b) 2.5 $-\frac{\pi}{2}$ c) 2.5 $+\frac{\pi}{2}$ d) 2.5 $-\frac{\pi}{4}$

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

a) 10 V b) $10/\sqrt{2}$ V c) (10/3) V d) 20 V

46. An rms voltage of 110 V is applied across a series circuit having a resistance 11 Ω and an impedance 22 Ω. The power consumed is

a) 275 W b) 366 W c) 550 W d) 1100 W

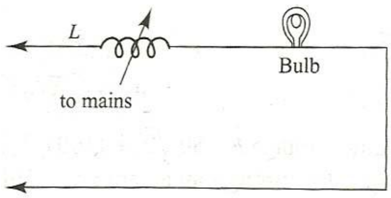
47. In an ideal transformer, the voltage and the current in the primary coil are 200 V and 2 A, respectively. If the voltage in the secondary coil is 2000 V, then the value of current in the secondary coil will be

a) 0.2 A b) 2 A c) 10 A d) 20 A

48. A 50 W, 100 V lamp is to be connected to an ac mains of 200 V, 50 Hz. What capacitor is essential to be put in series with the lamp?

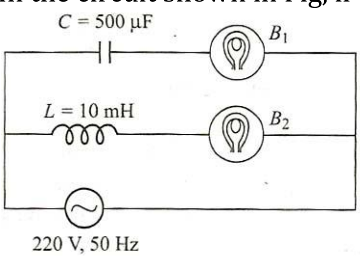
a) $\frac{25}{\sqrt{2}}$ μF b) $\frac{50}{\pi\sqrt{3}}$ μF c) $\frac{50}{\sqrt{2}}$ μF d) $\frac{100}{\pi\sqrt{3}}$ μF

49. A typical light dimmer used to dim the stage lights in a theatre consists of a variable induction for L (where inductance is adjustable between zero and $L_{\max}$) connected in series with a light bulb B as shown in Fig. The mains electrical supply is 220 V at 50 Hz, the light bulb is rated at 220 V, 1100 W. What $L_{\max}$ is required if the rate of energy dissipated in the light bulb is to be varied by a factor of 5 from its upper limit of 1100 W?



a) 0.69 H b) 0.28 H c) 0.38 H d) 0.56 H

50. In the circuit shown in Fig, if both the bulbs B_1 and B_2 are identical



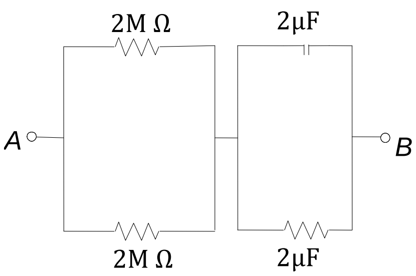
a) Their brightness will be the same

b) B_2 will be brighter than B_1

c) B_1 will be brighter than B_2

d) Only B_2 will glow because the capacitor has infinite impedance

51. At time $t = 0$, a battery of 10 V is connected across points A and B in the given circuit. If the capacitors have no charge initially, at what time (in second) does the voltage across them become 4 V?
(Take ln 5 = 1.6, ln 3 = 1.1)



a) 2 b) 3 c) 2.5 d) $\frac{3}{2}$

52. An8 μF capacitor is connected across a 220 V, 50 Hz line. What is the peak value of charge through the

capacitor?

a) 2.5×10^{-3}C b) 2.5×10^{-4}C c) 5×10^{-5}C d) 7.5×10^{-2}C

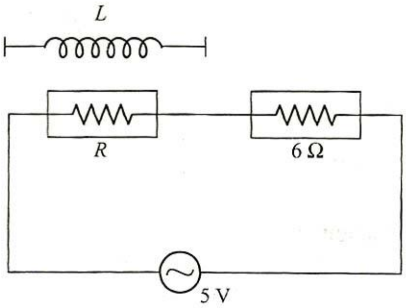
53. What reading would you expect of a square-wave current, switching rapidly between +0.5 A and −0.5 A, when passed through an ac ammeter?

a) 0 b) 0.5 A c) 0.25 A d) 1.0 A

54. A capacitor of 10 μF and an inductor of 1 H are joined in series. An ac of 50 Hz is applied to this combination. What is the impedance of the combination?

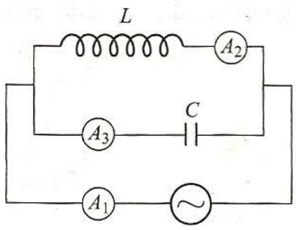
a) $\frac{5(\pi^2 - 5)}{\pi}$ Ω b) $\frac{10(10 - \pi^2)}{\pi}$Ω c) $\frac{10(\pi^2 - 5)}{\pi}$Ω d) $\frac{5(10 - \pi^2)}{\pi}$Ω

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



a) 1V b) 2V c) 3V d) 4V

56. For the circuit shown in Fig, the ammeter A_2 reads 1.6 A and ammeter A_3 reads 0.4 A. Then



a) $\omega = \frac{4}{\sqrt{LC}}$ b) $f = \frac{2\pi}{\sqrt{LC}}$

c) The ammeter A_1 reads 1.2 A d) The ammeter A_1 reads 2A

57. In the above question, the capacitance in the circuit is

a) $\frac{100}{100\,\pi}$F b) $\frac{25}{100\,\pi}$F c) $\frac{\sqrt{125 \times 75}}{100\,\pi}$ F d) $\frac{1}{100\,\pi\sqrt{125 \times 75}}$F

58. A direct current of 5 A is superimposed on an alternating current $I = 10 \sin \omega t$ flowing through a wire. The effective value of the resulting current will be

a) (15/2) A b) $5\sqrt{3}$ A c) $5\sqrt{5}$A d) 15 A

59. The rms value of an ac of 50 Hz is 10 A. The time taken by an alternating current in reaching from zero to maximum value and the peak value will be

a) 2×10^{-2} s and 14.14 A b) 1×10^{-2} s and 7.07 A

c) 5×10^{-3} s and 7.07 A d) 5×10^{-3} s and 14.14 A

60. 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

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

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

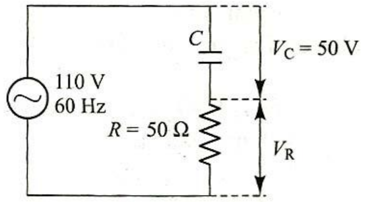
61. An ac is given by equation $I = I_1 \cos \omega t + I_2 \sin \omega t$. The rms value of current is given by

a) $\frac{I_1 + I_2}{2}$ b) $\frac{(I_1 + I_2)^2}{\sqrt{2}}$ c) $\sqrt{\frac{I_1^2 + I_2^2}{2}}$ d) $\frac{I_1^2 + I_2^2}{2}$

62. A resistance of 20 Ω is connected to a source of an alternating potential $V = 220 \sin(100\,\pi t)$. The time taken by the current to change from the peak value to rms value, is

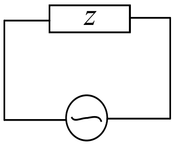
a) 0.2 s b) 0.25 s c) 2.5×10^{-3} s d) 2.5×10^{-3} s

63. In the circuit given in Fig $V_C = 50$ V and $R = 50\ \Omega$. The values of C and V_R are



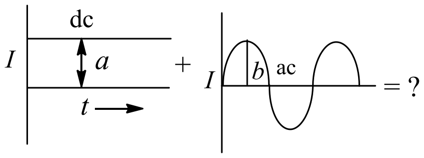
a) 3.3 mF, 60 V b) 104 μF, 98 V c) 52 μF, 98 V d) 2 μF, 60 V

64. In a black box of unknown elements (L or R or any other combination), an ac voltage $E = E_0 \sin(\omega t + \phi)$ is applied and current in the circuit was found to be $I = I_0 \sin[\omega t + \phi + (\pi/4)]$. Then the unknown elements in the box may be



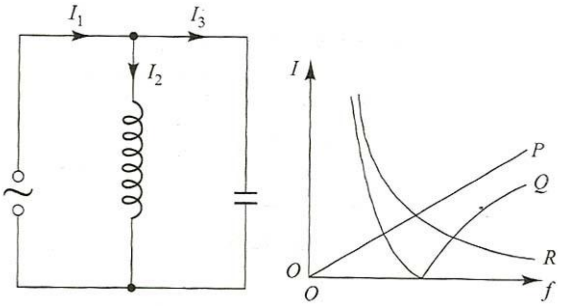
a) Only capacitor
b) Inductor and resistor both
c) Either capacitor, resistor and inductor or only capacitor and resistor
d) Only resistor

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

66. In the circuit shown in Fig, the rims currents I_1, I_2 and I_3 are altered by varying the frequency f of the oscillator. The output voltage of the oscillator remains sinusoidal and has a fixed amplitude
Which curves in figure correctly indicate the variation with frequency of the currents I_1, I_2,and I_3?



$I_1 I_2 I_3$
a) QQQ b) $R \quad Q \quad Q$ c) $Q \quad P \quad R$ d) $Q \quad R \quad P$

67. A sinusoidal alternating current of peak value I_0 passes through a heater of resistance R. What is the mean power output of the heater?

a) $I_0^2 R$ b) $\frac{I_0^2 R}{2}$ c) $2I_0^2 R$ d) $\sqrt{2} I_0^2 R$

68. In the above question, the capacitive reactance in the circuit is

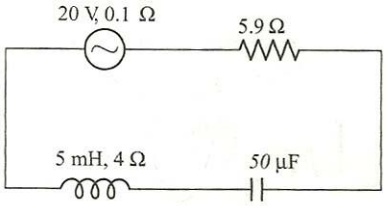
a) 100 Ω b) 25 Ω c) $\sqrt{125 \times 75}\ \Omega$ d) 400 Ω

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

a) $10/\sqrt{2}$ A b) 12.5 A c) 20 A d) 10 A

70. Current in an ac circuit is given by $I = 3\sin\omega t + 4\cos\omega t$, then
a) rms value of current is 5 A
b) Mean value of this current in any one half period will be $6/\pi$
c) If voltage applied is $V = V_m \sin\omega t$, then the circuit may be containing resistance and capacitance only
d) If voltage applied is $V = V_m \sin\omega t$, the circuit may contain resistance and inductace only

71. In the circuit of Fig the source frequency is $\omega = 2000$ rad/s. The current in the circuit will be



a) 2 A
b) 3.3 A
c) $2/\sqrt{5}$ A
d) $\sqrt{5}$ A

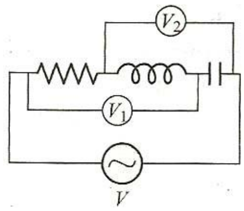
72. Power factor is one for
a) Pure resistor
b) Pure inductor
c) Pure capacitor
d) Either an inductor or a capacitor

Multiple Correct Answers Type

73. The magnetic flux (ϕ) linked with a coil depends on time t as $\phi = al^n$, where a and n are constants. The emf induced in the coil is e
a) If $0 < n < 1, e = 0$
b) If $0 < n < 1, e \neq 0$ and $|e|$ decreases with time
c) If $n = 1, e$ is constant
d) If $n > 1, |e|$ increases with time

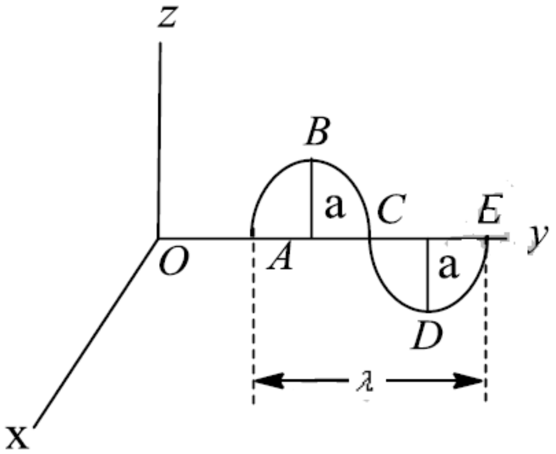
74. The previous questions, in position i of the loop,
a) The induced emf will increase linearly as the loop enters the field
b) The induced emf will increase from 0 to Bav sharply as the edge AC crosses PQ
c) the induced emf will have a constant value Ba^2v
d) The loop will experience a force to the left after entering the field partially

75. In anRLC series circuit shown in Fig, the readings of voltmeter V_1 and V_2 are 100 V and 120 V, respectively. The source voltage is 130 V. For this situation mark out the correct statement(s)



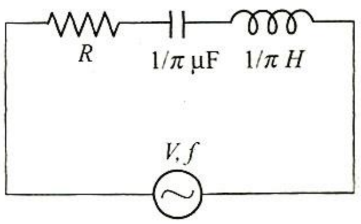
a) Voltage across resistor, inductor and capacitor are 50 V, $50\sqrt{3}$ V and $120 + 50\sqrt{3}$ V, respectively
b) Voltage across resistor, inductor and capacitor are 50 V, $50\sqrt{3}$ V and $120 - 50\sqrt{3}$ V, respectively
c) Power factor of the circuit is $\frac{5}{13}$
d) The circuit is capacitive in nature

76. The conductor $ABCDE$ has the shape shown in figure. It lies in the $y - z$ plane, with A and E on the y-axis. When it moves with a velocity v in a magnetic field B, an emf e is induced between A and E

