SINGLE CORRECT TYPE QUESTIONS

Faraday's law & motional emf.

1. A square of side 2 meters lies in the *x-y* plane in a region, where the magnetic field is given by $\vec{B} = B_0\left(2\hat{i} + 3\hat{j} + 4\hat{k}\right)T$, where B_o is constant. The magnitude of flux passing through the square is:-

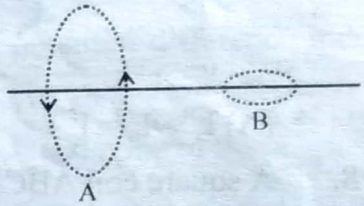
(A) $8B_o$ Wb. (B) $12B_o$ Wb. (C) $16B_o$ Wb. (D) $\sqrt{4\times 29B_0 Wb}$

2. **Statement-1 :** When a magnet is made to fall freely through a closed coil, its acceleration is always less than acceleration due to gravity.

Statement-2 : Current induced in the coil opposes the motion of the magnet, as per Lenz's law.

(A) Statement-1 is true, Statement-2 is true ; Statement-2 is a correct explanation for Statement-1
(B) Statement-1 is true, Statement-2 is true, Statement-2 is NOT a correct explanation for Statement-1
(C) Statement-1 is True, Statement-2 is False
(D) Statement-1 is False, Statement-2 is True

3. In the given figure the centre of a small conducting circular loop B lies on the axis of bigger circular loop A and their axis are mutually perpendicular. An anticlockwise (when viewed from the side of B) current in the loop A start increasing then :-



(A) current induced in the loop B is in clockwise direction (when viewed from above the B)
(B) current induced in the loop B is in anti-clockwise direction (when viewed from above the B)
(C) current must induced in the loop B but its direction can not be predicted
(D) no current is induced in the loop B

4. A vertical bar magnet is dropped from position on the axis of a fixed metallic coil as shown in fig - I. In fig.II the magnet is fixed and horizontal coil is dropped. The acceleration of the magnet and coil are a_1 and a_2 respectively then :-

Fig. (I)

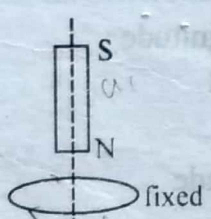
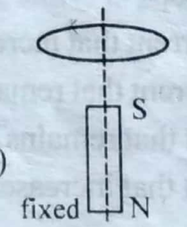


Fig. (II)

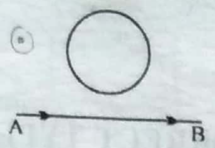


(A) $a_1 > g$, $a_2 > g$ (B) $a_1 > g$, $a_2 < g$ (C) $a_1 < g$, $a_2 < g$ (D) $a_1 < g$, $a_2 > g$

5. Two identical coaxial circular loops carry a current *i* each circulating in the same direction. If the loops approach each other

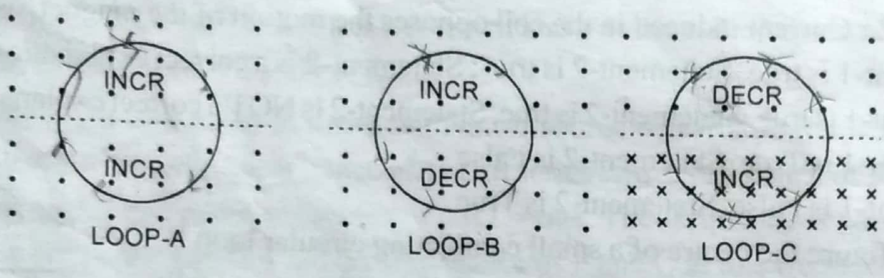
(A) the current in each will decrease
(B) the current in each will increase
(C) the current in each will remain the same
(D) the current in one will increase and in other will decrease

6. In the arrangement shown in given figure current from A to B is increasing in magnitude. Induced current in the loop will :-



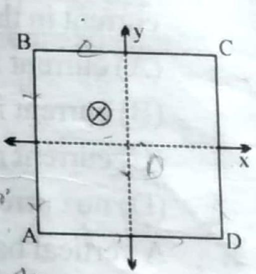
(A) have clockwise direction
(B) have anticlockwise direction
(C) be zero
(D) oscillate between clockwise and anticlockwise

