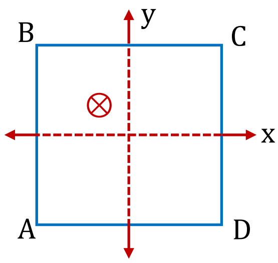
EXERCISE - O

SINGLE CORRECT TYPE QUESTIONS

Faraday Law and Lenz Law

1. 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 :



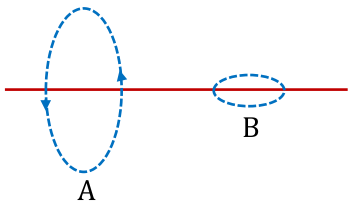
(A) clockwise (B) anticlockwise (C) zero (D) alternating

PEM045

2. 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

PEM046

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*.

PEM048

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 :-

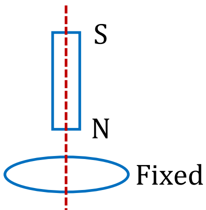


Fig. (I)

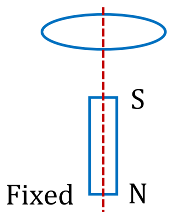
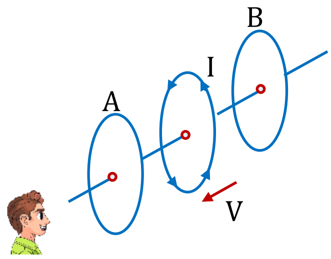


Fig. (II)

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

PEM049

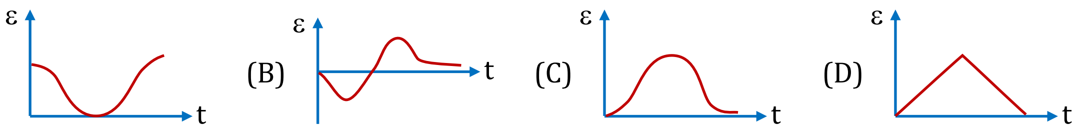
5. Three wire loops and an observer are positioned as shown in the figure. From the observer's point of view, a current I flows counter clockwise in the middle loop, which is moving towards the observer with a velocity v. Loops A and B are stationary. This same observer would notice that



(A) clockwise currents are induced in loops A and B.
(B) counterclockwise currents are induced in loops A and B.
(C) a clockwise current is induced in loop A, but a counterclockwise current is induced in loop B.
(D) a counterclockwise current is induced in loop A, but a clockwise current is induced in loop B.

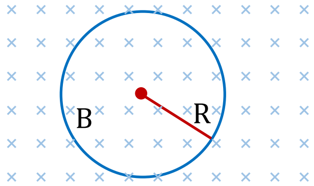
PEM050

6. 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



PEM051

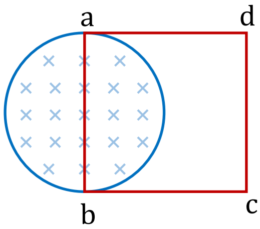
7. A conducting loop of radius R is present in a uniform magnetic field B perpendicular to the plane of the ring. If radius R varies as a function of time 't', as $R = R_0 + t$. The e.m.f induced in the loop is



(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

PEM052

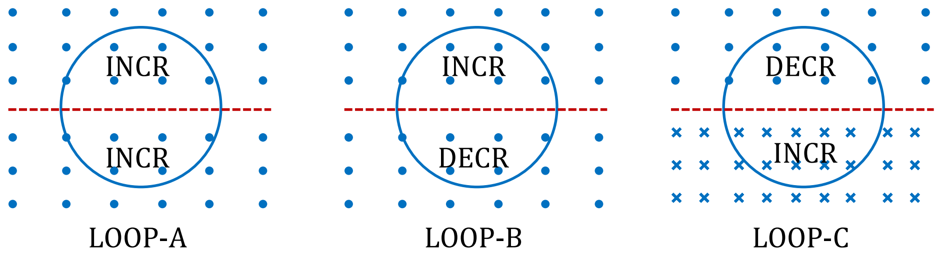
8. A uniform magnetic field B exists in a cylindrical region of radius 10 cm as shown in figure. A uniform wire of length 80 cm and resistance 40 ohms is bent into a square frame and is placed with one side along a diameter of cylindrical region. If the magnetic field increases at a constant rate 0.1 tesla per second, find the current induced in the frame.



(A) $3.14 \times 10^{-5}\ A$
(B) $3.9 \times 10^{-5}\ A$
(C) $1 \times 10^{-5}\ A$
(D) $2.8 \times 10^{-5}\ A$

PEM053

9. 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 :-

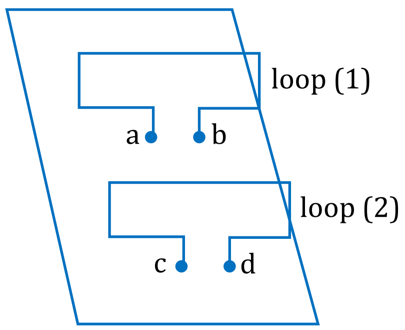


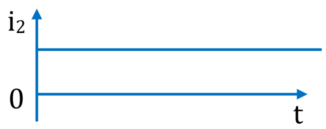
(A) $I_A > I_B = I_C$ (B) $I_A = I_C > I_B$

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

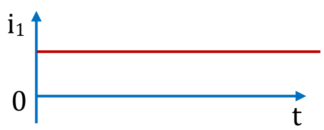
PEM118

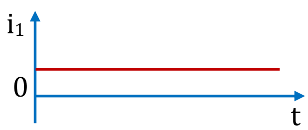
10. An electric current i_1 can flow either direction through loop (1) and induced current i_2 in loop (2). Positive i_1 is when current is from '*a*' to '*b*' in loop (1) and positive i_2 is when the current is from '*c*' to '*d*' in loop (2) In an experiment, the graph of i_2 against time '*t*' is as shown below

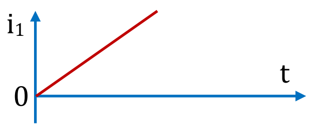


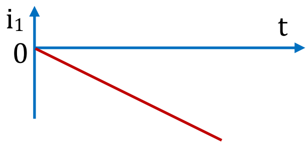


Which one(s) of the following graphs could have caused i_2 to behave as given above.

(A)


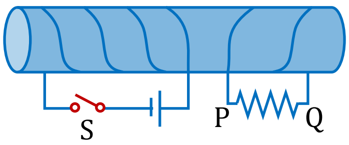
(B)


(C)


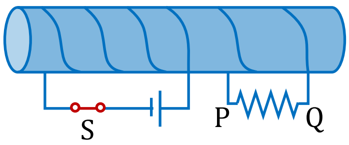
(D)


PEM119

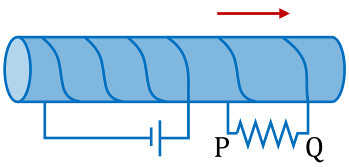
11. For each of the experiments (1, 2, 3, 4) shown in figure. Choose the **CORRECT** option(s) which shows the direction of current flow through the resistor *PQ*? Note that the wires are not always wrapped around the plastic tube in the same way.

(1)


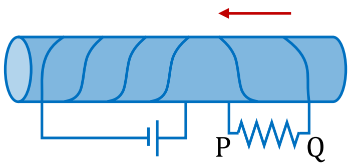
(1) S to be closed

(2)


(2) S to be opened

(3)


(3) Resistor coil PQ moves to right

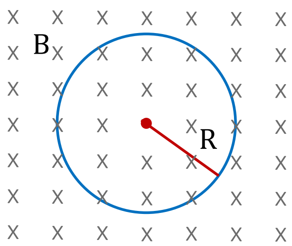
(4)


(4) Resistor coil PQ moves to left

(A) P to Q P to Q P to Q P to Q
(B) P to Q Q to P P to Q Q to P
(C) Q to P Q to P Q to P Q to P
(D) Q to P Q to P P to Q P to Q

PEM120

12. A conducting loop of radius R is present in a uniform magnetic field B perpendicular 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

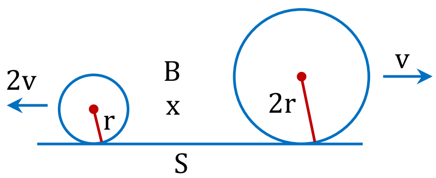


(A) $4\pi(R_0 + t)B$
(B) $\pi(R_0 + t)B$ clockwise
(C) $2\pi(R_0 + t)B$ anticlockwise
(D) zero

PEM151

Motional EMF

13. Two conducting rings of radii r and $2r$ move in opposite directions with velocities $2v$ and v respectively on a conducting surface S. There is a uniform magnetic field of magnitude B perpendicular to the plane rings. The potential difference between the highest points of the two rings is:



(A) zero
(B) $2rvB$
(C) $4rvB$
(D) $8rvB$

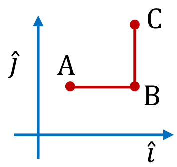
PEM121

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

PEM054

15. There is a uniform magnetic field B normal to the xy plane. A conductor ABC has length $AB = \ell_1$, parallel to the x-axis, and length $BC = \ell_2$, parallel to the y-axis. ABC moves in the xy plane with velocity $v_x\hat{\imath} + v_y\hat{\jmath}$. The potential difference between A and C is proportional to :-



(A) $v_x\ell_1 + v_y\ell_2$ (B) $v_x\ell_2 + v_y\ell_1$ (C) $v_x\ell_2 - v_y\ell_1$ (D) $v_x\ell_1 - v_y\ell_2$

PEM055

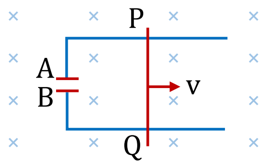
16. A conducting rod PQ of length $L = 1.0\ m$ is moving with a uniform speed $v = 20\ m/s$ in a uniform magnetic field $B = 4.0\ T$ directed into the paper. A capacitor of capacity $C = 10\ \mu F$ is connected as shown in figure. Then

(A) $q_A = +800\mu C$ and $q_B = -800\mu C$

(B) $q_A = -800\mu C$ and $q_B = +800\mu C$

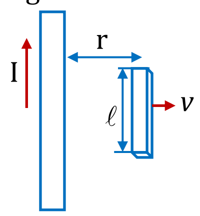
(C) $q_A = 0 = q_B$

(D) charge stored in the capacitor increases exponentially with time.