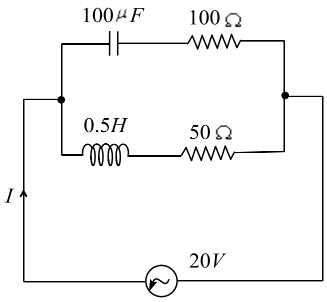


a) $e = 0$, if v is in y-direction and B is the x-direction
b) $e = 2\,Bav$, if v is in the y-direction and B is in x-direction
c) $e = B\lambda v$, if v is in x-direction and B is in x-direction
d) $e = B\lambda v$, if v is in x-direction and B is in z-direction

77. Resonance occurs in a series LCR circuit when the frequency of the applied emf is 1000 Hz
   a) When frequency = 900 Hz, then the current through the voltage source will be ahead of emf of the source
   b) The impedance of the circuit is minimum at $f = 1000$ Hz
   c) At only resonance the voltage across L and C differ in phase by 180°
   d) If the value of C is doubled, resonance occurs at $f = 2000$ Hz
78. In an ac circuit shown below in Fig, the supply voltage has a constant rms value V but variable frequency f. At resonance, the circuit



   a) Has current I given by $I = \frac{V}{R}$
   b) Has a resonance frequency 500 Hz
   c) Has a voltage across the capacitor which is 180° out of phase with that across the inductor
   d) Has a current given by $I = \frac{V}{\sqrt{R^2 + \left(\frac{1}{\pi} + \frac{1}{\pi}\right)^2}}$
79. Which of the following statements are true? Heat produced in a current carrying conductor depends upon
   a) The time for which the current flows in the conductor
   b) The resistance of the conductor
   c) The strength of the current
   d) The nature of current (ac or dc)
80. A choke coil of resistance 5 Ω and inductance 0.6 H is in series with a capacitance of 10 μF. If a voltage of 200 V is applied and the frequency is adjusted to resonance, the current and voltage across the inductance and capacitance are I_0, V_0, and V_1 respectively. We have
   a) $I_0 = 40$ A
   b) $V_0 = 9.8$ kV
   c) $V_1 = 9.8$ kV
   d) $V_1 = 19.6$ kV
81. In previous question, the plane of the coil is initially kept parallel to B. All other details remain the same
   a) If $\theta = 90°$, $Q = \frac{\mathrm{BAn}}{\mathrm{R}}$
   b) If $\theta = 180°$, $Q = \frac{\mathrm{2BAn}}{\mathrm{R}}$
   c) If $\theta = 180°$, $Q = 0$
   d) If $\theta = 360°$, $Q = 0$
82. In the given circuit, the AC source has $\omega = 100\ rad/s$, 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 100Ω resistor $= 10\sqrt{2}V$

d) The voltage across 50Ω resistor $= 10V$

83. An alternating e.m.f. of frequency $v \left(= \frac{1}{2\pi\sqrt{LC}}\right)$ 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 the applied $e$mf

c) The sum of the p.d.'s across the inductance and capacitance equals the applied e.m.f. which is 180° 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 magnification (produced by the circuit at resonance) as well as the sharpnes of resonance of the circuit

84. An L-C circuit has capacitance $C_1 = C$ and inductance $L_1 = i$. A second circuit has $C_2 = C/2$ and $L_2 = 2L$ and a third circuit has $C_3 = 2\ C$ and $L_3 = L/2$. All the three capacitors are charged to the same potential V, and then made to oscillate. Then

a) Maximum current is greatest in second circuit

b) Maximum current is greatest in third circuit

c) Maximum current is greatest in first circuit

d) Angular frequency of oscillation is same for all the three circuits

85. In an ac circuit, the power factor

a) Is zero when the circuit contains an ideal resistance only

b) Is unity when the circuit contains an ideal resistance only

c) Is zero when the circuit contains an ideal inductance only

d) Is unity when the circuit contains an ideal inductance only

Assertion - Reasoning Type

This section contain(s) 0 questions numbered 86 to 85. Each question contains STATEMENT 1(Assertion) and STATEMENT 2(Reason). Each question has the 4 choices (a), (b), (c) and (d) out of which **ONLY ONE** is correct.

a) Statement 1 is True, Statement 2 is True; Statement 2 **is** correct explanation for Statement 1

b) Statement 1 is True, Statement 2 is True; Statement 2 **is not** correct explanation for Statement 1

c) Statement 1 is True, Statement 2 is False

d) Statement 1 is False, Statement 2 is True

86

Statement 1: Inductance coil are made of copper.

Statement 2: Induced current is more in wire having less resistance

87

Statement 1: If the frequency of alternating current in an ac circuit consisting of an inductance coil is increased then current gets decreased

Statement 2: The current is inversely proportional to frequency of alternating current

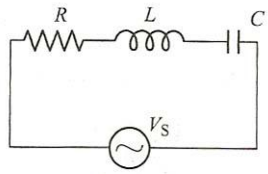
88

Statement 1: Average value of ac over a complete cycle is always zero

Statement 2: Average value of ac is always defined over half cycle

89

Statement 1: In a series RLC circuit, if V_R, V_L and V_C denote rms voltage across R, L and C,respectively and V_S is the rms voltage across the source, then $V_S = V_R + V_L + V_C$



Statement 2: In ac circuits, Kirchhoff's voltage law is correct at every instant of time

90

Statement 1: The energy stored in the inductor of 2 H, when a current of 10 A flows through it is 100 J.

Statement 2: Energy stored in an inductor is directly proportional to its inductance.

91

Statement 1: Two identical heaters are connected to two different sources one DC and other AC having same potential difference across their terminals. The heat produced in heater supplied with AC source is greater.

Statement 2: The et impedance of a AC source is greater than resistance.

92

Statement 1: In series $L - C - R$ circuit resonance can take place

Statement 2: Reasonance takes place if inductive and capacitive reactance are equal and opposite.

93

Statement 1: Capacitor serves as a block for dc and offers an easy path to ac

Statement 2: Capacitive reactance is inversely proportional to frequency

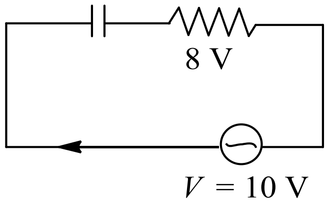
94

Statement 1: The divisions are equally marked on the scale of ac ammeter

Statement 2: Heat produced is directly proportional to the current

95

Statement 1: KVL rule is also being applied in ac circuit shown below



V_C in the circuit =2V

Statement 2: An inductor, a capacitor and a resistor are connected in series. The combination is connected across an ac source

96

Statement 1: The average value of alternating emf is 63.69% of the peak value.

Statement 2: The rms value of alternating emf is 70.72% of peak value.

97

Statement 1: For an electric lamp connected in series with a variable capacitor and ac source, its brightness increases with increase in capacitance

Statement 2: Capacitive reactance decreases with increase in capacitance of capacitor

98

Statement 1: The capacitor blocks DC but allows AC.

Statement 2: The capacitor offers infinite resistance to DC.

99

Statement 1: If a variable frequency AC source is connected to a capacitor, the displacement current in it increases with increase in frequency.

Statement 2: The increase in frequency results in an increase of impedance.

100

Statement 1: The mutual inductance of two coils is doubled if the self-inductance of the primary or secondary coil is doubled.

Statement 2: Mutual inductance is proportional to the self-inductance of primary and secondary coils.

101

Statement 1: Ac is more dangerous than dc

Statement 2: Frequency of ac is dangerous for human body

102

Statement 1: An inductance and a resistance are connected in series with an ac circuit. In this circuit the current and the potential difference across the resistance lags behind potential difference across the inductance by an angle $\pi/2$

Statement 2: In LR circuit voltage leads the current by phase angle which depends on the value of inductance and resistance both

103

Statement 1: In a series $R - L - C$ circuit the voltage across resistor, inductor and capacitor are 8V, 16V and 10V respectively. The resultant emf in the circuit is 10.

Statement 2: Resultant emf of the circuit is given by the relation $E = \sqrt{V_R^2 + (V_L - V_C)^2}$

104

Statement 1: The alternating current lags behind the e.m.f. by a phase angle of $\pi/2$, when ac flows through an inductor

Statement 2: The inductive reactance increases as the frequency of ac source decreases

105

Statement 1: A sinusoidal AC current flows through a resistance R. If the peak current is I_0, then the power dissipated is $\frac{RI_0^2}{2}$.

Statement 2: For purely resistive circuit, power factor $\cos \phi = 1$.

106

Statement 1: When capacitive reactance is smaller than the inductive reactance in LCR circuit, e.m.f. leads the current

Statement 2: The phase angle is the angle between the alternating e.m.f. and alternating current of the circuit

107

Statement 1: In a series LCR circuit, at resonance condition power consumed by circuit is maximum

Statement 2: At resonance condition, the effective resistance of circuit is maximum

108

Statement 1: An alternating current shows magnetic effect

Statement 2: Alternating current varies with time

109

Statement 1: A capacitor of suitable capacitance can be used in an ac circuit in place of the choke coil

Statement 2: A capacitor blocks dc and allows ac only

110

Statement 1: In a series R-L-C circuit the voltages across resistor, inductor and capacitor are 8 V, 16 V and 10 V respectively. The resultant emf in the circuit is 10 V.

Statement 2: Resultant emf of the circuit is given by the relation. $E = \sqrt{V_R^2 + (V_L - V_C)^2}$

111

Statement 1: Peak current through each remains same

Statement 2: Average power delivered by source is equal to average power developed across resistance

112

Statement 1: The armature current in DC motor maximum when the motor has just started.

Statement 2: Armature current is given by $i = \frac{E-e}{R_a}$ Where e = the back emf and R_a = resistance of armature.

113

Statement 1: dc and ac both can be measured by a hot wire instrument

Statement 2: The hot wire instrument is based on the principle of magnetic effect of current

114

Statement 1: In a series $R-L-C$ circuit the voltage across resistor, inductor and capacitor are 8 V, 16 V and 10 V respectively. The resultant emf the circuit is 10 V

Statement 2: Resultant emf of the circuit is given by the relation $E = \sqrt{V_R^2 + (V_L - V_C)^2}$

115

Statement 1: In the purely resistive element of a series LCR, ac circuit the maximum value of rms current increases with increase in the angular frequency of the applied emf

Statement 2: $I_{\max} = \frac{\varepsilon_{\max}}{Z}, Z = \sqrt{R^2 + \left(\omega L - \frac{1}{\omega C}\right)^2}$, where $I_{\max}$ is the peak current in a cycle

116

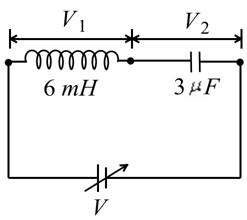
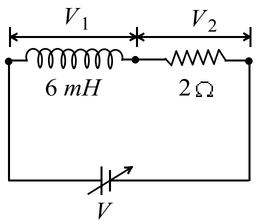
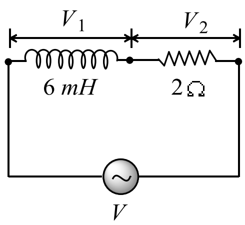
Statement 1: Making or breaking of current in a coil produces no momentary current in the neighbouring coil of another circuit

Statement 2: At the time of making or breaking of current changes.

Matrix-Match Type

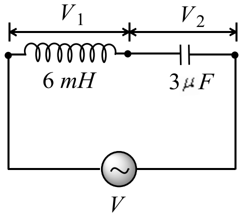
This section contain(s) 0 question(s). Each question contains Statements given in 2 columns which have to be matched. Statements (A, B, C, D) in **columns I** have to be matched with Statements (p, q, r, s) in **columns II**.