7. Three identical conducting circular loops are placed in uniform magnetic fields. Inside each loop, there are two magnetic field regions, separated by dashed line that coincides with a diameter, as shown. Magnetic fields may either be increasing (marked as INCR) or decreasing (marked as DECR) in magnitude at the same rates. If I_A, I_B and I_C are the magnitudes of the induced currents in the loops A, B and C respectively then choose the **CORRECT** relation :-



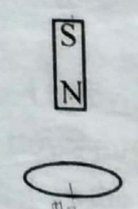
(A) $I_A > I_B = I_C$
(B) $I_A = I_C > I_B$
(C) $I_A = I_B = I_C$
(D) $I_C > I_A > I_B$

8. A square coil ABCD is placed in x-y plane with its centre at origin. A long straight wire, passing through origin, carries a current in negative z-direction. Current in this wire increases with time. The induced current in the coil is :



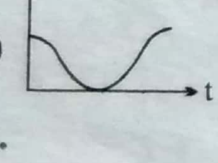
(A) clockwise
(B) anticlockwise
(C) zero
(D) alternating

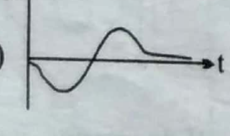
9. A short circuited coil is kept on the ground and a magnet is dropped on it as shown. The coil shows (when viewed from top)



(A) anticlockwise current that increases in magnitude
(B) anticlockwise current that remains constant
(C) clockwise current that remains constant
(D) clockwise current that increases in magnitude

10. The variation of induced emf (ε) with time (t) in a coil if a short bar magnet is moved along its axis with a constant velocity is best represented as **[JEE 2004(Scr)]**

(A)


(B)


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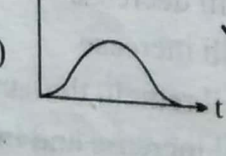
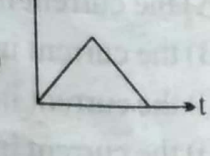
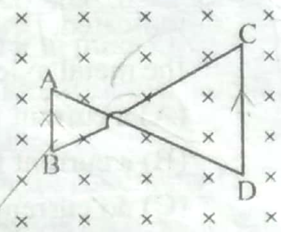


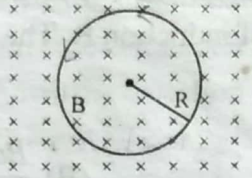
(D)


11. A conducting wire frame is placed in a magnetic field which is directed into the paper. The magnetic field is increasing at a constant rate. The directions of induced currents in wires AB and CD are



(A) B to A and D to C
(B) A to B and C to D
(C) A to B and D to C
(D) B to A and C to D

12. A conducting loop of radius R is present in a uniform magnetic field B perpendicular to the plane of the ring. If radius R varies as a function of time 't', as $R = R_0 + t$. The e.m.f induced in the loop is



(A) $2\pi(R_0 + t)B$ clockwise
(B) $\pi(R_0 + t)B$ clockwise
(C) $2\pi(R_0 + t)B$ anticlockwise
(D) zero

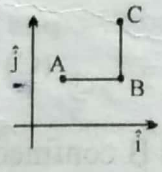
13. A thin wire of length 2m is perpendicular to the xy plane. It is moved with velocity $\vec{v} = (2\hat{i} + 3\hat{j} + \hat{k})\ m/s$ through a region of magnetic induction $\vec{B} = (\hat{i} + 2\hat{j})\ Wb/m^2$. Then potential difference induced between the ends of the wire :

(A) 2 volts
(B) 4 volts
(C) 0 volts
(D) none of these

14. A square loop of side a and resistance R is moved in the region of uniform magnetic field B (loop remaining completely inside field) ,with a velocity v through a distance x . The work done is :

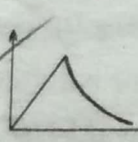
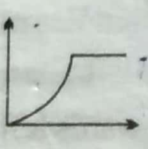
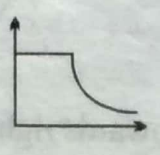
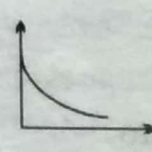
(A) $\frac{B\ell^2 vx}{R}$
(B) $\frac{2B^2\ell^2 vx}{R}$
(C) $\frac{4B^2\ell^2 vx}{R}$
(D) 0