PEM056

17. A conducting rod moves with constant velocity v perpendicular to the long, straight wire carrying a current I as shown. Compute the emf generated between the ends of the rod.



(A) $\frac{\mu_0 vI\ell}{\pi r}$ (B) $\frac{\mu_0 vI\ell}{2\pi r}$ (C) $\frac{2\mu_0 vI\ell}{\pi r}$ (D) $\frac{\mu_0 vI\ell}{4\pi r}$

PEM057

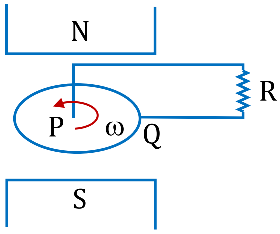
18. A metal disc rotates freely, between the poles of a magnet in the direction indicated. Brushes P and Q make contact with the edge of the disc and the metal axle. What current, if any, flows through R?

(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.



PEM063

19. A metallic rod of length ℓ is rotated in a horizontal plane with angular velocity ω where no magnetic field exists. The EMF induced in the rod is (Mass of e^- is m and charge of electron is e)

(A) $\frac{m\ell\omega^2}{e}$ (B) $\frac{m\omega\ell^2}{2e}$ (C) $\frac{m\omega^2\ell^2}{2e}$ (D) $\frac{m\omega^2\ell^2}{e}$

PEM064

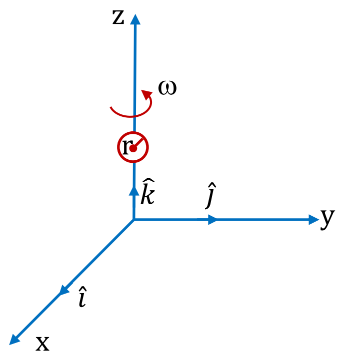
20. An electron is moving in a circular orbit of radius R with an angular acceleration α. At the centre of the orbit is kept a conducting loop of radius r, ($r << R$). The e.m.f induced in the smaller loop due to the motion of the electron is :-

(A) zero, since charge on electron in constant (B) $\frac{\mu_0 er^2}{4R}\alpha$

(C) $\frac{\mu_0 er^2}{4\pi R}\alpha$ (D) None of these

PEM065

21. A circular loop wire of radius r rotates about the z–axis with angular velocity ω. The normal to the loop is always perpendicular to the z–axis. At time $t = 0$, the normal is parallel to the y–axis. An external magnetic field $\vec{B} = B_y\hat{j} + B_z\hat{k}$ is applied. The EMF $\varepsilon(t)$ induced in the loop is



(A) $\pi r^2\omega B_y \sin\omega t$

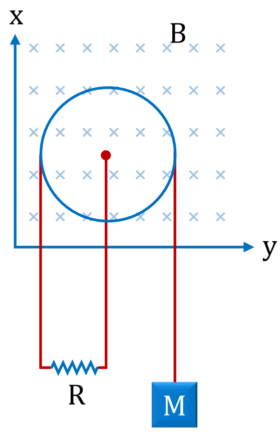
(B) $\pi r^2\omega B_z \cos\omega t$

(C) $\pi r^2\omega B_z \sin\omega t$

(D) $\pi r^2\omega B_y \cos\omega t$

PEM067

22. The block of mass (M) is connected by thread, which is wound on a pulley, free to rotate about fixed horizontal axis as shown. A uniform magnetic field B exists in a horizontal plane. The disc is connected with the resistance R as shown. Calculate the terminal velocity of the block if it was released from rest. Treat pulley as uniform metallic disc of radius L.



(A) $\frac{4mgR}{B^2L^2}$ (B) $\frac{3mgR}{4B^2L^2}$

(C) $\frac{2mgR}{B^2L^2}$ (D) $\frac{3mgR}{2B^2L^2}$

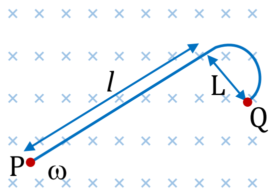
PEM068

23. The magnetic field in a region is given by $\vec{B} = B_0\left(1 + \frac{x}{a}\right)\hat{k}$. A square loop of edge - length d is placed with its edge along x and y axis. The loop is moved with constant velocity $\vec{V} = V_0\hat{\imath}$. The emf induced in the loop is

(A) $\dfrac{V_0B_0d^2}{a}$ (B) $\dfrac{V_0B_0d^2}{2a}$ (C) $\dfrac{V_0B_0a^2}{d}$ (D) None

PEM069

24. When a 'J' shaped conducting rod is rotating in its own plane with constant angular velocity ω, about one of its end P, in a uniform magnetic field $\vec{B}$ directed normally into the plane of paper then magnitude of emf induced across it will be

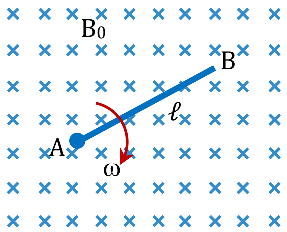


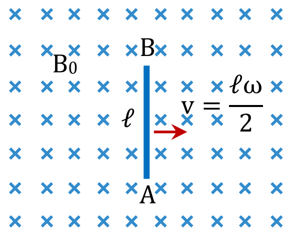
(A) $B\omega\sqrt{L^2 + l^2}$ (B) $\frac{1}{2}B\omega L^2$

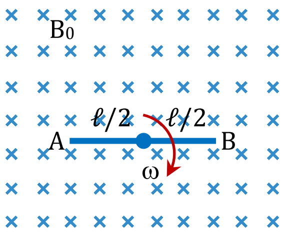
(C) $\frac{1}{2}B\omega(L^2 + l^2)$ (D) $\frac{1}{2}B\omega l^2$

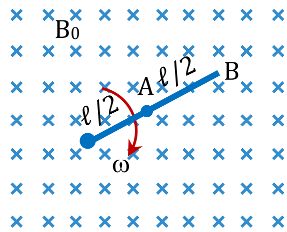
PEM070

25. The figure shows a rod of length ℓ with points A and B on it. The rod is moved in a uniform magnetic field (B_0) in different ways as shown. In which case potential difference ($V_A - V_B$) between A and B is minimum?

(A)


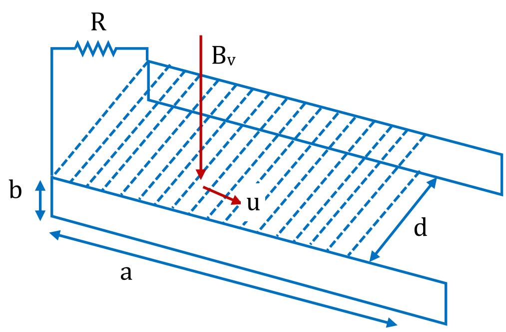
(B)


(C)


(D)


PEM122

26. The figure shows an apparatus suggested by Faraday to generate electric current from a flowing river. Two identical conducting plates of length a and width b are placed parallel facing one another on opposite sides of the river following with velocity u at a distance d apart. Now both the plates are connected by a load resistance R. Then the current through the load R is :- (Consider vertical component of the magnetic field produced by earth is B_v and the resistivity of river water is ρ.)

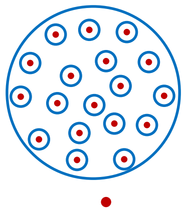


(A) $\dfrac{B_vub}{R}$ (B) $\dfrac{B_vub}{R + \frac{\rho d}{ab}}$ (C) $\dfrac{B_vud}{R + \frac{\rho d}{ab}}$ (D) None of the above

PEM124

Induced Electric Field

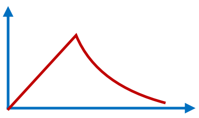
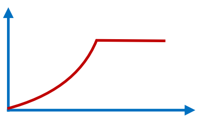
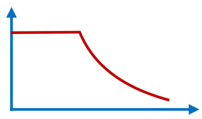
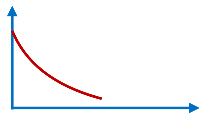
27. As shown, a uniform magnetic field B pointing out of the paper plane is confined in the shaded area of radius r. At a distance R ($R > r$) from the center of the shaded area there is a point particle of mass m and carrying charge q. Speed of the particle if the magnetic field in the region is quickly changed to zero will be.



(A) $v = \frac{qBr^2}{2mR}$ (B) 0 (C) $v = \frac{qBr^2}{mR}$ (D) $v = \frac{2qBr^2}{mR}$

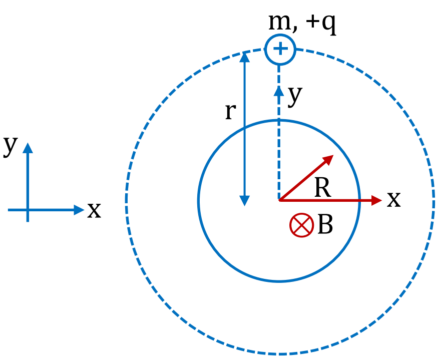
PEM073

28. 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) 

PEM074

29. Circular region of radius R has uniform magnetic field $\vec{B} = B_0 + B_0t(-\hat{k})$. At $t = 0$ acceleration of charged particle :-



(A) $\frac{qB_0R^2}{2mr}$ (B) $\frac{qB_0R}{2mr}$ (C) $\frac{qB_0R^3}{2mr^2}$ (D) $\frac{qB_0R^2}{mr}$

PEM075

30. Given a ring of mass M, radius r resting on a rough horizontal plane, with coefficient of friction 'μ'. A cylindrical, vertical magnetic field passing through ring is switched on at $t = 0$ which varies with time as $B = Kt^2$. Ring has charge Q distributed uniformly over it. Find the time after which ring starts rotating.