117. You are given many resistances, capacitors and inductors. These are connected to a variable DC voltage source (the first two circuits) or an AC voltage source of 50 Hz frequency (the next three circuits) in different ways as shown in Column-II. When a current I (steady state for DC or rms for AC) flows through the circuit, the corresponding voltage V_1 and V_2 (indicated in circuits) are related as shown in Column-I. Match the two

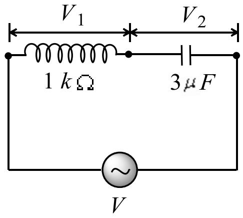
Column-I	Column- II
(A) $I \neq 0, V_1$ is proportional to I	(p) 
(B) $I \neq 0, V_2 > V_1$	(q) 
(C) $V_1 = 0, V_2 = V$	(r) 

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

(s)



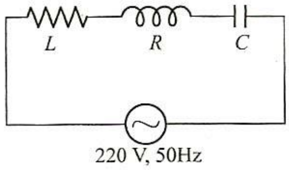
(t)



CODES :

	A	**B**	**C**	**D**
a)	r,s,t	q,r,s,t	p,q	q,r,s,t
b)	q,r,s,t	p,q	r,s,t	q,r
c)	p,q	r,s,t	q,r,s,t	s,t
d)	r,s,t	p,q	q,r,s,t	q,r,s,t

118. In series $R - L - C$ circuit, $R = 100\ \Omega, C = \frac{100}{\pi}$ μF, and $L = \frac{100}{\pi}$ mHare connected to an ac source as shown in Fig



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

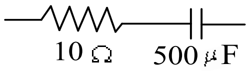
Column-I		**Column- II**	
(A)	Average power dissipated in the resistor is	(p)	Zero
(B)	Average power dissipated in the inductor is	(q)	Non-zero
(C)	Average power dissipated in the capacitor is	(r)	163 SI units
(D)	rms voltage across the capacitor is	(s)	265.7 SI units

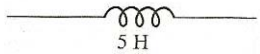
CODES :

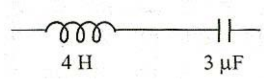
	A	**B**	**C**	**D**
a)	C,d	d	b	a
b)	b,d	a	a	b,c
c)	c	a	b,c	d
d)	b	a	d	a,c

119. 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

(A) 

(B) 

(C) 

(D) 

Column- II

(p) The magnitude of required phase difference is $\pi/2$

(q) The magnitude of required phase difference is $\pi/4$

(r) The current leads in phase to source voltage

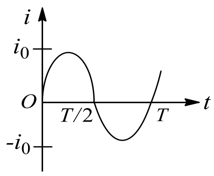
(s) The current lags in phase to source voltage

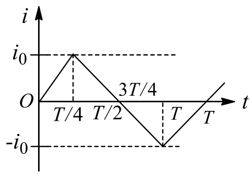
CODES :

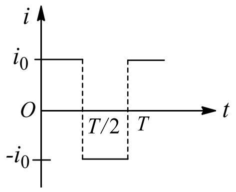
	A	**B**	**C**	**D**
a)	D	a	c	b
b)	a,d	b,d	a	a,c
c)	a	b	a,c	d
d)	b,c	a,d	a,c	b,d

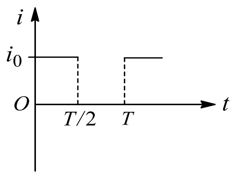
120. In column I, variation of current i with time t is given in the figure. In column II, root mean square current i_{rms} and average current are given. Match column I with corresponding quantities given in column II

Column-I

(A) 

(B) 

(C) 

(D) 

Column- II

(p) $i_{\text{rms}} = \dfrac{i_0}{\sqrt{3}}$

(q) Average current for positive half cycle is i_0

(r) Average current for positive half cycle is $\frac{i_0}{2}$

(s) Full cycle average current is zero

CODES :

A	**B**	**C**	**D**

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

121. Consider all possibilities [L, R, C are non-zero]

	Column-I		Column- II
(A)	In $L - R$ series ac circuit	(p)	Current lags inductor voltage by $\frac{\pi}{2}$
(B)	In $R - C$ series ac circuit	(q)	Current lags voltage by an angle less than $\frac{\pi}{2}$
(C)	In $L - C - R$ series ac circuit (consider all possibilities)	(r)	Current leads voltage by an angle less than $\frac{\pi}{2}$
(D)	In purely resistive ac circuit	(s)	Current and voltage are in phase

CODES :

	A	**B**	**C**	**D**
a)	A,b	c	a,b,c,d	d
b)	d	a,d	c,d	c
c)	b,c	d	b	a,c
d)	a,b	a,b	b,c	c

122. Match the following column

	Column-I		Column- II
(A)	Inductance of a coil	(p)	Depends on resistivity
(B)	Capacitance	(q)	Depends on shape
(C)	Impedance of coil	(r)	Depends on medium inserted
(D)	Reactance of a capacitor	(s)	Depends on external voltage source

CODES :

	A	**B**	**C**	**D**
a)	B,c	b,c	a,b,c,d	b,c,d
b)	b,c	a,b	c,d	a
c)	a	b,c	a,c	d
d)	b	a,c	b,c	c

Linked Comprehension Type

This section contain(s) 20 paragraph(s) and based upon each paragraph, multiple choice questions have to be answered. Each question has atleast 4 choices (a), (b), (c) and (d) out of which **ONLY ONE** is correct.

Paragraph for Question Nos. 123 to -123

A transformer is based on the principle of mutual induction. Input is supplied to primary coil and output is taken across the secondary coil of the transformer. It is found that $\frac{E_S}{E_p} = \frac{n_P}{n_S} = \frac{I_P}{I_S}$, when there is no energy loss.

The efficiency of a transformer is given by

$$\eta = \frac{P_{\text{output}}}{P_{\text{input}}} = \frac{E_S I_S}{E_P E_P}$$

123. How much current is drawn by the primary coil of a transformer which steps down 220 V to 44 V to operate a device with a impedance of 880 Ω?
a) 1 A b) 0.1 A c) 0.01 A d) 0.02 A

Paragraph for Question Nos. 124 to - 124

The amount of magnetic flux ϕ linked with an area $\vec{A}$ held in a magnetic field of intensity $\vec{B}$ is $\phi = \vec{B}.\vec{A}$. An emf is induced in a coil when amount of magnetic flux linked with the coil changes $e = \frac{-d\phi}{dt}$. Minus sign indicates that induced emf opposes the change in magnetic flux responsible for its production.

124. A circular coil of diameter 21 cm is held in a magnetic field of induction $10^{-4}T$. The magnitude of magnetic flux linked with the coil when the plane of the coil makes an angle of 30° with the field is
a) 3.1×10^{-6}Wb b) 1.414 Wb c) 1.73×10^{-6}Wb d) 14.14 Wb

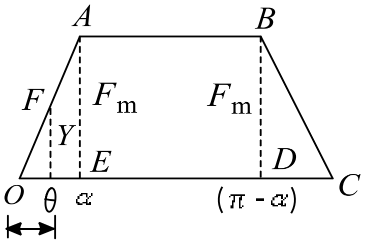
Paragraph for Question Nos. 125 to - 125

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

125. rmsvalue of the voltage
a) 220 V b) 314 V c) $220\sqrt{2}$ V d) $200/\sqrt{2}$ V

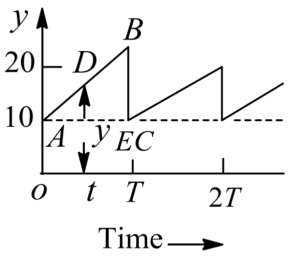
Paragraph for Question Nos. 126 to - 126

The half cycle of an alternating signal is shown in Fig. It increases uniformly from zero at 0° to F_m at α°, it remains constant from α° to $(180 - \alpha)$°, and decreases uniformly from F_m at 180°



126. The effective values of the signal is
a) $F_m\sqrt{\left(1 - \frac{4\alpha}{3\pi}\right)}$ b) $F_m\sqrt{\left(1 + \frac{4\alpha}{3\pi}\right)}$ c) $F_m\sqrt{\left(1 - \frac{3\alpha}{4\pi}\right)}$ d) $F_m\sqrt{\left(1 + \frac{3\alpha}{4\pi}\right)}$

Paragraph for Question Nos. 127 to - 127



127. The average value of the wave-form shown in Fig is

a) $15\sqrt{2}$ b) $10\sqrt{2}$ c) 10 d) 15

Paragraph for Question Nos. 128 to - 128

A 0.21 H inductor and a 12 Ω resistance are connected in series to a 220 V, 50 Hz ac source

128. The current in the circuit is

a) $\frac{220}{\sqrt{4400}}$A b) $\frac{22}{3\sqrt{5}}$A c) $\frac{220}{\sqrt{4550}}$A d) $\frac{22}{5\sqrt{3}}$A

Paragraph for Question Nos. 129 to - 129

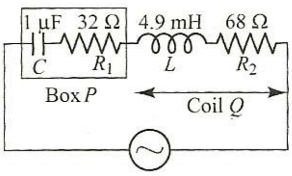
When 100 V dc is applied across a coil, a current of 1 A flows through it and when 100 V ac of 50 Hz is applied to the same coil, only 0.5 A flows

129. The resistance is

a) 200 Ω b) 50 Ω c) 100 Ω d) $50\sqrt{3}$Ω

Paragraph for Question Nos. 130 to - 130

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



130. The impedance of P at this frequency is

a) 77 Ω b) 36 Ω c) 40 Ω d) 125 Ω

Paragraph for Question Nos. 131 to - 131

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

131. The value of inductance L is
   a) 0.1 mH b) 0.2 mH c) 0.35 mH d) 0.4 mH

Paragraph for Question Nos. 132 to - 132

A current of 4 A flows in a coil when connected to a 12 V dc source. 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

132. The inductance of the coil is
   a) 0.02 H b) 0.04 H c) 0.08 H d) 1.0 H

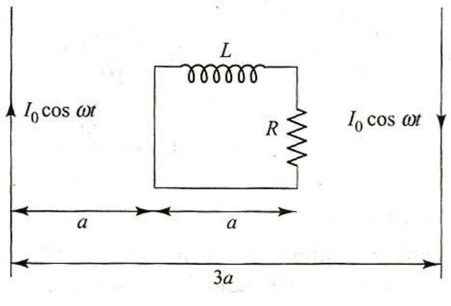
Paragraph for Question Nos. 133 to - 133

An inductor 20×10^{-3} H, a capacitor 100 μF and a resistor 50 Ω are connected in series across a source of emf $V = 10 \sin 3.14\, t$

133. Then the energy dissipated in the circuit in 20 min is
   a) 960 J b) 900 J c) 250 J d) 500 J

Paragraph for Question Nos. 134 to - 134

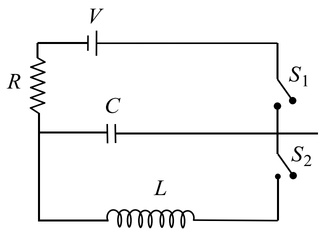
In Fig, a square loop consisting of an inductor of inductance L and resistor of resistance R is placed between two long parallel wires. The two long straight wires have time varying current of magnitude $I = I_0 \cos \omega t$ but the directions of current in them are opposite



134. Total magnetic flux in this loop is
   a) $\frac{\mu_0 I a}{\pi}$ In 2 b) $\frac{2\mu_0 I a}{\pi}$ In 2 c) $\frac{4\mu_0 I a}{\pi}$ In 2 d) $\frac{\mu_0 I a}{2\pi}$ In 2

Paragraph for Question Nos. 135 to - 135

In the given circuit the capacitor (C) may be charged through resitance R by battery V by closing switch S_1. Also when S_1 is opened and S_2 is closed the capacitor is connected in series with inductor (L)



135. Given that the total charge stored in the LC circuit is Q_0 for $t \geq 0$. The charge on the capacitor is

a) $Q = Q_0 \cos\left(\frac{\pi}{2} + \frac{t}{\sqrt{LC}}\right)$

b) $Q = Q_0 \cos\left(\frac{\pi}{2} - \frac{t}{\sqrt{LC}}\right)$

c) $Q = -LC\frac{d^2Q}{dt^2}$

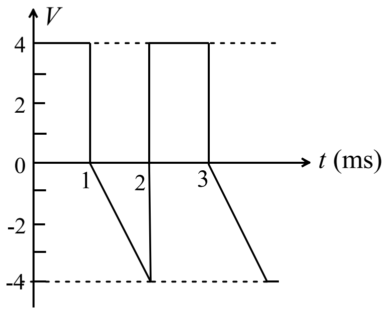
d) $Q = -\frac{1}{\sqrt{LC}}\frac{d^2Q}{dt^2}$

Integer Answer Type

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

137. The average value of current $i = I_m \sin\omega t$ from $t = \frac{\pi}{2\omega}$ to $t = \frac{3\pi}{2\omega}$ is how many times of I_m?

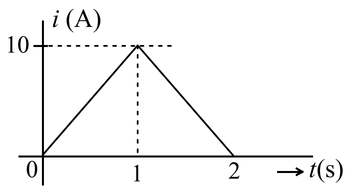
138. Variation of voltage with time is shown in the following figure



i. rms voltage is found to be $N\sqrt{\frac{2}{3}}$ V. Find N

ii. Also calculate the average value of voltage (in V)

139. Find the average value of current (in A) shown graphically in Fig, from $t = 0$ to $t = 2$ s



140. A series $R - C$ combination is connected to an AC voltage of angular frequency $\omega = 500$ radian/s. If the impedance of the R-C circuit is $R\sqrt{1.25}$, the time constant (in millisecond) of the circuit is

: ANSWER KEY :

1)	c	2)	a	3)	c	4)	c
5)	c	6)	b	7)	a	8)	a
9)	b	10)	a	11)	a	12)	b
13)	a	14)	b	15)	d	16)	b
17)	c	18)	c	19)	a	20)	b
21)	c	22)	d	23)	a	24)	c
25)	a	26)	a	27)	a	28)	b
29)	a	30)	a	31)	b	32)	b
33)	a	34)	d	35)	b	36)	b
37)	c	38)	c	39)	b	40)	c
41)	a	42)	a	43)	a	44)	b
45)	b	46)	a	47)	a	48)	b
49)	b	50)	b	51)	a	52)	a
53)	b	54)	b	55)	d	56)	c
57)	d	58)	b	59)	d	60)	b
61)	c	62)	d	63)	b	64)	c
65)	d	66)	d	67)	b	68)	c
69)	a	70)	c	71)	a	72)	a
1)	b,c,d	2)	b,d	3)	a,c,d	4)	
	a,c,d						
5)	a,b	6)	a,c	7)	a,b,c	8)	

	a,b,c						
9)	a,c,d	10)	a,c	11)	b,d	12)	
	b,d						
13)	b,c	1)	b	2)	a	3)	b
	4)	d					
5)	b	6)	a	7)	a	8)	a
9)	d	10)	c	11)	b	12)	a
13)	a	14)	c	15)	c	16)	a
17)	b	18)	a	19)	c	20)	b
21)	b	22)	c	23)	b	24)	b
25)	a	26)	b	27)	b	28)	c
29)	a	30)	d	31)	d	1)	a
	2)	b	3)	d	4)	c	
5)	a	6)	a	1)	c	2)	c
	3)	a	4)	a			
5)	d	6)	b	7)	a	8)	a
9)	b	10)	c	11)	a	12)	a
13)	c	1)	5	2)	0	3)	
	4, 1	4)	5				
5)	4						