15. There is a uniform magnetic field B normal to the xy plane. A conductor ABC has length AB = l_1, parallel to the x-axis, and length BC = l_2, parallel to the y-axis. ABC moves in the xy plane with velocity $v_x\hat{i} + v_y\hat{j}$. The potential difference between A and C is proportional to :-

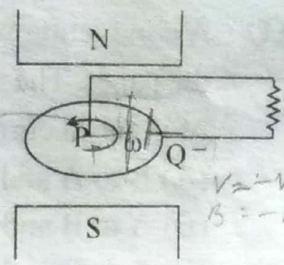


(A) $v_x l_1 + v_y l_2$
(B) $v_x l_2 + v_y l_1$
(C) $v_x l_2 - v_y l_1$
(D) $v_x l_1 - v_y l_2$

16. A uniform but time variant magnetic field exists in a cylindrical region directed along the axis of cylinder of radius R. The graph of induced electric field at a given time v/s. r is (r = distance from axis)

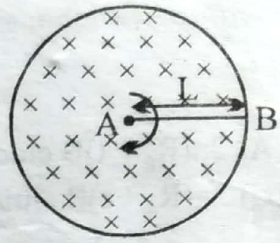
(A) 
(B) 
(C) 
(D) 

17. A metal disc rotates freely, between the poles of a magnet in the direction indicated. Brushes P and Q make contact with the edge of the disc and the metal axle. What current, if any, flows through R?



(A) a current from P to Q
(B) a current from Q to P
(C) no current, because the emf in the disc is opposed by the back emf
(D) no current, because the emf induced in one side of the disc is opposed by the emf induced in the other side.
(E) no current, because no radial emf is induced in the disc

18. A copper rod AB of length L, pivoted at one end A, rotates at constant angular velocity ω, at right angles to a uniform magnetic field of induction B. The e.m.f developed between the mid point C of the rod and end B is:-



(A) $\frac{B\omega L^2}{4}$ (B) $\frac{B\omega L^2}{2}$

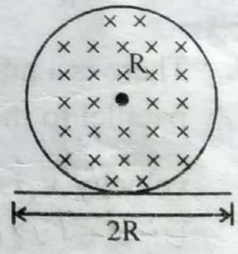
(C) $\frac{3B\omega L^2}{4}$ (D) $\frac{3B\omega L^2}{8}$

19. The e.m.f. induced in a coil of wire, which is rotating in a magnetic field, does not depend on
(A) the angular speed of rotation (B) the area of the coil
(C) the number of turns on the coil (D) the resistance of the coil

Induced electric field

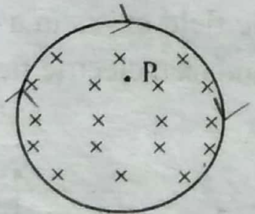
20. A ring of resistance 10Ω, radius 10cm and 100 turns is rotated at a rate 100 revolutions per second about its diameter is perpendicular to a uniform magnetic field of induction 10mT. The amplitude of the current in the loop will be nearly (Take : $\pi^2 = 10$)
(A) 200A (B) 2A (C) 0.002A (D) none of these

21. A uniform but time varying magnetic field is present in a circular region of radius R. The magnetic field is perpendicular and into the plane of the loop and the magnitude of field is increasing at a constant rate α. There is a straight conducting rod of length 2R placed as shown in figure. The magnitude of induced emf across the rod is



(A) $\pi R^2\alpha$ (B) $\frac{\pi R^2\alpha}{2}$ (C) $\frac{R^2\alpha}{\sqrt{2}}$ (D) $\frac{\pi R^2\alpha}{4}$

22. Figure shows a uniform magnetic field B confined to a cylindrical volume and is increasing at a constant rate. The instantaneous acceleration experienced by an electron placed at P is



(A) zero (B) towards right (C) towards left (D) upwards

23. **Statement–1 :** For a charged particle moving from point P to point Q the net work done by an induced electric field on the particle is independent of the path connecting point P to point Q.

Statement–2 : The net work done by a conservative force on an object moving along closed loop is zero.

(A) Statement-1 is true, statement-2 is true and statement-2 is correct explanation for statement-1.