(A) $\frac{\mu Mg}{QKr}$ (B) $\frac{2\mu Mg}{QKr}$ (C) $\frac{\mu Mg}{2QKr}$ (D) $\frac{\mu Mg}{4QKr}$

PEM076

31. **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.

PEM080

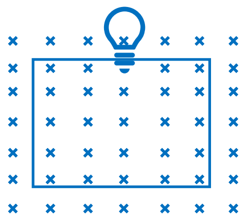
32. There exists a uniform cylindrically symmetric magnetic field directed along the axis of a cylinder but varying with time as $B = kt$. If an electron is released from rest in this field at a distance of 'r' from the axis of cylinder, its acceleration, just after it is released would be

(e and m are the electronic charge and mass respectively)

(A) $\frac{erk}{2m}$ (B) $\frac{erk}{m}$ (C) $\frac{erk}{4m}$ (D) $\frac{2erk}{m}$

PEM081

33. A square wire loop of 10.0 cm side lies at right angles to a uniform magnetic field of 20T. A 10 V light bulb is in a series with the loop as shown in the fig. The magnetic field is decreasing steadily to zero over a time interval Δt. The bulb will shine with full brightness if Δt is equal to :-

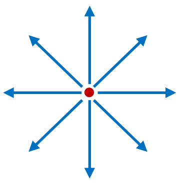
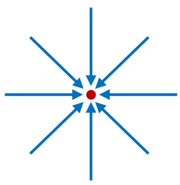
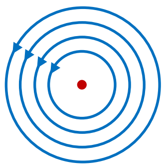
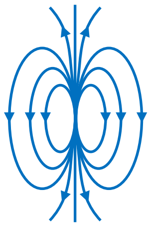


(A) 20 ms (B) 0.02 ms

(C) 2 ms (D) 0.2 ms

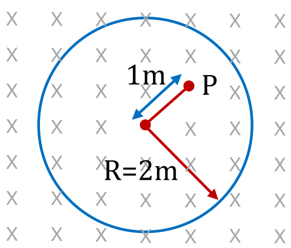
PEM125

34. Which of the field patterns given below is valid for electric field as well as for magnetic field?

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

PEM126

35. The magnetic field in a certain cylindrical region is changing with time according to the law $B = \left(16 - 4t^2\right)$ Tesla. The induced electric field at point P at time t = 2 sec.



(A) 8 Volt/m (B) 6 Volt/m (C) 4 Volt/m (D) None of these

PEM152

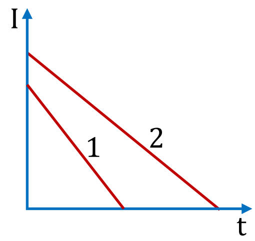
Self-Inductance and Mutual Inductance

36. 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

PEM083

37. 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

PEM084

38. 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

PEM085

39. 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) $\frac{\mu_0 \pi r}{2R^2}$

PEM088

40. 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

PEM089

41. There are 10 turns in coil M and 15 turns in coil N. If a current of 2A is passed through coil M then the flux linked with coil N is 1.8×10^{-3} Wb. If a current of 3A is passed through coil N then flux linked with coil M is :-

(A) 1.7×10^{-3} Wb (B) 2.7×10^{-3} Wb (C) 1.7×10^{-5} Wb (D) 2.7×10^{-5} Wb

PEM090

42. If the difference between the equivalent inductance in the following figures is nL then find the value of n. Given coupling coefficient is $C = \sqrt{2}$. (Where coupling coefficient is defined as $C = \frac{\sqrt{L_1 L_2}}{M}$)

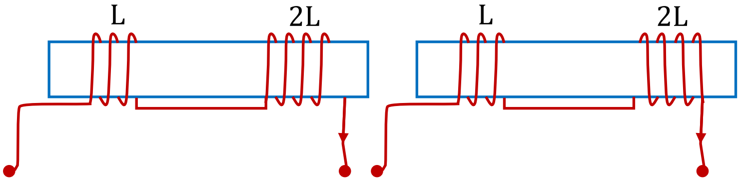


Figure (A) **Figure (B)**

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

PEM097

43. Two coils A and B have coefficient of mutual inductance $M = 2H$. The magnetic flux passing through coil A changes by 4 Weber in 10 seconds due to the change in current in B. Then

(A) the change in current in B in this time interval is 0.5 A

(B) the change in current in B in this time interval is $2A$

(C) the change in current in B in this time interval is $8A$

(D) a change in current of $1A$ in coil A will produce a change in flux passing through B by 4 Weber.

PEM127

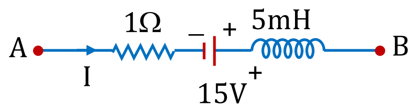
44. The magnetic flux through a conducting loop with resistance R varies during interval of time T as $\phi = at(T - t)$. The heat generated during this time, neglecting the inductance of loop will be

(A) $\frac{a^2T^3}{3R}$ (B) $\frac{a^2T^2}{3R}$ (C) $\frac{a^2T}{3R}$ (D) $\frac{a^2T^3}{R}$

PEM153

R–L Circuit

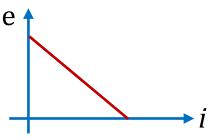
45. The network shown in the figure is part of a complete circuit. If at a certain instant, the current I is $5A$ and it is decreasing at a rate of 10^3 As^{-1} then $V_B - V_A$ equals

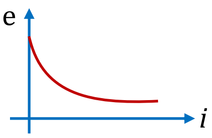


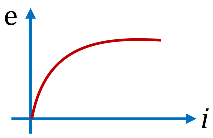
(A) 20 V (B) 15 V (C) 10 V (D) 5 V

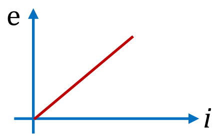
PEM086

46. If an L-R circuit is 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 is the current in the circuit at any time t. Then which of the following graphs shows the variation of e with i ?

(A) 

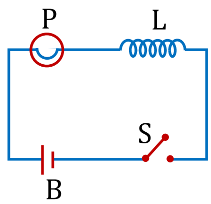
(B) 

(C) 

(D) 

PEM098

47. In figure, a lamp P is in series with an iron-core inductor L. When the switch S is closed, the brightness of the lamp rises relatively slowly to its full brightness than it would do without the inductor. This is due to



(A) the low resistance of P

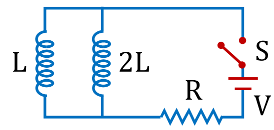
(B) the induced-emf in L

(C) the low resistance of L

(D) the high voltage of the battery B

PEM099

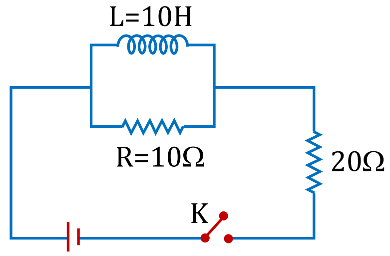
48. In the circuit shown, the switch is closed at $t = 0$. The current through the inductor of inductance L varies with time as :



(A) $(2V/3R)\,[1 - \exp\,(-3Rt/2L)]$ (B) $(2V/3R)\,\exp\,(-3Rt/2L)$
(C) $(V/R)\,[1 - \exp\,(-3Rt/2L)]$ (D) $(V/R)\,[1- \exp\,(-Rt/2L)]$

PEM100

49. 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) $\frac{1}{15}A, \frac{2}{25}A$

PEM101

50. 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.

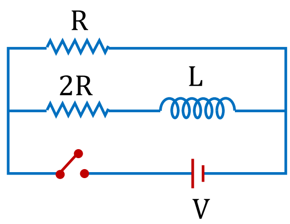
(B) ratio of the energy stored in the magnetic field to the rate of dissipation of energy in the resistance.

(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.

PEM102

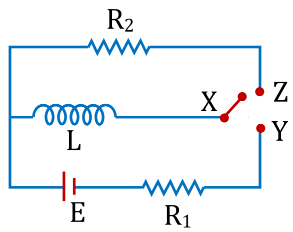
51. Find the ratio of time constant in build up and decay in the circuit as shown in figure :-



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

PEM106

52. 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) $\frac{LE^2R_2}{2R_1^2}$

PEM107

53. 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 of its initial value, is

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

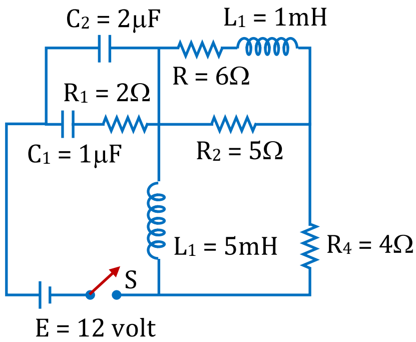
PEM108

54. 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) $\frac{2P}{U}$

PEM109

55. Find current through the battery just after switch S is closed. Initially all the capacitors are uncharged:



(A) $\frac{4}{3}A$ (B) $\frac{5}{3}A$ (C) 0 A (D) $\frac{3}{5}A$

PEM129

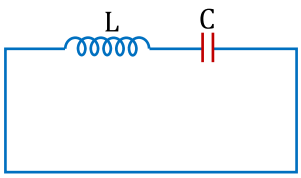
L–C oscillation

56. 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

PEM113

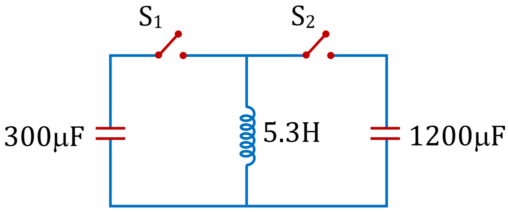
57. In an LC circuit the capacitor has maximum charge q_0. The value of $\left(\frac{dI}{dt}\right)_{\max}$ is :-



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

PEM114

58. The 300 μ*F* capacitor in figure is initially charged to 16 *V*, the 1200 μ*F* capacitor is uncharged and the switches are both open. What is the maximum voltage (in *V*) to which you can charge the 1200 μ*F* capacitor by the proper closing and opening of the two switches.