: HINTS AND SOLUTIONS :

1 **(c)**
Clearly, $X_{\mathrm{L}} = R$
or $L \times 2 \times 3.14 \times 1000 = 100$
or $L = \frac{100}{2\times3.14\times1000}$ H
$= 15.9 \times 10^{-3}\mathrm{H} = 15.9\ \mathrm{mH} \approx 16\ \mathrm{mH}$

2 **(a)**
Since the capacitor is connected in series to the resistor, current I_{C} from the supply and I_{R} through the resistor is in phase as represented by choice (a)

3 **(c)**
The equation of a semi-circular wave is
$x^2 + y^2 = a^2$ or $y^2 = a^2 - x^2$

$$I_{\mathrm{rms}} = \sqrt{\frac{1}{2a}\int_{-a}^{+a} y^2\, dx}$$

$$I_{\mathrm{rms}}^2 = \frac{1}{2a}\int_{-a}^{+a}(a^2 - x^2)dx$$

$$= \frac{1}{2a}\int_{-a}^{+a}(a^2 - x^2)dx = \frac{1}{2a}\left|a^2x - \frac{x^3}{3}\right|_{-a}^{+a}$$

$$= \frac{1}{2a}\left(a^3 - \frac{a^3}{3} + a^3 - \frac{a^3}{3}\right) = \frac{2a^2}{3}$$

$$I_{\mathrm{rms}} = \sqrt{\frac{2a^2}{3}} = \sqrt{\frac{2}{3}}a$$

4 **(c)**
$X_L = X_C$ at resonance
$\frac{X_L}{X_C} = 1$ for both circuits
Impedance may be different if applied voltage is different

5 **(c)**
According to the given question,
$\tan 60° = \frac{\omega L}{R}$ and $\tan 60° = \frac{1/\omega C}{R}$
$\therefore\ \omega L = (1/\omega C)$ (case of resonance)
Now $Z = \sqrt{R^2 + \left(\omega L - \frac{1}{\omega C}\right)^2} = 100\ \Omega$
$\therefore\ I_{\mathrm{rms}} = \frac{E_{\mathrm{rms}}}{Z} = \frac{200\ \mathrm{V}}{100\ \Omega} = 2\ \mathrm{A}$

6 **(b)**
At resonance, the series combination of L and C gives zero impedance
At resonance, the voltage across L and C are equal but opposite in phase

7 **(a)**
Here, $V_{\mathrm{L}} = V_{\mathrm{C}}$.They are in opposite phase. Hence, they will cancel each other. Now the resultant potential difference is equal to the applied potential difference = 100 V
$Z = R \quad (\because X_{\mathrm{L}} = X_{\mathrm{C}})$
$\therefore\ I_{\mathrm{rms}} = \frac{V_{\mathrm{rms}}}{Z} = \frac{V_{\mathrm{rms}}}{R} = \frac{100}{50} = 2\ \mathrm{A}$

8 **(a)**
Change on the capacitor,
$q_0 = CV = 1 \times 10^{-6} \times 1 = 10^{-6}\mathrm{C}$
or $I_0 = \omega q_0$ = Maximum current
Now $\omega = \frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{10^{-9}}} = (10^9)^{1/2}$
$\therefore I_0 = (10^9)^{1/2} \times (1 \times 10^{-6}) = \sqrt{10^{-3}}\mathrm{A}$
$= \sqrt{1000}\mathrm{mA}$

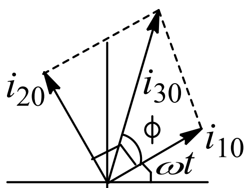
9 **(b)**
In an ac circuit, capacitor does not consume any power. Therefore, power is consumed by the resistor only
$\therefore P = I_{\mathrm{v}}^2 R$ or $100 = (2)^2 R$ or $R = 25\ \Omega$

10 **(a)**
As the current i leads the emf e by $\frac{\pi}{4}$, it is an $R - C$ circuit
$\tan\phi = \frac{X_C}{R}$
or $\tan\frac{\pi}{4} = \frac{\frac{1}{\omega C}}{R}$
$\therefore\quad \omega CR = 1$
As $\quad \omega = 100\ \mathrm{rads^{-1}}$
The product of $C - R$ should be $\frac{1}{100}\mathrm{s^{-1}}$.

11 **(a)**
Current remains unchanged in R. However, it becomes half in L, because reactance is doubled on doubling the frequency

12 **(b)**
$E_{\mathrm{v}} = \sqrt{120^2 + 160^2} = 200\ \mathrm{V}$

13 **(a)**
$i_3 = i_1 + i_2 = 3\sin\omega t + 4\cos\omega t$
$= 3\sin\omega t + 4\sin(\omega t + 90°)$



$i_{30} = \sqrt{i_{10}^2 + i_{20}^2} = \sqrt{3^2 + 4^2} = 5$
$\tan\phi = \frac{4}{3} \Rightarrow \phi = 53°$

So $i_3 = i_{30}\sin(\omega t + \phi) = 5\sin(\omega t + 53°)$

14 **(b)**

Wattles component of ac

$$= I_V \sin\phi = \frac{E_v}{Z}\frac{X_L}{Z} = \frac{E_v X_L}{Z^2} = \frac{220 \times \omega L}{(R^2 + \omega^2 L^2)}$$

As $\omega L = 0.7 \times 2\pi \times 50 = 220\ \Omega$

Hence, wattless component of ac

$$= \frac{200 \times (220)}{(220^2 + 220^2)} = 0.5\text{ A}$$

15 **(d)**

$$< V >= \frac{\int_0^T V dt}{\int_0^T dt} = 0$$

16 **(b)**

$$Z = \sqrt{R^2 + X_C^2}$$

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

In case (b) capacitance (c) will be more. Therefore, impedance Z will be less. Hence current will be more.

17 **(c)**

$\lambda = 300\text{ m}, c = 3 \times 10^8\text{m/s}$

Frequency $f = \frac{c}{\lambda} = \frac{3\times10^8}{300} = 10^6\text{Hz}$

Resonance frequency

$$f = \frac{1}{2\pi\sqrt{LC}} \text{ or } L = \frac{1}{C4\pi^2 f^2}$$

$$\therefore\ L = \frac{1}{4\pi^2(10^6)^2 \times 2.4 \times 10^{-6}} \equiv 10^{-8}\text{H}$$

19 **(a)**

Given, $V_C = 3V_R = 3(V - V_C)$

Here, V is the applied potential.

$\therefore\quad V_C = \frac{3}{4}\text{V}$

Or $V\left(1 - e^{-t/\tau_C}\right) = \frac{3}{4}\text{V}$

$\therefore\quad e^{-t/\tau_C} = \frac{1}{4}$ ... (i)

Here, $\tau_C = CR = 10\text{s}$

Substituting this value of τ_C in Eq.(i) and solving for t, we get

$t = 1\ 3.8\ \ 6\text{s}$

20 **(b)**

Charging current, $I = \frac{E}{R}\, e^{-\frac{t}{RC}}$

Taking log both sides,

$$\text{Log}\, I = \log\left(\frac{E}{R}\right) - \frac{t}{RC}$$

When R is doubled, slope of curve increases. Also at $t = 0$, the current will be less. Graph Q represents the best.

21 **(c)**

$E_1 = E_0 \sin\omega t; E_2 = E_0 \sin[\omega t + (\pi/3)]$

$E = E_2 + E_1$

$= E_0 \sin[\omega t + (\pi/3)] + E_0 \sin\omega t$

$= E_0[2\sin\{\omega t + (\pi/6)\}\cos(\pi/6)]$

$= \sqrt{3}E_0 \sin[\omega t + (\pi/6)]$

22 **(d)**

If an ac source $E = E_0 \sin\omega t$ is applied across an inductance and capacitance in parallel, the current in inductance will lag the applied voltage while that across the capacitor will lead, and so,

$$I_L = \frac{E_0}{X_L}\sin\left(\omega t - \frac{\pi}{2}\right) = -0.8\sqrt{2}\cos\omega t$$

$$I_C = \frac{V}{X_C}\sin\left(\omega t + \frac{\pi}{2}\right) = 0.6\sqrt{2}\cos\omega t$$

So the current drawn from the source

$I = I_L + I_C = -0.2\sqrt{2}\cos\omega t$

$$I_{rms} = \frac{I_0}{\sqrt{2}} = \frac{0.02\sqrt{2}}{\sqrt{2}} = 0.2\text{ A}$$

23 **(a)**

After time t, thickness of liquid will remain $\left(\frac{d}{3} - vt\right)$.

Now, time constant as function of time

$\tau_c = CR$

$$= \frac{\varepsilon_0(1).R}{\left(d - \frac{d}{3} + vt\right) + \frac{d/3 - vt}{2}} \left(\text{Applying } C = \frac{\varepsilon_0 A}{d - t + \frac{t}{k}}\right)$$

$$= \frac{6\varepsilon_0 R}{5d + 3vt}$$

24 **(c)**

The circuit will have inductive nature if

$$\omega > \frac{1}{\sqrt{LC}}\left(\omega L > \frac{1}{\sqrt{LC}}\right)$$

Hence (a) is false. Also, if circuit has inductive nature the current will lag behind voltage. Hence (d) is also false

If $\omega = \frac{1}{\sqrt{LC}}\left(\omega L = \frac{1}{\omega C}\right)$ the circuit will have resistance nature. Hence (b) is false

Power factor, $\cos\phi = \frac{R}{\sqrt{R^2 + \left(\omega L - \frac{1}{\omega C}\right)^2}} = 1$

If $\omega L = \frac{1}{\omega C}$. Hence (c) is true

25 **(a)**

Resultant current is superposition of two currents, i.e., I (instantaneous total current)$= 6 + I_0 \sin\omega t$

dc ammeter will read average value

$= \overline{6 + I_0 \sin\omega t} = 6 \quad (\because\ \overline{I_0 \sin\omega t} = 0)$

ac ammeter will read

$= \sqrt{\overline{(6 + I_0 \sin \omega t)^2}}$

$= \sqrt{\overline{36 + 12 I_0 \sin \omega t + I_0^2 \sin^2 \omega t}}$ ($\therefore \overline{I_0 \sin \omega t = 0}$)

Since $\overline{\sin^2 \omega t} = \frac{1}{2}$ and $I_{\text{rms}} = 8 = \frac{I_0}{\sqrt{2}} \Rightarrow I_0 = 8\sqrt{2}$A

Therefore, ac reading

$= \sqrt{36 + \frac{I_0^2}{2}} = \sqrt{36 + 64} = 10$ A

26 **(a)**

$R = \frac{E}{I} = \frac{100}{1} = 100\ \Omega$

For ac: $Z = [R^2 + (2\pi f L)^2]^{1/2}$

$Z = \frac{E_v}{I_v} = \frac{100}{0.5} = 200\ \Omega$

or $200 = [(100)^2 + (100\ \pi L)^2]^{1/2}$

Solving, we get $L = 0.55$ H

27 **(a)**

Current leads emf so the circuit is $R - C$

$\tan\phi = X_C/R, \phi = 45°, R = 1000\ \Omega, \omega = 100$

$C = ?$

Since $\tan 45° = \frac{1}{\omega CR}$, So $C = 10\ \mu$F

28 **(b)**

$V_{\text{rms}} = \sqrt{16^2 + 20^2} = 25.6$ V

29 **(a)**

In an ac circuit, a pure inductor does not consume any power. Therefore, power is consumed by the resistor only

$\therefore P = I_v^2 R$

or $108 = (3)^2 R$ or $R = 12\ \Omega$

30 **(a)**

$V = \frac{V_0}{T/4} t; V = \frac{4V_0}{T} t$

$V_{\text{rms}} = \sqrt{<V^2>} = \frac{4V_0}{T}\sqrt{<t>}$

$= \frac{4V_0}{T}\left\{\frac{\int_0^{T/4} t^2\, dt}{\int_0^{T/4} dt}\right\}^{1/2} = \frac{V_0}{\sqrt{3}}$

31 **(b)**

Given that $E_0 = 10$ V, $t = \frac{1}{600}$ s

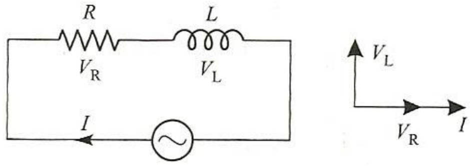
$\therefore E = E_0 \cos 2\pi f t$

$= 10 \cos\left[2\pi \times 50 \times \frac{1}{600}\right]$

$= 10\cos(\pi/6) = 10\ (\sqrt{3}/2) = 5\sqrt{3}$V

32 **(b)**

Here inductance and resistance are connected in series. We know that in case of resistance, both current and potential difference are in the same phase. In inductor voltage leads current by $\pi/2$



33 **(a)**

$E = E_0 \cos \omega t$

$\therefore\ \omega = 50\pi$

$2\pi f = 50\pi \Rightarrow f = 25$ Hz

In one cycle ac current becomes zero twice.