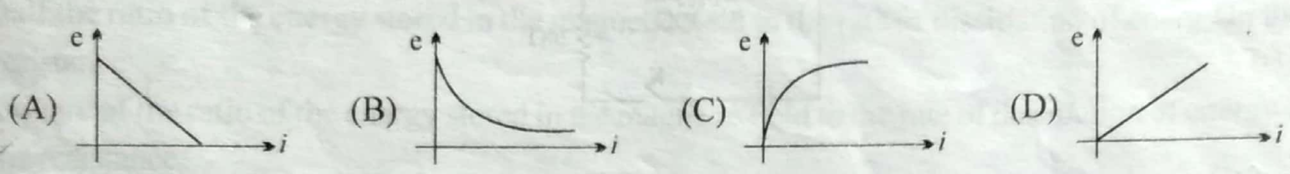
(B) Statement-1 is true, statement-2 is true and statement-2 is NOT the correct explanation for statement-1

(C) Statement-1 is true, statement-2 is false.

(D) Statement-1 is false, statement-2 is true.

Inductance

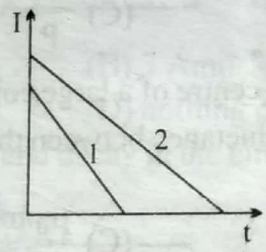
24. In an L-R circuit connected to a battery of constant e.m.f. E switch S is closed at time t = 0. If e denotes the magnitude of induced e.m.f. across inductor and *i* the current in the circuit at any time t. Then which of the following graphs shows the variation of e with *i* ?



25. A current of 2A is increasing at a rate of 4 A/s through a coil of inductance 2H. The energy stored in the inductor per unit time is :-

(A) 2 J/s (B) 1 J/s (C) 16 J/s (D) 4 J/s

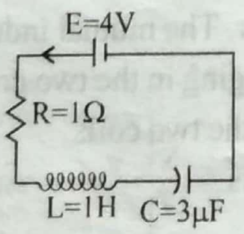
26. Two identical inductance carry currents that vary with time according to linear laws (as shown in figure). In which of two inductance is the self induction emf greater?



(A) 1 (B) 2

(C) same (D) data are insufficient to decide

27. The current in the given circuit is increasing with a rate a = 4 amp/s. The charge on the capacitor at an instant when the current in the circuit is 2 amp will be :

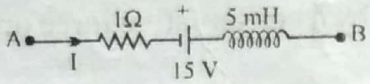


(A) 4μC (B) 5μC (C) 6μC (D) none of these

28. A long solenoid of N turns has a self inductance L and area of cross section A. When a current i flows through the solenoid, the magnetic field inside it has magnitude B. The current i is equal to:

(A) BAN/L (B) BANL (C) BN/AL (D) B/ANL

29. The network shown in the figure is part of a complete circuit. If at a certain instant, the current I is 5A and it is decreasing at a rate of 10^3 As^{-1} then $V_B - V_A$ equals

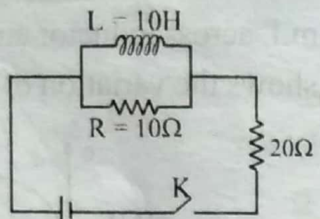


(A) 20 V (B) 15 V (C) 10 V (D) 5 V

30. In **Problem 29**, if I is reversed in direction, then $V_B - V_A$ equals

(A) 5 V (B) 10 V (C) 15 V (D) 20 V

31. Two resistors of 10Ω and 20Ω and an ideal inductor of 10H are connected to a 2V battery as shown. The key K is shorted at time $t = 0$. Find the initial ($t = 0$) and final ($t \to \infty$) currents through battery.



(A) $\frac{1}{15}A, \frac{1}{10}A$ (B) $\frac{1}{10}A, \frac{1}{15}A$ (C) $\frac{2}{15}A, \frac{1}{10}A$ (D) $\frac{1}{15}A, \frac{2}{25}A$

32. An inductor coil stores U energy when i current is passed through it and dissipates energy at the rate of P. The time constant of the circuit, when this coil is connected across a battery of zero internal resistance is :-

(A) $\frac{4U}{P}$ (B) $\frac{U}{P}$ (C) $\frac{2U}{P}$ (D) $\frac{2P}{U}$

33. A small coil of radius r is placed at the centre of a large coil of radius R, where R >> r. The coils are coplanar. The coefficient of mutual inductance between the coils is :-

(A) $\frac{\mu_0 \pi r}{2R}$ (B) $\frac{\mu_0 \pi r^2}{2R}$ (C) $\frac{\mu_0 \pi r^2}{2R^2}$ (D) $\frac{\mu_0 \pi r}{2R^2}$