(A) 2 (B) 8 (C) 5 (D) 9

PEM115

59. A condenser of capacity 6 μ*F* 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*

PEM130

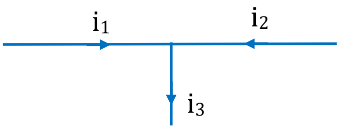
A–C Circuits

60. 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

PAC052

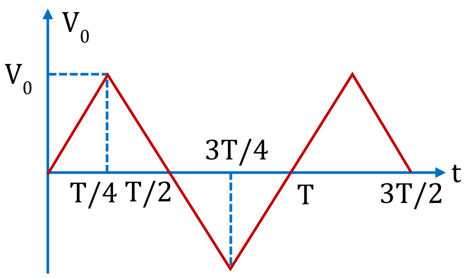
61. In the given figure if $i_1 = 3 \sin \omega t$ and $i_2 = 4 \cos \omega t$, then i_3 is



(A) 5 sin (ω*t* + 53°) (B) 5 sin (ω*t* + 37°) (C) 5 sin (ω*t* + 45°) (D) 5 cos (ω*t* + 53°)

PAC053

62. The mean and rms value of an alternating voltage as shown in figure is



(A) $\frac{V_0}{3}, \frac{V_0}{2}$ (B) $\frac{V_0}{\sqrt{2}}, \frac{V_0}{\sqrt{3}}$ (C) $\frac{V_0}{2}, \frac{V_0}{3}$ (D) $\frac{V_0}{2}, \frac{V_0}{\sqrt{3}}$

PAC054

63. In an ac circuit, the instantaneous voltage $e(t)$ and current $I(t)$ are given by

$$e(t) = 5[\cos \omega t + \sqrt{3}\ \sin \omega t] \text{ volt}\ ,\ \ i\,(t) = 5\left[\sin\left(\omega t + \frac{\pi}{4}\right)\right] amp$$

then:-

(A) Current leads voltage by $\frac{\pi}{4}$

(B) Voltage leads current by $\frac{\pi}{3}$

(C) Voltage leads current by $\frac{\pi}{6}$

(D) Current leads voltage by $\frac{\pi}{12}$

PAC057

64. An alternating voltage $V = 300\sqrt{2}\sin(100t)$ is connected to a $1\mu F$ capacitor through an AC ammeter. The reading of the ammeter will be :-

(A) 10 mA (B) 30 mA (C) $30\sqrt{2}\,mA$ (D) $20\sqrt{2}\,mA$

PAC059

65. A series RLC circuit is driven by a generator at frequency 1000 Hz. The inductance is 90.0 mH; capacitance is 0.500 μF; and the phase constant has a magnitude of 60.0° (Take $\pi^2 = 10$) Choose **INCORRECT** statement :-

(A) Here current leads the voltage in phase

(B) Here voltage leads the current in phase

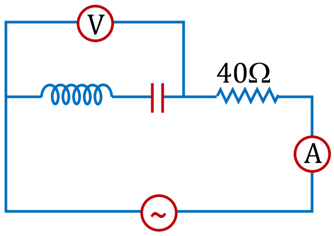
(C) Resistance of circuit is $\frac{80\pi}{\sqrt{3}}\,\Omega$

(D) At resonance $\omega = \frac{\sqrt{2}}{3} \times 10^4$ rad/sec.

PAC061

66. In the given LCR series circuit find the reading of the hot wire ammeter.

120V

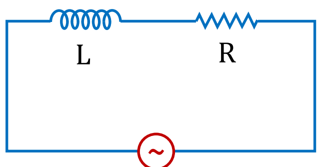


$200\sqrt{2}sin\omega t$

(A) 2 A (B) 4 A (C) 5 A (D) 9 A

PAC063

67. In the given figure, the current amplitude is :-



$V = V_0 sin\omega t + (V_0/2)\ cos\ \omega t$

(A) $\sqrt{\frac{5V_0^2}{4\left(\omega^2L^2 + R^2\right)}}6$ (B) $\frac{V_0}{\sqrt{4\left(\omega^2L^2 + R^2\right)}}$ (C) $\frac{\sqrt{5}V_0}{2\sqrt{\omega^2L^2 - R^2}}$ (D) $\frac{\sqrt{5}V_0}{2\sqrt{R^2 - \omega^2L^2}}$

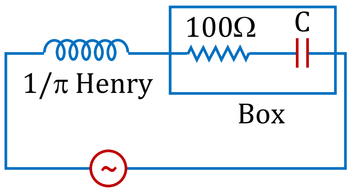
PAC064

68. 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) $\sqrt{2}$

PAC066

69. 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, $\omega = 100\pi s^{-1}$

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

PAC067

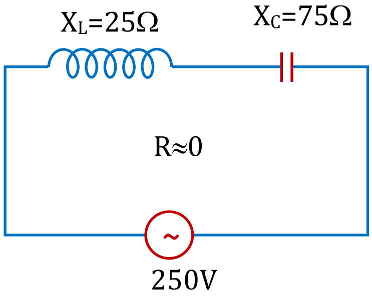
70. For shown circuit :-

(A) Current in circuit is 10A

(B) Voltage across inductor is 100V

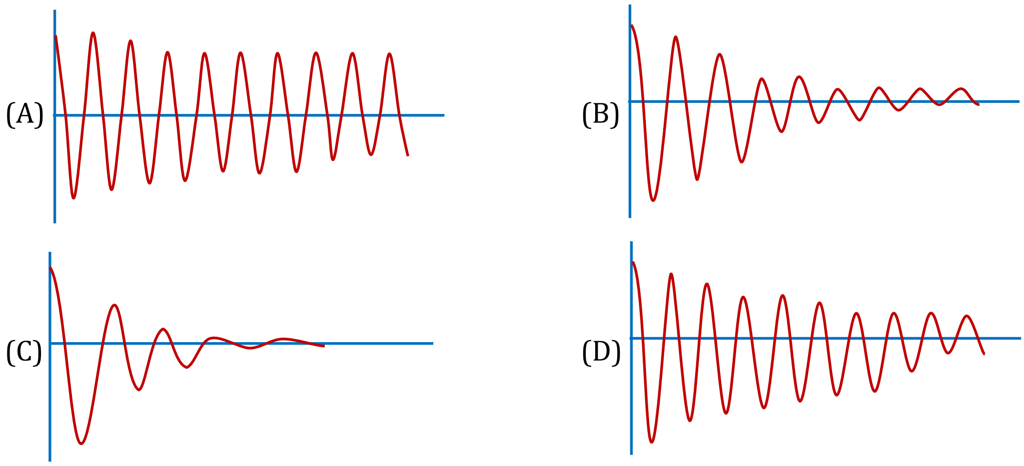
(C) Voltage across capacitor is 200V

(D) Voltage on capacitor is more than that of supply voltage because the phase difference between V_L and V_C is 180°.



PAC070

71. Which graph has the highest Q factor ?



PAC072

72. Figure (a) shows plot of voltage across the capacitor as a function of the driving frequency for a sinusoidally driven electromagnetic oscillator LCR circuit. Figure (b) shows phase angle ϕ (phase difference between voltage and current) vs ω/ω_0 graph for same circuit, for three different quality factor graph 1, 2, 3 of figure (a) and each one can be matched by one of graphs a, b, c also of figure (b) :-

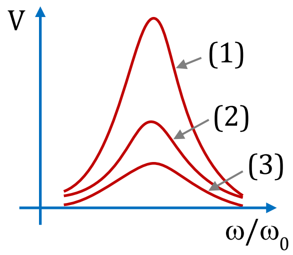


Figure (a)

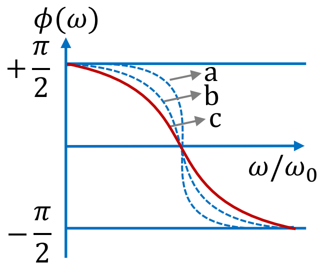


Figure (b)

(A) Graph (3) corresponds to graph (a)

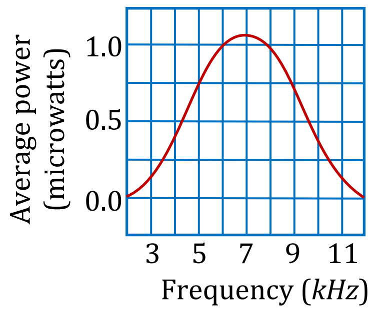
(B) Graph (1) corresponds to graph (c)

(C) The circuit of graph 1 has high quality factor

(D) The circuit of graph 3 has high quality factor

PAC073

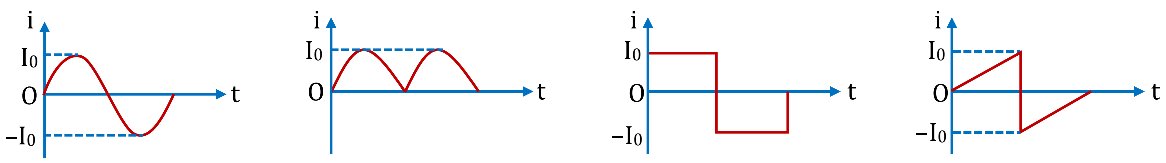
73. The plot given below is of the average power delivered to an LRC circuit versus frequency. The quality factor of the circuit is :



(A) 5 (B) 2.4 (C) 2.8 (D) 1.4

PAC074

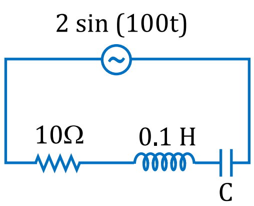
74. If I_1, I_2, I_3 and I_4 are the respective r.m.s. values of the time varying currents as shown in the four cases I, II, III and IV. Then identify the correct relations.