Therefore, 50 times the current becomes zero in 1 s

34 **(d)**

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

(Also $\cos\phi$ can never be greater than 1)

Hence (c) is wrong

Also $IX_C > IX_L \Rightarrow X_C > X_L$

$\therefore$ Current will be leading

In an LCR circuit,

$V = \sqrt{(v_L - v_C)^2 + v_R^2} = \sqrt{(6-12)^2 + 8^2}$

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

35 **(b)**

$E = E_0 \sin \omega t$

Voltage read is rms value

$\therefore\ E_0 = \sqrt{2} \times 234$ V $= 331$ V

and $\omega t = 2\pi f t = 2\pi \times 50 \times t = 100\pi t$

thus, the equation of the line voltage is give by

$E = 331 \sin(100\ \pi t)$

36 **(b)**

$X_C = \frac{1}{\omega C} = \frac{1}{100 \times 10^{-6}} = 10^4 \Omega$

So, $I_{\text{rms}} = \frac{E_{\text{rms}}}{Z} = \frac{50\sqrt{2}}{\sqrt{2} \times 10^4} = 5$ mA

37 **(c)**

Quality factor

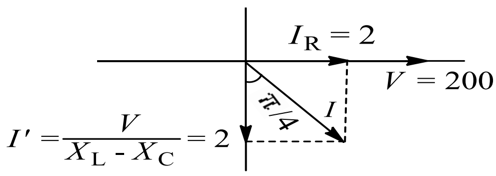
$= \frac{f_0}{f_2 - f_1} = \frac{600}{650 - 550} = \frac{600}{100} = 6$

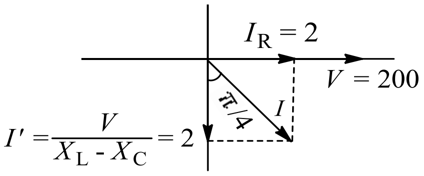
38 **(c)**

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

Putting the values, $C = 500\ \mu$F

39 **(b)**





$I_R = \frac{V}{R} = \frac{200}{100} = 2\text{ A}$

$I' = \frac{V}{X_L - X_C} = \frac{200}{100} = 2\text{ A}$

$I = \sqrt{I_R^2 + I'^2} = 2\sqrt{2}\text{A}$

40 **(c)**

$V_R = I_v R = 1 \times 50 = 50\ \Omega$

$V_L = \sqrt{E_v^2 - V_R^2} = \sqrt{220^2 - 50^2} = 214\text{ V}$

41 **(a)**

$X_L = 2\pi f L = 2\pi\left(\frac{50}{\pi}\right) \times 1 = 100\Omega$

$X_C = \frac{1}{2\pi f C}$

$= \frac{1}{2\pi\left(\frac{50}{\pi}\right) \times 20 \times 10^{-6}}$

$= 500\ \Omega$

Impedence $Z = \sqrt{(R)^2 + (X_c - X_L)^2}$

$= \sqrt{(300)^2 + (400)^2}$

$= 500\ \Omega$

42 **(a)**

The equivalent primary load is

$R_1 = \left(\frac{N_1}{N_2}\right)^2 R_2 = \left(\frac{20}{1}\right)^2 (6.0) = 2400\ \Omega$

Current in the primary coil

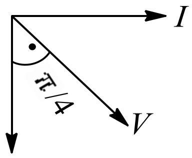
$= \frac{240}{R_1} = \frac{240}{2400} = 0.1\text{ A}$

43 **(a)**

$v = v_0 \sin[\omega t + (\pi/4)]$

$= v_0 \cos[\omega t - (\pi/4)]$

Since V lags current, an inductor can bring it in phase with current



44 **(b)**

The period of sinusoidal voltage, $T = 0.4$ s

$f = \frac{1}{T} = \frac{1}{0.4} = 2.5\text{ Hz}$

N lags M by 0.1 s which is equivalent to $\left(\frac{0.1}{0.4}\right) 2\pi$ or $\frac{\pi}{2}$ rad

Thus, the lead of N over M is $-\frac{\pi}{2}$ rad

45 **(b)**

Here $R = X_L = X_C$ ($\therefore$ voltage across them is same)

When capacitor is short circuited,

$I = \frac{10}{(R^2 + X_L^2)^{1/2}} = \frac{10}{\sqrt{2}R}$

$\therefore$ Potential drop across inductance $IX_L = IR = 10/\sqrt{2}\text{ V}$

46 **(a)**

$P = E_v I_v \cos\phi;\ P = E_v \frac{E_v}{Z}\frac{R}{Z}$

or $P = \frac{E_v^2 R}{Z^2} = \frac{110 \times 110 \times 11}{22 \times 22} = 275\text{ W}$

47 **(a)**

Given:

Voltage in primary coil, $V_P = 200$ V

Current in primary coil, $i_p = 2$ A

Voltage in secondary coil, $V_s = 2000$ V

The relation for the current in the secondary coil is

$\frac{V_s}{V_p} = \frac{i_p}{i_s} \Rightarrow \frac{2000}{200} = \frac{2}{i_s} = \frac{2 \times 200}{2000} = 0.2\text{ A}$

48 **(b)**

As resistance of the lamp

$R = \frac{V_S^2}{P_0} = \frac{100^2}{50} = 200\ \Omega$

The rms current $I = \frac{V}{R} = \frac{100}{200} = \frac{1}{2}$A

So when the lamp is put in series with a capacitance and run at 200 V ac, from $V = IZ$, we have

$Z = \frac{V}{I} = \frac{200}{(1/2)} = 400\Omega$

Now as in case of $C - R$ circuit,

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

i.e., $R^2 + \left(\frac{1}{\omega C}\right)^2 = 160000$

or, $\left(\frac{1}{\omega C}\right)^2 = 16 \times 10^4 - (200)^2 = 12 \times 10^4$

$\frac{1}{\omega C} = \sqrt{12} \times 10^2$

$C = \frac{1}{100\pi \times \sqrt{12} \times 10^2}$F

$C = \frac{100}{\pi\sqrt{12}}\mu\text{F} = \frac{50}{\pi\sqrt{3}} = 9.2\ \mu\text{F}$

49 **(b)**

Resistance of bulb: $R = \frac{V_0^2}{P_0} = \frac{(220)^2}{1100} = 44\ \Omega$

When L is maximum, power consumed will be minimum

Which is $P = \frac{1100}{5} = 220$ W

Now $P = I_v^2 R \Rightarrow 220 = I_v^2 \times 44 \Rightarrow I_v = \sqrt{5}$A

$$I_v = \frac{E_v}{Z} \Rightarrow \sqrt{5} = \frac{220}{\sqrt{44^2 + X_L^2}} \Rightarrow X_L = 88\ \Omega$$

$$\Rightarrow 2\pi f\ L_{max} = 88 \Rightarrow 2 \times \frac{22}{7} \times 50\ L_{max} = 88$$

$$\Rightarrow L_{max} = 0.28 \text{ H}$$

50 **(b)**

$$X_C = \frac{1}{2\pi f C} = \frac{10^6}{2\pi 50 \times 500} = \frac{20}{11}\Omega$$

$X_L = 2\pi f L = 2\pi \times 50 \times 10 \times 10^{-3} = \pi\Omega$

Since $X_L < X_C$, so inductive branch has less impedance, and so more current. Hence B_2 will be brighter

51 **(a)**

Voltage across the capacitors will increase from 0 to 10 V exponentially. The voltage at time t will be given by

$V = 10(1 - e^{-t/\tau_C})$

Here $\tau_C = C_{net}R_{net} = (1 \times 10^6)(4 \times 10^{-6}) = 4$ s

$\therefore\ V = 10(1 - e^{-t/4})$

Substituting $V = 4$ volt, we have,

$$4 = 10(1 - e^{-t/4})$$

$$e^{-t/4} = 0.6 = \frac{3}{5}$$

Taking log both sides we have,

$$-\frac{t}{4} = \text{In } 3 - \text{In } 5$$

or $t = 4(\text{In } 5 - \text{In } 3) = 2\text{s}$.

52 **(a)**

$q_0 = CE_0 = 8 \times 10^{-6} \times 220\sqrt{2} = 2.5 \times 10^{-3}$C

53 **(b)**

$$(0.5)^2 R\left(\frac{T}{2}\right) + (0.5)^2 R\left(\frac{T}{2}\right) = I_{rms}^2 RT$$

or $I_{rms} = \frac{1}{2}$A $= 0.5$ A

54 **(b)**

Here, $X_L = \omega L = 2\pi f L = 2\pi \times 50 \times 1 = 100\ \pi\Omega$

$$X_c = \frac{1}{\omega C} = \frac{1}{2\pi f C} = \frac{1}{2\pi \times 50 \times 10 \times 10^{-6}} = \frac{10^3}{\pi}\Omega$$

So,

$$X = |X_L - X_C| = \left|100\pi - \frac{10^3}{\pi}\right| = \left|10^2\left[\frac{\pi^2 - 10}{\pi}\right]\right|\Omega$$

55 **(d)**

$V_{6\Omega} = 3 = 6I_V\ \therefore I_V = 0.5$ A

$$I_V = \frac{1}{2} = \frac{5}{\sqrt{6^2 + X_L^2}}, X_L = 8\ \Omega$$

Now, $V_L = I_V \cdot X_L = \frac{1}{2} \times 8 = 4$ V

56 **(c)**

The current of 1.6 A lags emf in phase by $\pi/2$. The current of 0.4 A leads emf in phase by $\pi/2$. So, these two currents are 180° out of phase with each other

$\therefore$Net current, $I_1 = (1.6 - 0.4)$A $= 1.2$ A

$1.6 = \frac{E_v}{X_L}$ and $0.4 = \frac{E_v}{X_C}$

$$\Rightarrow \frac{X_C}{X_L} = 4 \Rightarrow \frac{1}{\omega C \omega L} = 4$$

$$\Rightarrow \omega = \frac{1}{2\sqrt{LC}}$$

$$\Rightarrow f = \frac{\omega}{2\pi} = \frac{1}{4\pi\sqrt{LC}}$$

57 **(d)**

$$\frac{1}{\omega C} = \sqrt{125 \times 75}$$

Here $\omega = 2\pi f = 2\pi \times 50 = 100\pi$ radian/sec

$$\therefore C = \frac{1}{100\pi\sqrt{125 \times 75}}\text{F}$$

58 **(b)**

Given $I = 5 + 10 \sin \omega t$

$$I_{eff} = \left[\frac{\int_0^T I^2 dt}{\int_0^T dt}\right]^{1/2} = \left[\frac{1}{T}\int_0^T (5 + 10 \sin \omega t)^2 dt\right]^{1/2}$$

$$= \left[\frac{1}{T}\int_0^T (25 + 100 \sin \omega t + 100 \sin^2 \omega t)\right]^{1/2}$$

But as $\frac{1}{T}\int_0^T \sin \omega t\ dt = 0$

and $\frac{1}{T}\int_0^T \sin^2 \omega t\ dt = \frac{1}{2}$

so $I_{eff} = \left[25 + \frac{1}{2} \times 100\right]^{1/2} = 5\sqrt{3}$A

59 **(d)**

Time for reaching maximum or peak value from 0

$$= \frac{T}{4} = \frac{1}{4} \times \frac{1}{50}\text{s} = \frac{1}{200}\text{s} = 5 \times 10^{-3}\text{s}$$

$I_0 = 10\sqrt{2}$A $= 14.14$ A

60 **(b)**

$$Z = \sqrt{R^2 + X_C^2}\ : I_{rms} = \frac{V_{rms}}{Z} : P = I_{rms}^2 R$$

Where $X_C = \frac{1}{\omega C}$

As ω is increased, X_C will decrease or Z will decrease. Hence I_{rms} or P will increase. Therefore, bulb glows brighter.

Hence the correct option is (b).