34. A long straight wire is placed along the axis of a circular ring of radius R. The mutual inductance of this system is :-

(A) $\frac{\mu_0 R}{2}$ (B) $\frac{\mu_0 \pi R}{2}$ (C) $\frac{\mu_0}{2}$ (D) 0

35. Two coils are placed close to each other. The mutual inductance of the pair of coils depends upon-

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(A) the rates at which currents are changing in the two coils

(B) relative position and orientation of the two coils

(C) the materials of the wires of the coils

(D) the currents in the two coils

36. A small square loop of wire of side l is placed inside a large square loop of wire of side $L (L >> l)$. The loop are coplanar & their centres coincide. The mutual inductance of the system is proportional to :

(A) $\frac{\ell}{L}$ (B) $\frac{\ell^2}{L}$ (C) $\frac{L}{\ell}$ (D) $\frac{L^2}{\ell}$

37. L, C and R represent physical quantities inductance, capacitance and resistance. The combination which has the dimensions of frequency is

(A) $\frac{1}{RC}$ and $\frac{R}{L}$ (B) $\frac{1}{\sqrt{RC}}$ and $\sqrt{\frac{R}{L}}$ (C) $\sqrt{LC}$ (D) $\frac{C}{L}$

38. A coil of inductance 5H is joined to a cell of emf 6V through a resistance 10Ω at time t = 0. The emf across the coil at time t = $ln\sqrt{2}$ s is:

(A) 3V (B) 1.5 V (C) 0.75 V (D) 4.5 V

39. For L-R circuit, the time constant is equal to

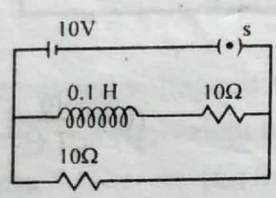
(A) twice the ratio of the energy stored in the magnetic field to the rate of dissipation of energy in the resistance

(B) ratio of the energy stored in the magnetic field to the rate of dissipation of energy in the resistance

(C) half the ratio of the energy stored in the magnetic field to the rate of dissipation of energy in the resistance

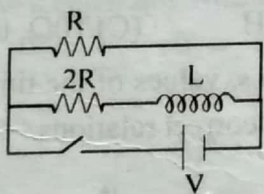
(D) square of the ratio of the energy stored in the magnetic field to the rate of dissipation of energy in the resistance

40. In the adjoining circuit, initially the switch S is open. The switch 'S' is closed at t = 0. The difference between the maximum and minimum current that can flow in the circuit is



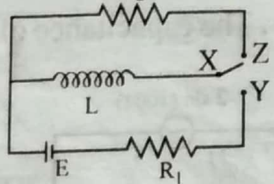
(A) 2 Amp (B) 3 Amp
(C) 1 Amp (D) nothing can be concluded

41. Find the ratio of time constant in build up and decay in the circuit as shown in figure :-



(A) 1 : 1 (B) 3 : 2 (C) 2 : 3 (D) 1 : 3

42. In the circuit shown, X is joined to Y for a long time, and then X is joined to Z. The total heat produced in R_2 is :



(A) $\frac{LE^2}{2R_1^2}$ (B) $\frac{LE^2}{2R_2^2}$ (C) $\frac{LE^2}{2R_1R_2}$ (D) $\frac{LE^2R_2}{2R_1^2}$

43. In a L–R decay circuit, the initial current at t = 0 is I. The total charge that has flown through the resistor till the energy in the inductor has reduced to one–fourth its initial value, is

(A) LI/R (B) LI/2R (C) $LI\sqrt{2}/R$ (D) None

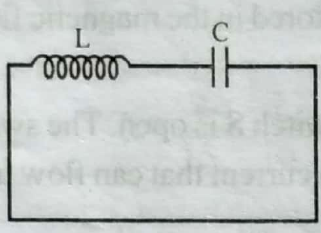
44. The inductor in a L–C oscillation has a maximum potential difference of 16 V and maximum energy of 640 μJ. Find the value of capacitor in μF in L–C circuit.