(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) $I_3 > I_2 > I_1 > I_4$

PAC086

75. 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

PAC087

76. When a resistance R is connected in series with an element A, the electric current is found to be lagging behind the voltage by angle θ_1. When the same resistance is connected in series with element B, current leads voltage by θ_2. When R, A, B are connected in series, the current now leads voltage by θ. Assume same AC source is used in all cases, then

(A) $\theta = \theta_2 - \theta_1$ (B) $\tan\theta = \tan\theta_2 - \tan\theta_1$

(C) $\theta = \dfrac{\theta_1 + \theta_2}{2}$ (D) None of these

PAC088

77. When a voltage v_s $200\sqrt{2}$ = sin (ωt + 15°) is applied to an AC circuit the current in the circuit is found to be $i = 2\sin(\omega t + \pi/4)$ then average power consumed in the circuit is

(A) 200 watt (B) $400\sqrt{2}$ watt (C) $100\sqrt{6}$ watt (D) $200\sqrt{2}$ watt

PAC089

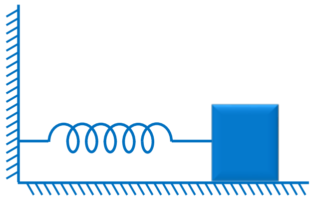
78. An ideal efficient transformer has a primary power input of 10 kW. The secondary current when the transformer is on load is 25 A. If the primary : secondary turns ratio is 8 : 1, then the potential difference applied to the primary coil is

(A) $\dfrac{10^4 \times 8^2}{25}V$ (B) $\dfrac{10^4 \times 8}{25}V$ (C) $\dfrac{10^4}{25 \times 8}V$ (D) $\dfrac{10^4}{25 \times 8^2}V$

PAC090

Damped and Forced Oscillation

79. In the situation shown, the block can execute free oscillation (no damping) with angular frequency ω_1. In presence of weak damping, it executes damped SHM with angular frequency ω_2. When it is subjected to a sinusoidal force, it executes forced oscillation with maximum amplitude at angular frequency ω_3 (assume damping is present) :-



(A) $\omega_1 > \omega_2 > \omega_3$ (B) $\omega_1 > \omega_2 = \omega_3$ (C) $\omega_1 = \omega_2 = \omega_3$ (D) $\omega_1 > \omega_3 > \omega_2$

PAC080

80. A simple pendulum has a time period T if there is no air resistance. If a small air resistance is acting on the bob as it oscillates,

(A) The time period will be initially more than T and decreases with time.
(B) The time period will be less than T initially and increases with time
(C) The time period will be less than T and remains constant
(D) The time period will be more than T and remains constant.

PAC081

81. A pendulum with time period of 1s is losing energy due to damping. At certain time its energy is 45 J. If after completing 15 oscillations, its energy has become 15 J, its damping constant (in s^{-1}) is:-

(A) 2 (B) $\dfrac{1}{15}\ln 3$ (C) $\dfrac{1}{2}$ (D) $\dfrac{1}{30}\ln 3$

PAC083

82. A spring-mass system has undamped natural angular frequency $\omega_0 = 100\ rad\ s^{-1}$. The solution $x(t)$ at critical damping is given by $x(t) = x_0(1 + \omega_0 t)\ e^{-\omega_0 t}$, where x_0 is a constant. The system experiences the maximum damping force at time

(A) 0.01 s (B) 0.1 s (C) 0.01 πs (D) 0.1 πs

PAC084

83. An RLC circuit has a capacitance of 12 μF, an inductance of 25 mH, and a resistance of 60Ω. The current oscillates with an angular frequency of :

(A) $1.2 \times 10^3\ rad/s$ (B) $1.4 \times 10^3\ rad/s$ (C) $1.8 \times 10^3\ rad/s$ (D) $2.2 \times 10^3\ rad/s$

PAC060

84. An RLC circuit has an inductance of 25mH and a capacitance of 5.0μF. The charge on the capacitor does NOT oscillate but rather decays exponentially to zero. The resistance in the circuit must be:

(A) greater than or equal to $100\sqrt{2}\Omega$

(B) less than $100\sqrt{2}\Omega$ but greater than $50\sqrt{2}\Omega$

(C) less than $50\sqrt{2}\Omega$ but greater than $25\sqrt{2}\Omega$

(D) less than $25\sqrt{2}\Omega$ but greater than 0

PAC091

85. In forced oscillation of a particle the amplitude is maximum for a frequency ω_1 of the force, while the power is maximum for a frequency ω_2 of the force; then –

(A) $\omega_1 = \omega_2$

(B) $\omega_1 > \omega_2$

(C) $\omega_1 < \omega_2$ when damping is small and $\omega_1 > \omega_2$ when damping is large

(D) $\omega_1 < \omega_2$

PAC092

86. The angular frequency of the damped oscillator is given by $\omega = \sqrt{\frac{k}{m} - \frac{r^2}{4m^2}}$, where k is the spring constant, m is the mass of the oscillator and r is damping constant. If the ratio $\frac{r^2}{mk}$ is 8%, the change in time period composed to the undamped oscillator is approximately as follows:

(A) decreases by 8% (B) decreases by 1% (C) increases by 1% (D) increases by 8%

PAC093

MULTIPLE CORRECT TYPE QUESTIONS

87. A current carrying infinitely long wire is kept along the diameter of a circular wire loop, without touching it. The correct statement(s) is (are)

(A) The emf induced in the loop is zero if the current is constant.

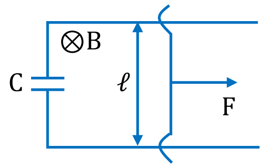
(B) The emf induced in the loop is infinite if the current is constant.

(C) The emf induced in the loop is zero if the current decreases at a steady rate.

(D) The emf induced in the loop is finite if the current decreases at a steady rate.

PEM131

88. A conducting wire of length ℓ and mass m can slide without friction on two parallel rails and is connected to capacitance C initial charge zero. Whole system lies in a magnetic field B and a constant force F is applied to the rod at $t = 0$. If initial speed of rod is zero. Then



(A) Speed of the rod at time $t = \dfrac{Ft}{B^2\ell^2C+m}$

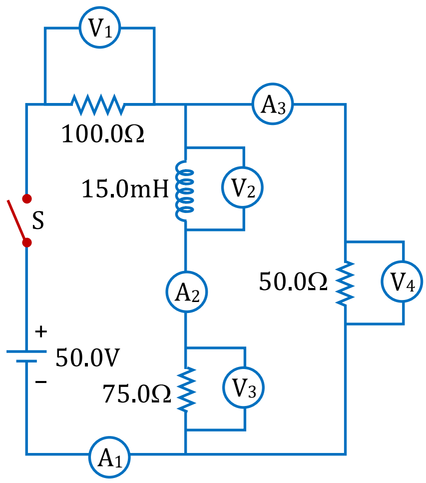
(B) The rod moves with constant acceleration

(C) The charge of capacitor varies linearly with velocity

(D) Charge on the capacitor will never attain steady state value.

PEM132

89. In the circuit shown in figure, just after switch S is closed, the reading in each ammeter (in amp) and voltmeter (in V) will be :-



(A) $A_1 = \dfrac{1}{3}$, $A_2 = 0$ and $A_3 = \dfrac{1}{3}$

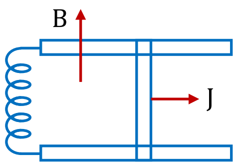
(B) $A_1 = \dfrac{5}{13}$, $A_2 = \dfrac{2}{13}$ and $A_3 = \dfrac{3}{13}$

(C) $V_1 = \dfrac{100}{3}$, $V_3 = 0$

(D) $V_2 = \dfrac{50}{3}$, $V_4 = \dfrac{100}{3}$

PEM133

90. Two parallel resistanceless rails are connected by an inductor of inductance L at one end as shown in the figure. A magnetic field B exists in the space which is perpendicular to the plane of the rails. Now a conductor of length ℓ and mass m is placed transverse on the rails and given an impulse J towards the rightward direction. Then choose the **CORRECT** option (s).



(A) Velocity of the conductor is half of the initial velocity after a displacement of the conductor $d = \sqrt{\dfrac{3J^2L}{4B^2\ell^2m}}$

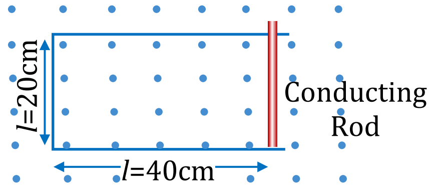
(B) Current flowing through the inductor at the instant when velocity of the conductor is half of the initial velocity is $i = \sqrt{\dfrac{3J^2}{4Lm}}$

(C) Velocity of the conductor is half of the initial velocity after a displacement of the conductor $d = \sqrt{\dfrac{3J^2L}{B^2\ell^2m}}$

(D) Current flowing through the inductor at the instant when velocity of the conductor is half of the initial velocity is $i = \sqrt{\dfrac{3J^2}{mL}}$

PEM134

91. Figure shows a conducting rod of negligible resistance that can slide on smooth U-shaped rail made of wire of resistance 1 Ω/m. Position of the conducting rod at t = 0 is shown. A time dependent magnetic field B = 2t Tesla is switched on at t = 0. After the magnetic field is switched on, the conducting rod is moved to the left perpendicular to the rails at constant speed 5 cm/s by some external agent.