61 **(c)**

$I = I_1 \cos \omega t + I_2 \sin \omega t$

$$(I)_{mean}^2 = I_1^2 \overline{\cos^2 \omega t} + I_2^2 \overline{\sin^2 \omega t} + 2I_1 I_2 \overline{\cos \omega t \sin \omega t}$$

$$= I_1^2 \times \frac{1}{2} + I_2^2 \times \frac{1}{2} + 2I_1 I_2 \times 0$$

$$I_{rms} = \sqrt{(I^2)_{mean}} = \sqrt{\frac{I_1^2 + I_2^2}{2}}$$

62 **(d)**

Both V and I are in the same phase. So, let us calculate the time taken by the voltage to change from peak value to rms value. Now, $220 = 220 \sin 100\pi t_1$

or $100\pi t_1 = \frac{\pi}{2}$ or $t_1 = \frac{1}{200}$ s

Again, $\frac{220}{\sqrt{2}} = 220 \sin 100\pi t_2$

or $\frac{1}{\sqrt{2}} = \sin 100\pi t_2$ or $100\pi t_2 = \frac{3\pi}{4}$

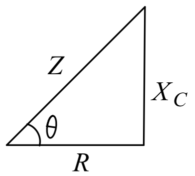
or $t_2 = \frac{3}{400}$ s

Required time $= t_2 - t_1 = \frac{1}{400}$ s $= 2.5 \times 10^{-3}$s

63 **(b)**

$V_C^2 + V_R^2 = V^2$

$50^2 + V_R^2 = 110^2 \Rightarrow V_R = \sqrt{160 \times 60} = 98$ V



Then, $I_V = \frac{\sqrt{160\times 60}}{50}$ $\quad (\therefore R = 50\ \Omega)$

Also, $I_V = \frac{110}{\sqrt{R^2+X_C^2}}$ $\therefore \frac{98}{50} = \frac{110}{\sqrt{50^2+X_C^2}}$

Flux X_C and now using $X_C = \frac{1}{\omega C}$, we get

$C = 104\ \mu$F

64 **(c)**

Since current is leading emf, capacitor must be present in the circuit. Along with capacitor there can be either (i) only resistor or (ii) resistor and inductor if $X_C > X_L$

In both of the above conditions, we can obtain a phase difference of $\pi/4$ with current leading emf

65 **(d)**

As current at any instant in the circuit will be

$I = I_{dc} + I_{ac} = a + b \sin \omega t$

So, $I_{eff} = \left[\frac{\int_0^T I^2 dt}{\int_0^T dt}\right]^{1/2} = \left[\frac{1}{T}\int_0^T (a + b \sin \omega t)^2\ dt\right]^{1/2}$

i.e.,

$I_{eff} = \left[\frac{1}{T}\int_0^T (a^2 + 2ab \sin \omega t + b^2 \sin^2 \omega t)\ dt\right]^{1/2}$

but as $\frac{1}{T}\int_0^T \sin \omega t\ dt = 0$ and $\frac{1}{T}\int_0^T \sin^2 \omega t\ dt = \frac{1}{2}$

so, $I_{eff} = \left[a^2 + \frac{1}{2}b^2\right]^{1/2}$

66 **(d)**

Reactance of the inductor O is given by $X_L = 2\pi f L$. Therefore, rms current through inductor L is I_2

$= \frac{V}{2\pi f L} \propto \frac{1}{f}$where$V$ is the rms of the supply voltage. Reactance of the capacitor C is given by

$X_C = \frac{1}{2\pi\ f\ C}$

Therefore, rms current through the capacitor is

$I_3 = \frac{V}{X_C} = 2\pi f\ CV \propto f$

The total current I_1 is given by $I_1 = I_2 + I_3$

$= \left(\frac{V}{2\pi f L} - 2\pi f CV\right)$

Thus, I_2 is best represented by curve R

I_3 is best represented by curve P

I_1 is best represented by curve Q

67 **(b)**

Root mean square current of the sinusoidal waveform, $I = \frac{I_0}{\sqrt{2}}$

Power output of the heater,

$P = I^2 R = \left(\frac{I_0}{\sqrt{2}}\right)^2 R = \frac{I_0^2 R}{2}$

68 **(c)**

Impedance $Z = \frac{E_v}{I_v}$ or $Z = \frac{200}{2} = 100\ \Omega$

But $Z^2 = R^2 + \left(\frac{1}{\omega C}\right)^2$

or $\left(\frac{1}{\omega C}\right)^2 = Z^2 - R^2 = (100)^2 - (25)^2 = 125 \times 75$

or $X_C = \frac{1}{\omega C} = \sqrt{125 \times 75}\Omega$

69 **(a)**

$R = \frac{125}{12.5} = 10\ \Omega$

$X_L = \omega L = 2\pi f L = \frac{V}{I} = \frac{125}{10} = 12.5$

$\therefore X_L' = 2\pi L \times f' = 0.25 \times 40 = 10\ \Omega$

Impedance of the circuit

$Z = \sqrt{R^2 + X_L^2} = 10/\sqrt{2}\ \Omega$

$\therefore$ Current $= \frac{100}{10\sqrt{2}} = 10/\sqrt{2}$A

70 **(c)**

$i = 3 \sin \omega t + 4 \cos \omega t$

$= 5\left[\frac{3}{5}\sin \omega t + \frac{4}{5}\cos \omega t\right] = 5[\sin(\omega t + \delta)]$

rms value $= \frac{5}{\sqrt{2}}$A

If voltage applied is $V = V_m \sin \omega t$ then I, given by Eq. (i), indicates that it is ahead of V by δ where $0 < \delta < 90$ which indicates that the circuit contains R and C

If we find average value for first half period (0 to $T/2$), then it will be $6/\pi$ A. But for different time interval, it will be different

71 **(a)**

$X_L = L\omega = 5 \times 10^{-3} \times 2000 = 10\ \Omega$

$X_C = \frac{1}{C\omega} = \frac{1}{50 \times 10^{-6} \times 2000} = \frac{100}{10}\Omega = 10\ \Omega$

Since, $X_L = X_C$, therefore

$Z = R = 5.9 + 0.10 + 4 = 10\ \Omega$

$I_v = \frac{E_v}{Z} = \frac{20}{10}\text{A} = 2\text{ A}$

72 **(a)**

Concept based

73 **(b,c,d)**

As $e = -\frac{d\phi}{dt} = -\frac{d}{dt}(at^n) = -a\,n\,t^{n-1}$

For $0 < n < 1, e \neq 0$ and $|e|$ decreases with time.

For $n = 1, e = -a =$ constant

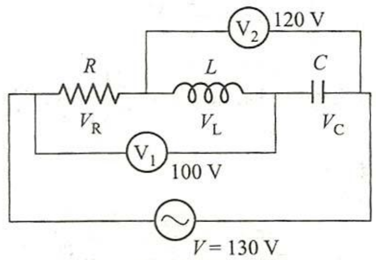
For $n > 1, |e|$ increases with time.

74 **(b,d)**

As soon as edge AC of loop crosses PQ, induced emf will increases from 0 to $B\,a\,v$. Also , the loop will experience a force to the left opposing its entry into the field.

75 **(a,c,d)**

$V_R^2 + V_L^2 = 100^2, |V_C - V_L| = 120$



$130^2 = V_R^2 + (V_C - V_L)^2 \Rightarrow V_R = 50\text{ V}$

$\Rightarrow V_L = \sqrt{100^2 - 50^2} = 50\sqrt{3}\text{V}$

$V_C = 120 + 50\sqrt{3}\text{V}$

$\cos\phi = \frac{V_R}{V} = \frac{50}{130} = \frac{5}{13}$

Since $V_C < V_L$, so circuit is capacitive

76 **(a,c,d)**

$e = 0$, when conductor moves along its length. In (c) and (d), conductor moves at right angle to its length and B is perpendicular to that, therefore, $e = Blv$.

77 **(a,b)**

$(f = 900\text{ Hz}) < (f_{res} = 1000\text{ Hz})$, so $X_C > X_L$, circuit becomes capacitive and current leads emf

At resistance, impedance is minimum.

Not only at resonance, but at all conditions voltage across L and C differs in phase by 180° when connected in series

78 **(a,c)**

$f_{res} = \frac{1}{2\pi\sqrt{LC}} = \frac{1}{2\pi\sqrt{\frac{1}{\pi} \times \frac{1}{\pi} \times 10^{-6}}}$

At resonance, $Z = R$,

So current $I = \frac{V}{Z} = \frac{V}{R}$

When L ad C are in series, voltage across capacitor and inductor is 180° out of phase

79 **(a,b,c)**

$H - I^2\,Rt/4.2$ (Heat produced in a conductor is independent of the nature of current. If the current flowing in a conductor changes its direction, then also heat being produced in it will not change). Hence, (a), (b) and (c) are true

80 **(a,b,c)**

The frequency

$f = \frac{1}{2\pi}\sqrt{\frac{1}{LC}} = \frac{1}{2\pi}\sqrt{\frac{1}{0.6 \times 10 \times 10^{-6}}} = 65\text{ Hz}$

The current at resonance is

$I_o = \frac{200\ V}{5\ \Omega} = 40\text{ A}$

The quantity $V_0 = I_0\sqrt{R^2 + (\omega L)^2}$

$= 40\sqrt{25^2 + (0.6 \times 2\pi \times 65)^2} = 9.8\text{ kV}$

$V_1 = \frac{I_0}{\omega C} = \frac{40 \times 10^5}{2\pi \times 65} = 9.8\text{ kV}$

81 **(a,c,d)**

When plane of coil is initially parallel to B,

θ = 90°.

∴ $When\ \theta = 90°$

$d\phi = n\,AB\cos 180°$

$- n\,AB\cos 90° = -nAB$. When θ $= 180°$

$d\phi = n\,AB\cos 270°$

$- n\,AB\cos 90° =$ zero. When θ $= 360°$

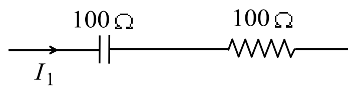
$d\phi = n\,AB\cos 180°$

$- n\,AB\cos 90° =$ zero, and $= d\phi/R$

82 **(a,c)**

$X_L = \omega L = 10 \times 0.5 = 50\Omega$

$X_C = \frac{1}{\omega C} = \frac{1}{100 \times 100 \times 10^{-6}} = 100\Omega$



$Z_1 = 100\sqrt{2}; I_1 = \frac{20}{100\sqrt{2}} = \frac{1}{5\sqrt{2}}$

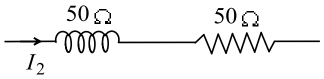
$V\ across\ 100\Omega = \frac{1}{5\sqrt{2}} \times 100 = \frac{20}{\sqrt{2}} \times \frac{\sqrt{2}}{\sqrt{2}} = 10\sqrt{2}$

Phase difference between I_1 and V

$\cos\phi_1 = \frac{R_1}{Z_1} = \frac{100}{100\sqrt{2}}$

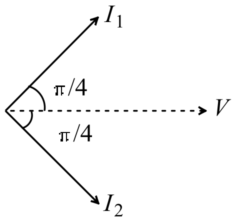
$\phi = \pi/4$

I_1 lead V



$Z_2 = 50\sqrt{2}; I_2 = \frac{20}{50\sqrt{2}} = \frac{2}{5\sqrt{2}}$

$V\ across\ 50\Omega = \frac{2}{50\sqrt{2}} \times 50 = \frac{20}{\sqrt{2}} = 10\sqrt{2}$



$\phi_2 = \pi/4$

I_2 lag V by $\pi/4$

$I = I_1 + I_2$

$I_{\text{Net}} = \sqrt{I_1^2 + I_2^2}$

$I = \sqrt{\frac{4}{25 \times 2} + \frac{1}{25 \times 2}} = \sqrt{\frac{5}{50}} = \frac{1}{\sqrt{10}}$

$I = 0.316$

84 **(b,d)**

Angular frequency, $\omega = \frac{1}{\sqrt{LC}}$. As $L_1C_1 = L_2C_2 = L_3C_3$, therefore, angular frequency of oscillation is same for all the three circuits.

From conservation of mechanical energy,

$\frac{1}{2} L\, i_2^2 = \frac{1}{2} CV^2$

$i_2^2 = \frac{C}{L} V^2$

As V is constant, therefore, $i_0 \propto \sqrt{\frac{C}{L}}$

As $\frac{C}{L}$ is maximum for 3 rd circuit, therefore, maximum current (i_0) is greater for 3 rd circuit.

86 **(b)**

Since, copper consists of a very small ohmic resistance so, inductance coils are made of copper. A large induced current is produced in such an inductance due to change in flux, which offers a pretty opposition to the flow of current.

87 **(a)**

When frequency of alternating current is increasing, the effective resistance of the inductive coil increases. Current $(X_L - \omega L = 2\pi f L)$ in the circuit containing inductor is given by $I = \frac{V}{X_L} = \frac{V}{2\pi f L}$. As inductive resistance of the inductor increases, current in the circuit decreases

88 **(b)**

The mean average value of alternating current (or emf) during half cycle is given by $I_m = 0.636\ I_0$ (or $E_m = 0.636 E_0$)

During the next half cycle, the mean value of ac will be equal in magnitude but opposite in direction

For this reason the average value of ac over a complete cycle is always zero. So the average value is always defined over a half cycle of ac

89 **(d)**

Statement 1 is false because the given relation is true if all voltages are instantaneous

90 **(b)**

The energy stored in the inductor is given by

$V = \frac{1}{2} L i_0^2 = \frac{1}{2} \times 2 \times (10)^2 = 100\text{ J}$

It is obvious that energy stored is directly proportional to its inductance.

91 **(a)**

For the case of DC, the frequency is zero and the net impedance is equal to the resistance.

For the case of AC, the impedance of the AC circuit is given by

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

Where $R =$ resistance, $\omega =$ angular frequency and $L =$ inductance.

92 **(a)**

Resonance in $L - C - R$ series circuit takes place when inductive reactance and capacitive reactance are equal and opposite *ie*,

$X_L = X_C$

Or $\omega_0 L = \omega_0 C$

Or $\omega_0 = \frac{1}{\sqrt{C}}$ or $f_0 = \frac{1}{2\pi\sqrt{LC}}$

In other words we can say that at resonant frequency $\left(f_0 = \frac{1}{2\pi\sqrt{LC}}\right)$ resonance can take place.