(A) 5 (B) 4 (C) 3 (D) 2

45. A condenser of capacity 6 μF is fully charged using a 6-volt battery. The battery is removed and a resistanceless 0.2 mH inductor is connected across the condenser. The current which is flowing through the inductor when one-third of the total energy is in the magnetic field of the inductor is :-

(A) 0.1 A (B) 0.2 A (C) 0.4 A (D) 0.6 A

46. In an LC circuit the capacitor has maximum charge q_0. The value of $\left(\frac{dI}{dt}\right)_{max}$ is :-



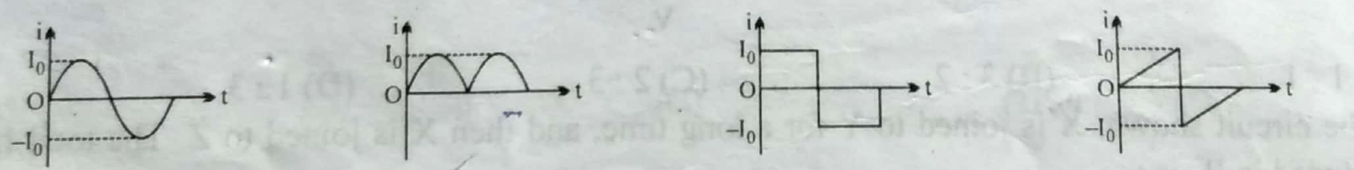
(A) $\frac{q_0}{LC}$ (B) $\frac{q_0}{\sqrt{LC}}$ (C) $\frac{q_0}{2LC}$ (D) $\frac{2q_0}{LC}$

Alternating current

47. When 100 V DC is applied across a solenoid a current of 1 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:

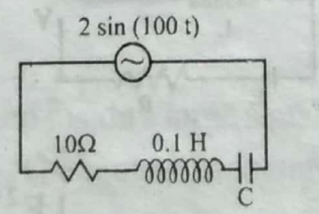
(A) 100Ω, 0.93 H (B) 200Ω, 1.0 H (C) 10Ω, 0.86H (D) 200Ω, 0.55 H

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



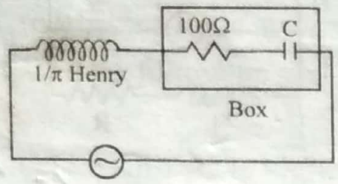
(A) $I_1 = I_2 = I_3 = I_4$ (B) $I_3 > I_1 = I_2 > I_4$ (C) $I_3 > I_4 > I_2 = I_1$ (D) $I_3 > I_2 > I_1 > I_4$

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



(A) 400 μF (B) 300 μF (C) 500 μF (D) 200 μF

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



V_{rms} = 220 volt, ω = 100 π s^{-1}

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

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

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

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

(A) $\frac{i}{\sqrt{2}}$ (B) $\sqrt{2}\,i$ (C) 0.637 i (D) zero

53. The phase difference between current and voltage in an AC circuit is π/4 radian. If the frequency of AC is 50 Hz, then the phase difference is equivalent to the time difference :

(A) 0.78 s (B) 15.7 ms (C) 0.25 s (D) 2.5 ms

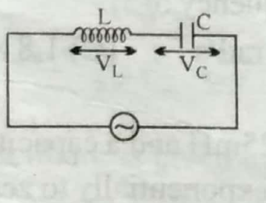
54. The effective value of current $i = 2 \sin 100\pi t + 2 \sin(100\pi t + 30°)$ is :

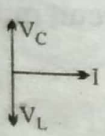
(A) $\sqrt{2}$ Amp (B) $2\sqrt{2+\sqrt{3}}$ Amp (C) 4 Amp (D) None

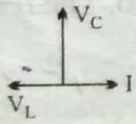
55. In series LR circuit X_L = 3R. Now a capacitor with X_C = R is added in series. Ratio of new to old power factor is :-

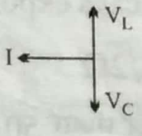
(A) 1 (B) 2 (C) $\frac{1}{\sqrt{2}}$ (D) $\sqrt{2}$

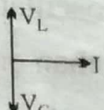
56. The current I, potential difference V_L across the inductor and potential difference V_C across the capacitor in circuit as shown in the figure are best represented vectorially as



(A) 

(B) 

(C) 

(D) 

57. In a series R-L-C circuit, the frequency of the source is half of the resonance frequency. The nature of the circuit will be

(A) capacitive (B) inductive (C) purely resistive (D) data insufficient