(A) The current in the loop at t = 0 due to induced emf is 0.16 A, clockwise

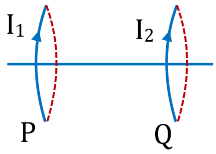
(B) At t = 2s, induced emf has magnitude 0.08 V

(C) The magnitude of the force required to move the conducting rod at constant speed 5 cm/s at t = 2s, is equal to 0.08 N

(D) The magnitude of the force required to move the conducting rod at constant speed 5 cm/s at t = 2s, is equal to 0.16 N

PEM024

92. Two circular coils P and Q are fixed coaxially and carry currents I_1 and I_2 respectively



(A) if I_2 = 0 and P moves towards Q, a current in the same direction as I_1 is induced in Q

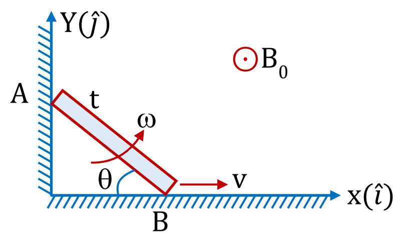
(B) if I_1 = 0 and Q moves towards P, a current in the opposite direction to that of I_2 is induced in P

(C) when $I_1 \neq 0$ and $I_2 \neq 0$ are in the same direction then the two coils tend to move apart

(D) when $I_1 \neq 0$ and $I_2 \neq 0$ are in opposite directions then the coils tends to move apart

PEM026

93. A thin conducting rod of length ℓ is moved such that its end B moves along the X-axis while end A moves along the Y-axis. A uniform magnetic field $B = B_0\hat{k}$ exists in the region. At some instant, velocity of end B is v and the rod makes an angle of θ = 60° with the X-axis as shown in the figure. Then, at this instant



(A) angular speed of rod AB is $\omega = \dfrac{2v}{\sqrt{3}\ell}$

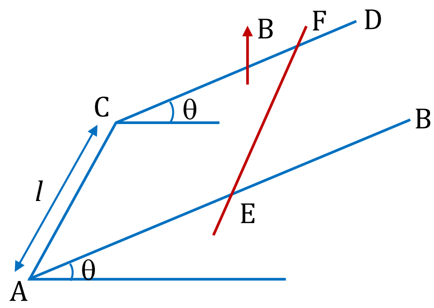
(B) angular speed of rod AB is $\omega = \dfrac{\sqrt{3}v}{2\ell}$

(C) e.m.f. induced in rod AB is $B\ell v\sqrt{3}$

(D) e.m.f. induced in rod AB is $B\ell v/2\sqrt{3}$

PEM059

94. *AB* and *CD* are smooth parallel rails, separated by a distance *l*, and inclined to the horizontal at an angle θ. A uniform magnetic field of magnitude *B*, directed vertically upwards, exists in the region. *EF* is a conductor of mass *m*, carrying a current *i*. For *EF* to be in equilibrium,



(A) *i* must flow from *E* to *F*

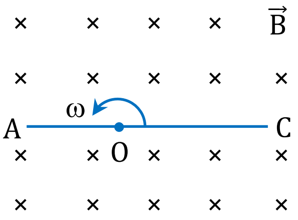
(B) Bil = $mg \tan\theta$

(C) Bil = $mg \sin\theta$

(D) Bil = mg

PEM060

95. A conducting rod *AC* of length 4ℓ is rotated about a point *O* in a uniform magnetic field directed into the paper. $AO = \ell$ and $OC = 3\ell$. Then

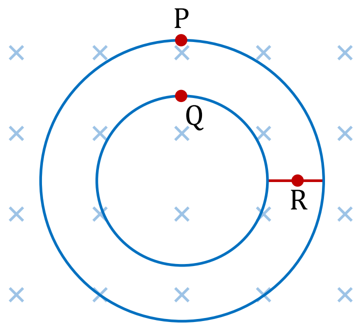


(A) $V_A - V_0 = \dfrac{B\omega\ell^2}{2}$ (B) $V_0 - V_C = \dfrac{9}{2}B\omega\ell^2$

(C) $V_A - V_C = 4B\omega\ell^2$ (D) $V_C - V_0 = \dfrac{9}{2}B\omega\ell^2$

PEM135

96. Figure shows plane figure made of a conductor located in a magnetic field along the inward normal to the plane of the figure. The magnetic field starts diminishing. Then the induced current

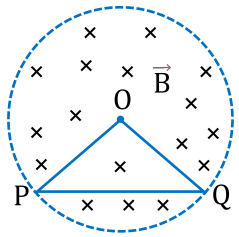


(A) at point *P* is clockwise (B) at point *Q* is anticlockwise

(C) at point *Q* is clockwise (D) at point *R* is zero

PEM025

97. A cylindrical region has a uniform magnetic field $\vec{B}$ as shown, which varies linearly with time. A conducting loop in the shape of equilateral triangle is placed in the region as shown. A current flows in the loop due to changing flux. Then :-



(A) in wire *OP* only conservative electric field drives the current.

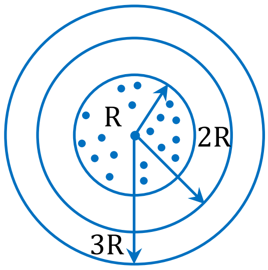
(B) in wire *PQ* both conservative and non-conservative electric field drive the current.

(C) in wire *QO* only non-conservative electric field drives the current.

(D) in all the wires only non-conservative electric field drives the current.

PEM136

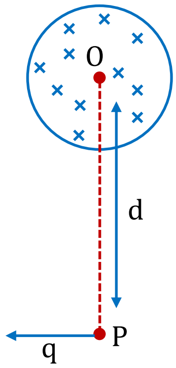
98. A uniform magnetic field $\vec{B}$ exists in circular region of radius R as shown which is decreasing with time at a constant rate. There is a concentric wooden ring that has uniformly distributed charge Q and radius $2R$ and another concentric uncharged copper ring of radius $3R$, then select correct alternative. (Assuming rings are placed on frictionless surface)



(A) There is no induced current in wooden ring
(B) Induced electric field in wooden ring is more in magnitude then copper ring
(C) Induced electric field in copper ring is more in magnitude then wooden ring
(D) Wooden ring will start rotating

PEM137

99. In the cylindrical region of radius $R = 2m$, there exists a time varying magnetic field B such that $\frac{dB}{dt} = 2$ Tesla/sec. A charged particle having charge $q = 2C$ is placed at the point P at a distance d from its centre O. Now, the particle is moved in the direction perpendicular to line OP by an external agent to infinity so that there is no gain in kinetic energy of charged particle. Then



(A) Work done by external agent is 4π joule when $d = 4m$
(B) Work done by external agent is 4π Joule when $d = 8\ m$
(C) Work done by external agent is independent of d
(D) Work done by external agent is positive

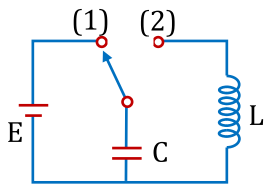
PEM138

100. Two different coils have self inductance $8mH$ and $2mH$. The current in one coil is increased at a constant rate. The current in the second coil is also increased at the same constant rate. At a certain instant of time, the power given to the two coils is the same. At that time the current, the induced voltage and the energy stored in the first coil are I_1, V_1 and W_1 respectively. Corresponding values for the second coil at the same instant are I_2, V_2 and W_2 respectively.
Then for $L_1 = 8\ mH$, $L_2 = 2mH$, i_1, V_1, W_1, i_2, V_2, W_2, which of the following may be true.

(A) $\frac{I_1}{I_2} = \frac{1}{4}$ (B) $\frac{I_1}{I_2} = 4$ (C) $\frac{W_2}{W_1} = 4$ (D) $\frac{V_2}{V_1} = \frac{1}{4}$

PAC034

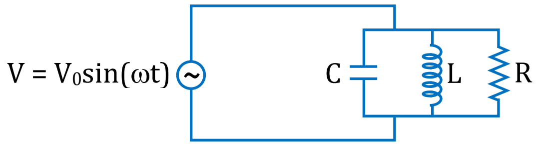
101. Initially key was placed on (1) till the capacitor got fully charged. Key is placed on (2) at $t = 0$. The time when the energy in both capacitor and inductor will be same-



(A) $\frac{\pi\sqrt{LC}}{4}$ (B) $\frac{\pi\sqrt{LC}}{2}$ (C) $\frac{5\pi\sqrt{LC}}{4}$ (D) $\frac{5\pi\sqrt{LC}}{2}$

PEM116

102. In the following circuit, the AC source is an ideal voltage source. Resonance is defined as a situation where the current through the source and the voltage across the source are in the same phase. At resonance, which of the following will be in the same phase as that of the applied voltage? (V_R voltage across resistor, I_R current across resistor, I_C current across capacitor, I_L current across inductor)

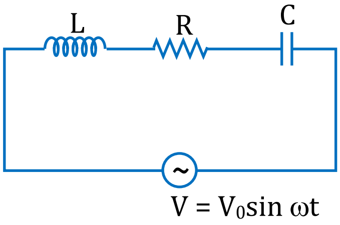


(A) V_R (B) I_C (C) I_L (D) I_R

PAC094

103. Consider an A-C circuit consisting of an ideal inductor (solenoid), capacitor and a resistor joined in series as shown in diagram. Choose the correct statement(s) :-

[Given : $L = 100\ mH$, $C = 10\ \mu F$, $R = 100\ \Omega$, $V = 5 \sin(500\ t)$]



(A) The circuit is in resonance for the given value of L, C, R and ω.

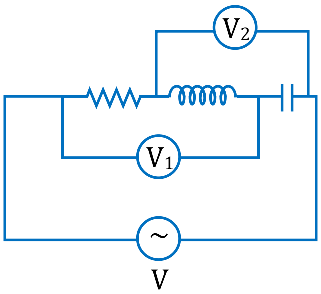
(B) When number of turns in solenoid is doubled keeping other parameters unchanged, circuit is in resonance.