93 **(a)**

The capacitive reactance of capacitor is given by

$X_C = \frac{1}{\omega C} = \frac{1}{2\pi f C}$

So this is infinite for dc $(f = 0)$ and has a very small value of ac. Therefore a capacitor blocks dc

94 **(d)**

An ac ammeter is constructed on the basis of heating effect of the electric current. Since heat produced varies as square of current ($H = I^2R$), therefore the division marked on the scale of ac ammeter are not equally spaced

95 **(c)**
Voltage will be added vectorially

96 **(b)**
The average value of alternating emf $E = E_0 \sin \omega t$ over a positive half cycle is

$$E_{\text{av half cycle}} = \frac{2E_0}{\pi} = 0.6369$$

Percentage of $E_{\text{av}} = 0.6369 \times 100 = 63.69\%$

Also rms value of emf is given as

$$E_{\text{rms}} = \frac{E_0}{\sqrt{2}} = 0.7072$$

Percentage $E_{\text{rms}} = 0.7072 \times 100 = 70.72\%$

97 **(a)**
Capacitive reactance $X_C = \frac{1}{\omega C}$. When capacitance (C) increases, the capacitive reactance decreases. Due to decrease in its values, the current in the circuit will increase $\left(I = \frac{E}{\sqrt{R^2+X_C^2}}\right)$ and hence brightness of source (or electric lamp) will also increase

98 **(a)**
From the formula the capacitive reactance is

$$X_C = \frac{1}{\omega C} = \frac{1}{2\pi fC}$$

Where ω represents angular frequency, C for capacitance and f represent the frequency.

The frequency of DC is zero hence capacitive reactance becomes infinity. When the same capacitor is connected with AC, capacitive reactance is not equal to infinity hence capacitor allows AC to pass through it, and offers infinite resistance to DC.

99 **(c)**
The impedance of a capacitor is given by

$$X_C = \frac{1}{2\pi fC}$$

$$\Rightarrow X_C \propto \frac{1}{f}$$

Thus, the impedance of the capacitor decreases with increase in the frequency f of a source.

Current now increase in the capacitor with decrease of impedance or resistance. This is equal to displacement current between the plates of capacitor.

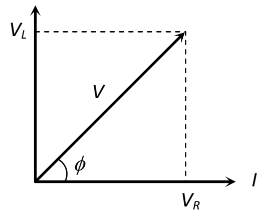
100 **(c)**
It two coil of inductance L_1 and L_2 are joined together, then their mutual inductance is given by

$$M = k\sqrt{L_1L_2}$$

It is clear from the relation, if self-inductance of primary and secondary coil are doubled the mutual inductance of the coils will be doubled.

101 **(a)**
It is because for a given value of voltage, peak value of ac voltage is greater than the dc voltage
For *e.g.*, In case of 220 V ac, $V_0 = 220\sqrt{2} = 311\ V$
$\therefore$ 311 V will cause more harm to the human body than 220 V dc

102 **(b)**
As both the inductive and resistance are joined in series, hence current through both will be same. But in case of resistance, both the current and potential vary simultaneously, hence they are in same phase. In case of an inductance when current is zero, potential difference across it is maximum and when current reaches maximum (at $\omega t = \pi/2$), potential difference across it becomes zero, *i.e.*, potential difference leads the current by $\pi/2$ or current lags behind the potential difference by $\pi/2$. Phase angle in case of LR circuit is given as $\phi = \tan^{-1}\left(\frac{\omega L}{R}\right)$



103 **(a)**
The resultant emf in the $L - C - R$ circuit is given by

$$E = \sqrt{V_R^2 + (V_L - V_C)^2}$$

$E = \sqrt{(8)^2 + (16-10)^2}$

$= \sqrt{64+36}$

$E = 10$ V

104 **(c)**

When ac flows through an inductor, current lags behind the emf by phase of $\pi/2$. Inductive reactance, $X_L = \omega L = \pi.2f.L$, so when frequency increases correspondingly inductive reactance also increases

105 **(b)**

Power dissipated is given by

$$P = E_{\mathrm{rms}}\, I_{\mathrm{rms}} \cos\phi$$

We know that for purely resistance circuit power factor $\cos\phi = \frac{R}{Z} = \frac{R}{R} = 1$

Hence, $P = E_{\mathrm{rms}} \times I_{\mathrm{rms}}$

$= (RI_{\mathrm{rms}}) \times I_{\mathrm{rms}}$

$= R\,(I_{\mathrm{rms}})^2$

$= R\left(\frac{I_0}{\sqrt{2}}\right)^2 = \frac{RI_0^2}{2}$

106 **(b)**

The phase angle for the LCR circuit is given by

$\tan\phi = \frac{X_L - X_C}{R} = \frac{\omega L - 1/\omega C}{R}$

Where X_L, X_C are inductive reactance and capacitive reactance respectively. When $X_L > X_C$ then $\tan\phi$ is positive, $i.e.$, ϕ is positive (between 0 and $\pi/2$). Hence $e$mf leads the current

107 **(c)**

$P_{\mathrm{av}} = \frac{VI\cos\phi}{2}$

At resonance condition, $\cos\phi = 1$

But $Z = R$

Which is minimum

108 **(b)**

Like direct current, alternating current also produces magnetic field. But the magnitude and direction of the field goes on changing continuously with time

109 **(b)**

We can use a capacitor of suitable capacitance as a choke coil because average power consumed per cycle in an ideal capacitor is zero. Therefore, like a choke coil, a condenser can reduce ac without power dissipation

110 **(a)**

The resultant emf in the $L - C - R$ circuit is given by

$E = \sqrt{V_R^2 + (V_L - V_C)^2}$

$E = \sqrt{(8)^2 + (16-10)^2}$

$E = \sqrt{64+36} \Rightarrow E = 10\mathrm{V}$

111 **(b)**

Average power consumed by capacitor or inductor is zero

112 **(b)**

From the relation

$i = \frac{E-e}{R_a}$

When the motor is started $e = 0$

Hence, Eq (i) becomes $i_{\mathrm{start}} = \frac{E}{R_a}$

It is obvious that current is maximum when the motor has just started.

113 **(c)**

Both ac and dc produce heat, which is proportional to the square of current. The reversal of direction of current in ac is immaterial as far as production of heat is concerned

114 **(a)**

The resultant emf in the L-C-R circuit is given by

$E = \sqrt{V_R^2 + (V_L - V_C)^2}$

$E = \sqrt{(8)^2 + (16-10)^2}$

$= \sqrt{64+36}$

$E = 10$ V

115 **(d)**

The maximum value of rmscurrent $= \frac{\varepsilon_{\mathrm{rms}}}{Z} = \frac{\varepsilon_{\mathrm{rms}}}{R}$.

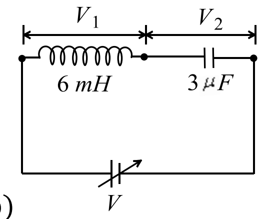
It does not depend upon ω

116 **(d)**

Before making current in a coil, the current is zero and before breaking the current is maximum. In other words, it is constant in both the cases. Obviously, on making or breaking the current in a circuit, the current starts changing. The changing current produces changing magnetic field, which in turn produces induced current in the neighbouring coil of the circuit.

117 **(a)**

As per given conditions, there will be no steady state in circuit 'p', so it should not be considered in options of 'C'



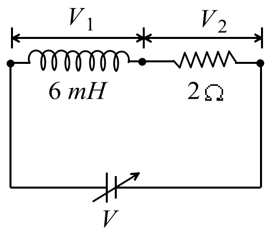
(p)

As I is steady state current

$V_1 = 0; I = 0$

Hence, $V_2 = V$

So, of $p \Rightarrow C$



(q)

In the steady state;

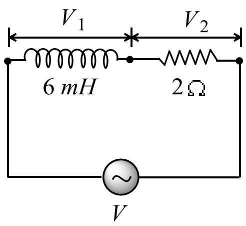
$V_1 = 0$ as $\frac{dI}{dt} = 0$

$\therefore V_2 = V = IR$ or

$V_2 \propto I$

and $V_2 > V_1$

So, of $q \Rightarrow B, C, D$



(r)

Inductive reactance

$X_L = \omega L$

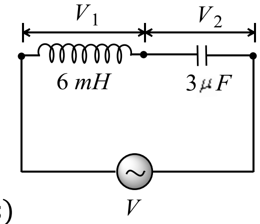
$X_L = 6\pi \times 10^{-1}\ \Omega$ and resistance

$= R = 2\Omega$

So, $V_1 = IX_L$ and $V_2 = IR$

Hence, $V_2 > V_1$

So, of $r \Rightarrow$ A, B, D



(s)

Here, $V_1 = IX_L$, where $X_L = 6\pi \times 10^{-1}\Omega$

Also, $V_2 = IX_C$, where

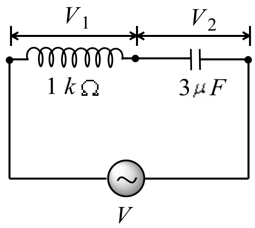
$X_C = \frac{10^4}{3\pi}$

So, $V_2 > V_1$

$V_1 \propto I$

$V_2 \propto I$

So, of s ⇒ A, B, D



(t)

Here, $V_1 = IR$, where

$R = 1000\Omega$,

$X_C = \frac{10^4}{3\pi}\Omega$

$V_2 = IX_C$,

So, $V_2 > V_1$ and $V_1 \propto I; V_2 \propto I$

So, of t ⇒ A, B, D

Note: for circuit 'p'

$V - \frac{Ldi}{dt} - \frac{q}{C} = 0$ or $CV = CL\frac{di}{dt} + q$ or $0 = LC\frac{d^2i}{dt^2} + \frac{dq}{dt}$

or $\frac{d^2i}{dt^2} = -\frac{1}{LC}\frac{dq}{dt}$

So, $i = i_0 \sin\left(\frac{1}{\sqrt{LC}}t + \phi_0\right)$

As per given conditions, there will be no steady state in circuit 'p'. So it should not be considered in options of 'C'

∴ (A) → r,s,t; (B) → q,r,s,t; (C) → p,q; (D) → q,r,s,t

118 **(b)**

$X_L = \omega L = 2\pi \times 50 \times \frac{100}{\pi} \times 10^{-3} = 10\ \Omega$

$X_C = \frac{1}{\omega C} = \frac{1}{2\pi \times 50 \times \frac{100}{\pi} \times 10^{-6}}\Omega = 100\ \Omega$

Impedence of the circuit is

$Z = \sqrt{R^2 + (X_L - X_C)^2} = 134.5\ \Omega$

rms value of the current through the circuit is

$I_{rms} = \frac{220}{Z} = 1.63$ A

rms value of voltage drop across the capacitor is

$V_{Cv} = I_{rms}X_C = 163$ V

Average power dissipated in the resistor is

$P_{av} = I_{rms}^2 R = 1.63^2 \times 100 = 265.7$ W
Average power dissipated in inductor and capacitor would be zero

119 **(d)**

i. $\tan\phi = \frac{1/\omega C}{R} = 1 \Rightarrow \phi = \frac{\pi}{4}$, current leads source voltage because reactance is capacitive

ii. Pure inductive circuit $\phi = \frac{\pi}{2}$, current lags behind source voltage because reactance is inductive

iii. as $R = 0, \tan\phi = \infty (X_C > X_L)$

$\phi = \frac{\omega C}{R} = 1 \Rightarrow \phi = \frac{\pi}{4}$, current lags behind source voltage because reactance is inductive

120 **(c)**

i. For sinusoidal curve $i_{rms} = \frac{i_0}{\sqrt{2}}$ and average current for positive half cycle is $\frac{2i_0}{\pi}$

ii. Let us find the average current (or rms current) for $t = 0$ to $T/4$. Then it will also be average current (or rms current) for half cycle, i.e., from $t = 0$ to $T/2$

for $t = 0$ to $T/4$: $i = \frac{4i_0}{T} t$

then $i_{av} = \frac{\int_0^{T/4} i dt}{T/4} = \frac{\int_0^{T/4} \frac{4i_0}{T} t dt}{T/4} = \frac{i_0}{2}$

and $i_{av} = \sqrt{\frac{\int_0^{T/4} i^2 dt}{T/4}} = \sqrt{\frac{64 i_0^2}{T^3} \int_0^{T/4} t^2 dt} = \frac{i_0}{\sqrt{3}}$

Full cycle average current is zero

iii. For positive half cycle, average current

$$= \frac{\int i dt}{\int dt} = \frac{i_0(T/2)}{T/2} = i_0$$

Full cycle average current is zero

iv. Average current for positive half cycle is i_0

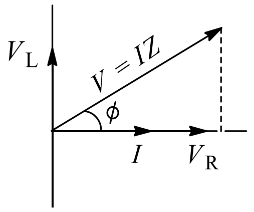
For full cycle, average current

$$= \frac{\int i dt}{\int dt} = \frac{i_0(T/2) + 0}{T} = \frac{i_0}{2}$$

and $i_{rms} = \sqrt{\frac{\int_0^{T/2} i_0^2 dt}{T}} = \frac{i_0}{\sqrt{2}}$

121 **(a)**

i. For LR series circuit, the phasor diagram is as shown below



I lags voltage by an angle $\phi (< \pi/2)$

I lags V_L by an angle $\pi/2$

ii. For RC series ac circuit, I leads V by an angle less than $\pi/2$

iii. Depending on the value of L, C and R, circuit would be either capacitive, inductive or purely resistive. All possibilities can be there

iv. In purely resistive circuit, current and voltage are in same phase

122 **(a)**

i. $L = \frac{\mu N^2 A}{\ell}$

So, L depends upon shape, size $(1, A)$ and medium (μ) inserted

ii. $C = \frac{\varepsilon A}{d}$

So, C depends upon shape, size (A, d) and medium (e) inserted

iii. $Z = \sqrt{R^2 + x_L^2}$

When $x_L = \omega L, \omega$ depends upon the external voltage source. So, Z depends upon all the factors in column II

iv.$X_C = \frac{1}{\omega C}$ (independent of resistivity)