(C) When a dielectric of dielectric constant 4 is inserted in the capacitor and other parameters are kept unchanged, the circuit is in resonance.

(D) Maximum current that can flow in the circuit for given value of L, C, R and ω is 0.05 A.

PAC095

104. In an RLC series circuit shown in fig the readings of voltmeters V_1 and V_2 are 100V and 120V, respectively. The source voltage is 130V. For this situation mark out the correct statements



(A) Voltage across resistor, inductor and capacitor are $50V$, $50\sqrt{3}V$ and $120+50\sqrt{3}V$, respectively

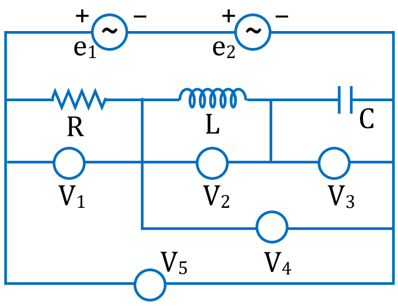
(B) Voltage across resistor, inductor and capacitor are $50V$, $50\sqrt{3}V$ and $120-50\sqrt{3}V$, respectively

(C) Power factor of the circuit is $\dfrac{5}{13}$

(D) The circuit is capacitive in nature

PAC096

105. A resistor R = 500 Ω, an ideal inductor L = 0.9 H and a capacitor C = 2.5 μF are connected with two alternating source e_1 = 100 sin(1000t) and e_2 = $100\sqrt{3}\cos(1000t)$. V_1, V_2, V_3, V_4 and V_5 are five ideal voltmeters and connected in the circuit as shown in the figure. Choose the correct option(s).



(A) Phase difference between voltages of V_3 and V_5 is

$$\frac{\pi}{2}+\tan^{-1}\left(\frac{9}{5}\right)$$

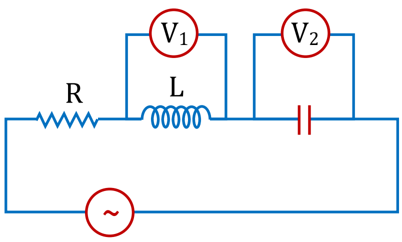
(B) Reading of V_4 is 180 volt.

(C) Difference between reading of V_2 and V_1 is 80 volt.

(D) Ratio of reading of V_4 and V_5 is $\frac{1}{\sqrt{2}}$

PAC097

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

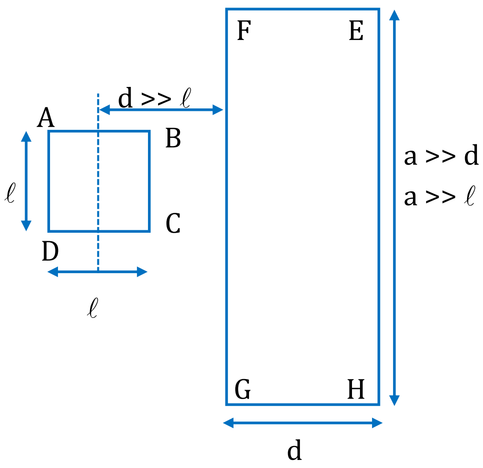


(A) f = 125 Hz (B) f = 250π Hz

(C) Current through R is 2A (D) V_1 = V_2 = 1000 volt

PAC098

107. A square conducting loop $ABCD$ and a rectangular conducting loop $EFGH$ are placed on the same plane as shown in the figure. The loop $ABCD$ is placed symmetrically with respect to $EFGH$ such that its central line is at a distance d from the loop $EFGH$. Side length 'ℓ' of small loop $ABCD$ is much smaller than the length 'a' and width 'd' of the bigger loop $EFGH$. A source is applied on loop $ABCD$, such that it sets up a current I = kt in it. Here k is a positive constant and t is time. Then choose the correct option(s).



(A) If the current in the loop $ABCD$ is in clockwise sense then the induced current in the loop $EFGH$ due to this current is in anticlockwise sense.

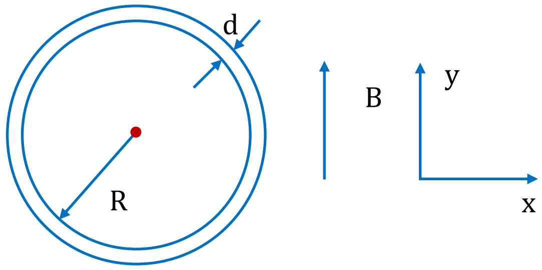
(B) If the current in the loop $ABCD$ is in clockwise sense then the induced current in the loop $EFGH$ due to this current is in clockwise sense.

(C) emf induced in the loop $EFGH$ due to current in the loop $ABCD$ is $\frac{\mu_0\ell^2k}{4\pi d}$

(D) emf induced in the loop $EFGH$ due to current in the loop $ABCD$ is $\frac{3\mu_0\ell^2k}{4\pi d}$

PAC120

108. A thin walled non-magnetic spherical shell with wall thickness d and radius R ($R >> d$) is placed in a uniform magnetic field $\vec{B} = B_0\hat{j}$, which slowly changes as $\frac{dB_0}{dt} = \alpha$, where α is a positive constant. Electrical resistivity of the material of the shell is ρ. Then choose the correct option(s).



(A) Induced magnetic moment of the shell is towards $+\hat{j}$ direction

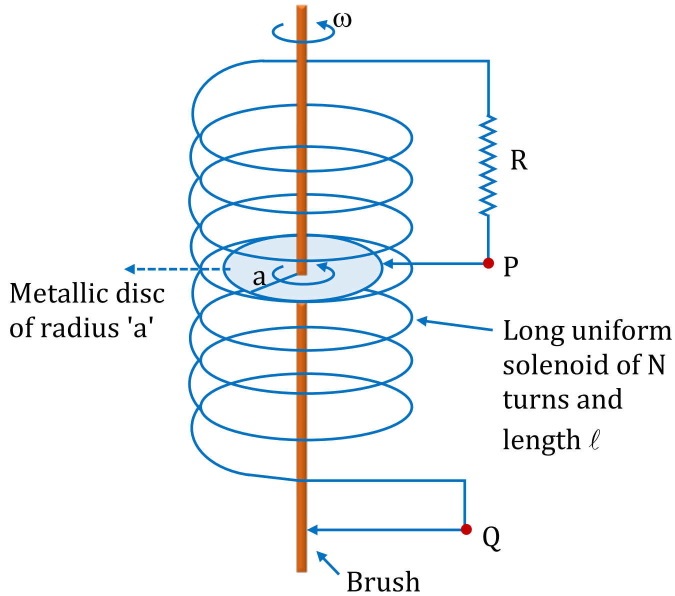
(B) Induced magnetic moment of the shell is towards $-\hat{j}$ direction

(C) Induced magnetic moment of the shell is $\frac{3\pi}{2\rho}dR^4\alpha$

(D) Induced magnetic moment of the shell is $\frac{2\pi}{3\rho}dR^4\alpha$

PAC121

109. A metallic disc of radius 'a' mounted on a rigid axle is rotating with a constant angular velocity ω inside a long solenoid of inductance L whose two ends are connected to the rotating disc by two brush contacts as shown. The total resistance of the whole circuit is R. The



(A) The induced emf between terminals P and Q is $\frac{\mu_0 Ni\omega a^2}{2\ell}$, when current in the coil is i.

(B) Current in the coil can increase or decrease with time depending upon the value of ω.

(C) ω_{min} for increasing the current in the coil always is $\frac{\ell R}{2\mu_0 Na^2}$.

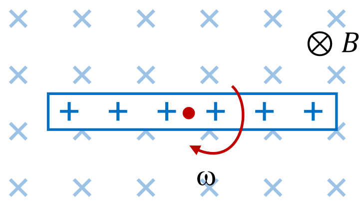
(D) ω_{min} for increasing the current in the coil always is $\frac{2\ell R}{\mu_0 Na^2}$.

PAC122

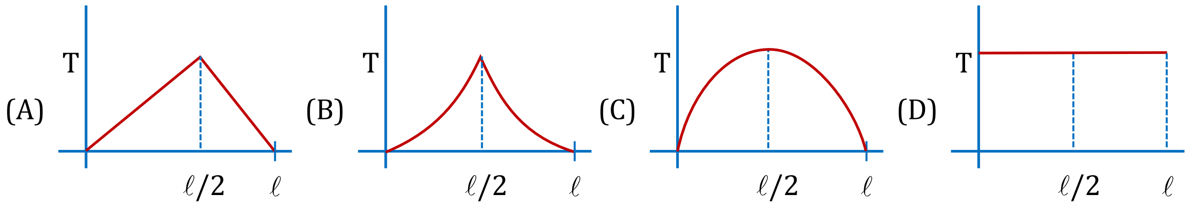
COMPREHENSION TYPE QUESTIONS

PARAGRAPH FOR QUESTION NO. 110 AND 111

A uniform rod of mass m length l is of a non-conducting material and has a uniform charge density λ. The rod is rotated with constant ω in a gravity free region having uniform magnetic field B.



110. Taking origin at one end of rod graph of magnitude of tension with length of rod would be :-



PEM071

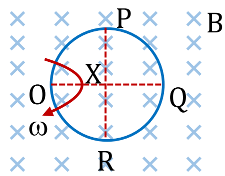
111. The ratio of magnitude of tension at $\frac{\ell}{2}$ and $\frac{3\ell}{4}$ distance from one end would be :-

(A) 1 : 1 (B) 4 : 3 (C) 3 : 2 (D) 5 : 4

PEM072

PARAGRAPH FOR QUESTION NO. 112 TO 114

A conducting ring of radius a is rotated about a point O on its periphery as shown in the figure in a plane perpendicular to uniform magnetic field B which exists everywhere. The rotational velocity is ω.