123 **(c)**

Here, $i_P = ? E_P = 220\ V, E_s = 44\ V, R_s = 880\ \Omega$

$i_s = \frac{E_s}{R_s} = \frac{44}{880} = \frac{1}{20}$ A

As $E_P i_P = E_s i_s$

$\therefore\ i_P = \frac{E_s i_s}{E_P} = \frac{44}{220} \times \frac{1}{20} = 0.01$ A

124 **(c)**

$A = \pi r^2 = \pi(10.5 \times 10^{-2})^2$ sqm, $B = 10^{-4}$ T

$\theta = 90° - 30° = 60°$

$\phi = BA\cos\theta$

$= 10^{-4} \times \pi(10.5 \times 10^{-2})^2 \cos 60°$

$\phi = 1.73 \times 10^{-6}$ Wb

125 **(a)**

The peak value $V_0 = 220\sqrt{2} = 311$ V

$$V_{rms} = \frac{V_0}{\sqrt{2}} = \frac{220\sqrt{2}}{\sqrt{2}} = 200 \text{ V}$$

126 **(a)**

For finding the average value, we would find the total area of the trapezium and divide it by π (as shown in fig)

Area = $2 \times \Delta OAE$ +rectangle $ABDE$

$= 2 \times (1/2) \times F_m\alpha + (\pi - 2\alpha)F_m = (\pi - \alpha)F_m$

Average value = $(\pi - \alpha)F_m/\pi$

rms value : From similar triangles, we get

$\frac{y}{\theta} = \frac{F_m}{\alpha}$ or, $y^2 = \frac{F_m^2}{\alpha^2}\theta^2$

This gives the equation of the signal over the two triangles OAE and DBC. The signal remains constant over the angle α to $(\pi - \alpha)$, i.e., over an angular distance of $(\pi - \alpha) - \alpha = (\pi - 2\alpha)$

Sum of the square

$$= \frac{2F_m^2}{\alpha^2}\int_0^{\alpha}\theta^2 d\theta + F_m^2(\pi - 2\alpha) = F_m^2\left(\pi - \frac{4\alpha}{3}\right)$$

The mean value of the squares

$$= \frac{1}{\pi}F_m^2\left(\pi - \frac{4\alpha}{3}\right) = F_m^2\left(1 - \frac{4\alpha}{3\pi}\right)$$

rms values $= F_m\sqrt{\left(1 - \frac{4\alpha}{3\pi}\right)}$

127 **(d)**

Equation of line AB is given by $y = 10 + \left(\frac{10}{T}\right)t$

$$y_{av} = \frac{1}{T}\int_0^T y\,dt = \frac{1}{T}\int_0^T \left(10 + \frac{10}{T}t\right)dt$$

$$= \frac{1}{T}\left|10t + \frac{5t^2}{T}\right|_0^T = 15$$

128 **(b)**

Here,

$X_L = \omega L = 2\pi f L = 2\pi \times 50 \times 0.21 = 21\pi\Omega$

So, $Z = \sqrt{R^2 + X_L^2} = \sqrt{12^2 + (21\pi)^2}$

$= \sqrt{12^2 + (21 \times 22/7)^2} = \sqrt{4500} = 30\sqrt{5}\Omega$

So, (a)$I = \frac{V}{Z} = \frac{220}{30\sqrt{5}} = \frac{22}{3\sqrt{5}}$ A

and (b) $\phi = \tan^{-1}\left(\frac{X_L}{R}\right) = \tan^{-1}\left(\frac{21\pi}{12}\right) =$

$\tan -17\pi 4$

i.e., the current will lag the lag the applied voltage

129 **(a)**

When dc is applied, $R = \frac{V}{I} = \frac{100}{1} = 100\ \Omega$

and when ac of 50 Hz is applied

$I = \frac{V}{Z}$ i.e., $Z = \frac{V}{I} = \frac{100}{0.5} = 200\ \Omega$

but, $Z = \sqrt{R^2 + \omega^2 L^2}$

i.e., $\omega^2 L^2 = Z^2 - R^2$

i.e., $(2\pi f L)^2 = 200^2 - 100^2 = 3 \times 10^4$ (as $\omega = 2\pi f$)

So, $L = \frac{\sqrt{3}\times 10^2}{2\pi \times 50} = \frac{\sqrt{3}}{\pi}$H $= 0.55$ H

130 **(a)**

As this circuit is a series LCR circuit, current will be maximum at resonance, i.e.,

$$\omega = \frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{4.9 \times 10^{-3})(10^{-6})}} = \frac{10^5}{7}\text{rad/s}$$

with, $I = \frac{V}{R} = \frac{10}{(32+68)} = \frac{1}{10}$A

So, the impedance, $Z_P = [R_1^2 + (1/\omega C)^2]^{1/2} = \sqrt{5924} = 77\ \Omega$

131 **(b)**

At resonance as $X = 0, I = \frac{V}{R} = \frac{60}{120} = \frac{1}{2}$A

As $V_L = LX_L = I\omega L, L = \frac{V_L}{I\omega}$

So, $L = \frac{40}{(1/2)\times 4 \times 10^5} = 0.2$ mH

$$\omega = \frac{1}{\sqrt{LC}} \Rightarrow C = \frac{1}{L\omega^2}$$

i.e., $C = \frac{1}{0.2\times 10^{-3}\times(4\times 10^5)^2} = \frac{1}{32}$μF

Now in case of series LCR circuit,

$$\tan\phi = \frac{X_L - X_C}{R}$$

So current will lag the applied voltage by 45° if,

$$\tan 45° = \frac{\omega L - \frac{1}{\omega C}}{R}$$

$$1 \times 120 = \omega \times 2 \times 10^{-4} - \frac{1}{\omega(1/32)\times 10^{-6}}$$

$$\omega^2 - 6\times 10^5\omega - 16 \times 10^{10} = 0$$

i.e., $\omega = \frac{6\times 10^5 \pm\sqrt{(6\times 10^5)^2 + 64\times 10^{10}}}{2}$

i.e., $\omega = \frac{6\times 10^5 + 10\times 10^5}{2} = 8 \times 10^5$rad/s

132 **(c)**

When dc is applied, $I = \frac{V}{R}$, i.e., $R = \frac{12}{4} = 3\ \Omega$

and when ac is applied, $Z = \left(\frac{V}{I}\right) = \left(\frac{12}{2.4}\right) = 5\ \Omega$

$R^2 + X_L^2 = 5^2$(as $Z = \sqrt{R^2 + X_L^2}$)

So, $X_L^2 = 5^2 - R^2 = 5^2 - 3^2 = 4^2$, i.e., $X_L = 4\ \Omega$

But as, $X_L = \omega L, L = \frac{X_L}{\omega} = \frac{4}{50} = 0.08$ H

133 **(a)**

$$Z^2 = (X_C - X_L)^2 + R^2 = (31.85 - 6.28)^2 + (50)^2 = 3154$$

$$P = \left(\frac{E_{rms}^2}{Z^2}\right)R = \frac{(10/\sqrt{2})^2}{3154} \times 50 = 0.8\text{ W}$$

Heat produced in 20 min $= (0.8)(20 \times 60) = 960$ J

$X_C - X_L = 31.85 - 2(6.28) = 19.29$

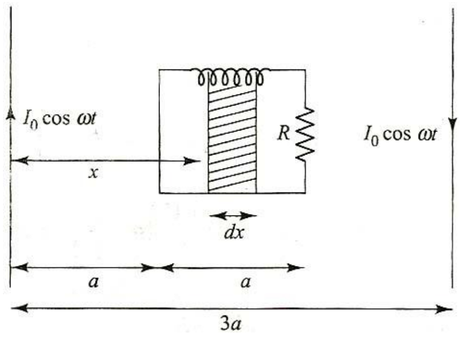
$$I_m = \frac{10}{19.29} = 0.52$$

Hence, $I = 0.52\sin(314t + \pi/2) = 0.52\cos 314t$

134 **(a)**

$d\phi = BdA$

$$d\phi = \left[\frac{\mu_0 I}{2\pi x} + \frac{\mu_0 I}{2\pi(3a - x)}\right]adx$$



$$\phi = \frac{\mu_0 I}{2\pi}\left[\int_a^{2a}\frac{dx}{x} + \int_a^{2a}\frac{dx}{(3a - x)}\right]a;\ \phi = \frac{\mu_0 I a}{\pi}\text{In } 2$$

Magnitude of emf in this circuit:

$$\varepsilon = \left|\frac{d\phi}{dt}\right| = \frac{\mu_0 a(\text{In } 2)}{\pi}\left|\frac{dI}{dt}\right|$$

$$\varepsilon = \frac{\mu_0 a \text{ In } 2}{\pi} I_0 \omega \sin \omega t$$

ac current, $I = \frac{\mu_0 a \text{ In } 2 I_0 \omega}{\pi\sqrt{R^2+\omega^2 L^2}} \sin(\omega t - \phi)$

135 **(c)**

Total charge stored in L-C circuit $= CV$

Thus, $\frac{1}{2}LI^2 + \frac{Q^2}{2C} = E$

'E' is constant

Hence, $\frac{1}{2}L(2I).\frac{dI}{dt} + \frac{1}{2C}.2Q.\left(\frac{dQ}{dt}\right) = 0$

Hence, $L\frac{dI}{dt} = -\frac{Q}{C}$ $\quad \left[\because I = \frac{dQ}{dt}\right]$

$$Q = -LC\frac{d^2Q}{dt^2}$$

136 **(5)**

Net current : $I = 3 + 4\sqrt{2}\sin \omega t$

Now find $I_v = \sqrt{\frac{\int_0^T (3+4\sqrt{2}\sin\omega t)^2 dt}{T}} = 5$ A

137 **(0)**

$$< i > = \frac{\int_{\pi/2\omega}^{3\pi/2\omega} I_m \sin \omega t \, dt}{\frac{3\pi}{2\omega} - \frac{\pi}{2\omega}} = \frac{I_m\left(-\frac{\cos\omega t}{\omega}\right)_{\pi/2\omega}^{3\pi/2\omega}}{\frac{\pi}{\omega}}$$

$$= 0$$

138 **(4, 1)**

In such cases it is difficult to develop a single equation. Hence, it is usual to consider two equations, one applicable from 0 to 1 ms and another from 1 to 2 ms

For t lying between 0 and 1 ms, $V_1 = 4$. For t lying between 1 and 2 ms, $V_2 = -4t + 4$

i. $V_{\text{rms}} = \sqrt{\frac{1}{2}\left(\int_0^1 V_1^2 dt + \int_1^2 V_2^2 \, dt\right)}$

$$V_{\text{rms}}^2 = \frac{1}{2}\left[\int_0^1 4^2 dt + \int_1^2 (-4t+4)^2 \, dt\right]$$

$$= \frac{1}{2}\left[|16t|_0^1 + \left|\frac{16t^3}{3}\right|_1^2 + |16t|_1^2 - \left|\frac{32t^2}{2}\right|_1^2\right] = \frac{32}{3}$$

$$V_{\text{rms}} = \sqrt{\frac{32}{3}} = 4\sqrt{\frac{2}{3}}\text{V, Hence } N = 4$$

ii.

$V_{\text{av}} = \frac{1}{2}\left[\int_0^1 V_1 dt + \int_1^2 V_2 \, dt\right] =$

$\frac{1}{2}\left[\int_0^1 4dt + \int_1^2 (-4t+4)\, dt\right]$

$$= \frac{1}{2}\left[|4t|_0^1 + \left|-\frac{4t^2}{2} + 4t\right|_1^2\right] = 1 \text{ V}$$

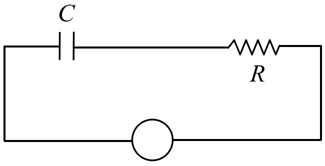
139 **(5)**

Form the $i - t$ graph, area from $t = 0$ to $t = 2$ s

$\frac{1}{2} \times 2 \times 10 = 10$ A s

$\therefore$ Average current $= \frac{10}{2} = 5$ A

140 **(4)**



$\omega = 500 \, rad/s$

$$Z = \sqrt{\left(\frac{1}{\omega C}\right)^2 + R^2} = R\sqrt{1.25}$$

$$\left(\frac{1}{\omega C}\right)^2 + R^2 = R^2(1.25)$$

$$\left(\frac{1}{\omega C}\right)^2 + R^2 = R^2 + \frac{R^2}{4}$$

$$\Rightarrow \frac{1}{\omega C} = \frac{R}{2}$$

$$CR = \frac{2}{\omega} = \frac{2}{500} sec$$

$$= \frac{2}{500} \times 10^3 ms = \frac{2 \times 1000}{500} ms = 4 \, ms$$