112. Choose the correct statement(s) related to the potential of the points P, Q and R

(A) $V_P - V_O > 0$ and $V_R - V_O < 0$
(B) $V_P = V_R < V_O$
(C) $V_O > V_P = V_Q$
(D) $V_Q - V_P = V_P - V_O$

PEM027

113. Choose the correct statement(s) related to the magnitude of potential differences

(A) $V_P - V_O = \frac{1}{2} B\omega a^2$
(B) $V_P - V_Q = \frac{1}{2} B\omega a^2$
(C) $V_Q - V_O = 2\, B\omega a^2$
(D) $V_P - V_R = 2\, B\omega a^2$

PEM028

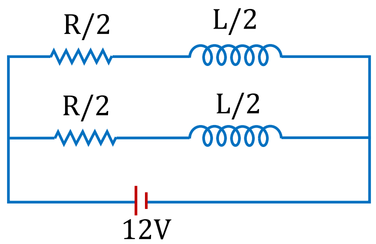
114. Choose the correct statement(s) related to the induced current in the ring

(A) Current flows from $Q \longrightarrow P \longrightarrow O \longrightarrow R \longrightarrow Q$
(B) Current flows from $Q \longrightarrow R \longrightarrow O \longrightarrow P \longrightarrow Q$
(C) Current flows from $Q \longrightarrow P \longrightarrow O$ and from $Q \longrightarrow R \longrightarrow O$
(D) No current flows

PEM029

PARAGRAPH FOR QUESTION NO. 115 TO 117

A uniformly wound solenoidal coil of self-inductance 1.8×10^{-4} *H* and resistance 6Ω is broken up into two identical coils. These identical coils are then connected in parallel across 12*V* battery of negligible internal resistance.



115. Values of equivalent resistance and equivalent inductance are respectively

(A) 1.5 Ω, 4.5×10^{-5} *H* (B) 3 Ω, 9×10^{-5} *H*

(C) 6 Ω, 1.8×10^{-4} *H* (D) 12 Ω, 3.6×10^{-4} *H*

PEM110

116. Time constant for the circuit is

(A) 15 μs (B) 45 μs (C) 30 μs (D) 60 μs

PEM111

117. Steady state current through the battery is

(A) 12*A* (B) 8*A* (C) 2*A* (D) 4*A*

PEM112

PARAGRAPH FOR QUESTION NO. 118 TO 120

In a series *L*-*R* circuit, connected with a sinusoidal ac source, the maximum potential difference across *L* and *R* are respectively 3 volts and 4 volts.

118. At an instant the potential difference across resistor is 2 volts. The potential difference in volt, across the inductor at the same instant will be :

(A) 3 cos 30° (B) 3 cos 60° (C) 3 cos 45° (D) None of these

PAC076

119. At the same instant, the magnitude of the potential difference in volt, across the ac source may be

(A) $4+3\sqrt{3}$ (B) $\frac{4+3\sqrt{3}}{2}$ (C) $1+\frac{\sqrt{3}}{2}$ (D) $2+\frac{\sqrt{3}}{2}$

PAC077

120. If the current at this instant is decreasing the magnitude of potential difference at that instant across the ac source is

(A) Increasing (B) Decreasing (C) Constant (D) Cannot be said

PAC078

EXERCISE - S

Faraday Law and Lenz Law

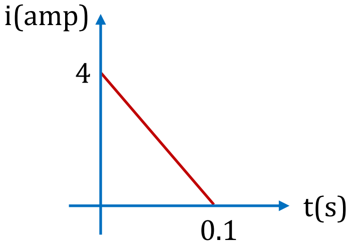
1. An air -cored solenoid of length 30 *cm*. area of cross-section 25 cm^2 and number of turns 500, carries a current of 2.5 *A*. The current is suddenly switched off in a brief time of $10^{-3}s$. How much is the average back emf induced across the ends of the open switch in the circuit? Ignore the variation in magnetic field near the ends of the solenoid.

PEM139

2. It is desired to measure the magnitude of field between the poles of a powerful loud speaker magnet. A small flat search coil of area 2 cm^2 with 25 closely wound turns, is positioned normal to the field direction, and then quickly snatched out of the field region. Equivalently, one can give it a quick 90° turn to bring its plane parallel to the field direction. The total charge flown In the coil (measured by a ballistic galvanometer connected to coil) is 7.5 *mC*. The combined resistance of the coil and the galvanometer is 0.50 Ω. Estimate the field strength of magnet.

PEM140

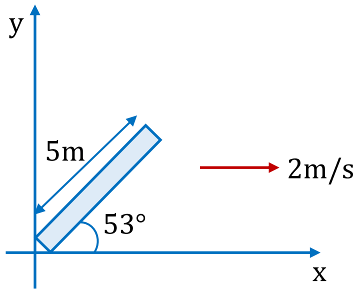
3. When magnetic flux through a coil is changed, the variation of induced current in the coil with time is as shown in graph. If resistance of coil is 10Ω, then the total change in flux (in Weber) of coil will be



PEM154

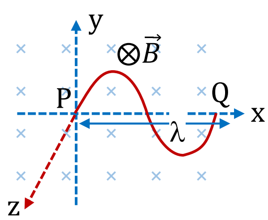
Motional EMF

4. A conducting rod *PQ* of $l = 5m$ oriented as shown is moving with $V = (2m/s)\,\hat{i}$ without any rotation in a uniform magnetic field $(3\hat{j} + 4\hat{k})$ Tesla. Emf (*V*) induced in the rod is



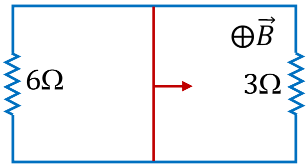
PEM043

5. A wire forming one cycle of sine curve is moved in *x-y* plane with velocity $\vec{V} = V_x\hat{\imath} + V_y\hat{\jmath}$. There exist a magnetic field $\vec{B} = -B_0\hat{k}$. Find the motional emf develop across the ends *PQ* of wire.



PEM058

6. A rectangular loop with a sliding connector of length $l = 1.0\ m$ is situated in a uniform magnetic field $B = 2T$ perpendicular to the plane of loop. Resistance of connector is $r = 2\Omega$. Two resistances of 6Ω and 3Ω are connected as shown in figure. Find the external force (in N) required to keep the connector moving with a constant velocity $v = 2m/s$.

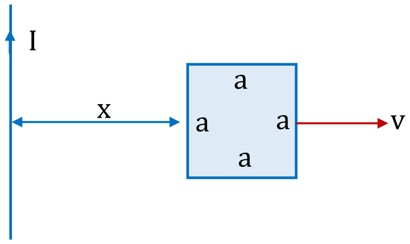


PEM062

7. A uniform magnetic field of magnitude $\frac{1.2}{\pi}$ T is in the z-direction. A conducting rod of length 1.5 m lies parallel to the y-axis and oscillates in the x-direction with displacement given by $x = (2\ cm)\cos 120\ \pi t$. What is the emf induced (in volts) in the rod at $t = 1/80$ sec? Round off to nearest integer.

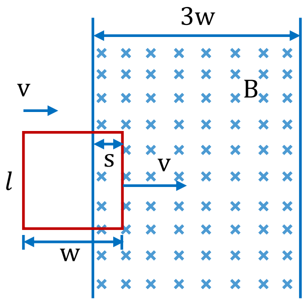
PEM066

8. Now assume that the straight wire carries a current of 50 A and the loop is moved to the right with a constant velocity, $v = 10\ m/s$. Calculate the induced emf (μV) in the loop at the instant when $x = 0.2m$. Take $a = 0.1\ m$ and assume that the loop has a large resistance.



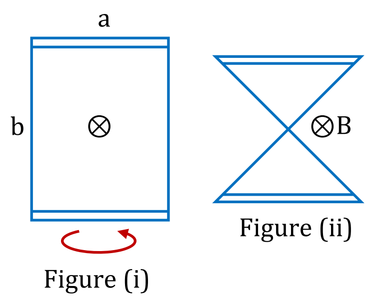
PEM091

9. A rectangular loop of dimensions l and w and resistance R moves with constant velocity V to the right as shown in the figure. It continues to move with same speed through a region containing a uniform magnetic field B directed into the plane of the paper and extending a distance 3 w. Sketch the flux, induced emf and external force acting on the loop as a function of the distance.



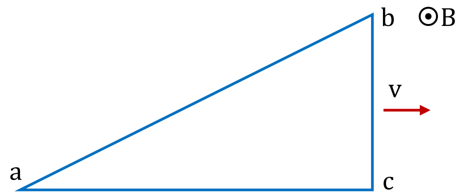
PEM141

10. Two straight conducting rod are connected by flexible conducting wires to form a rectangular outline (figure i). The sides of the rectangle are $a = 30\ cm$ and $b = 50\ cm$. The circuit is placed in a uniform magnetic field with induction $B = 5 \times 10^{-3}\ T$ directed perpendicular to the plane. What is the charge Δq (in μC) that flows along the contour, if you turn it by 180° symmetrically as shown without the wires touching each other (figure ii)? Loop resistance $R = 1$ ohm. Take self-inductance of the system to be $L = 1\ H$. Fill $\dfrac{\Delta q}{150}$ in OMR sheet.



PEM142

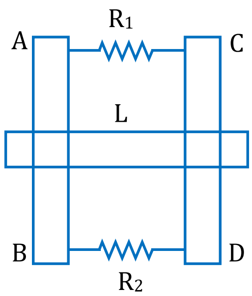
11. A right-angled triangle *abc*, made from a metallic wire, moves at a uniform speed *v* in its plane as shown in figure. A uniform magnetic field *B* exists in the perpendicular direction. Find the emf induced



(a) In the loop *abc*,
(b) In the segment *bc*,
(c) In the segment *ac* and
(d) In the segment *ab*

PEM143

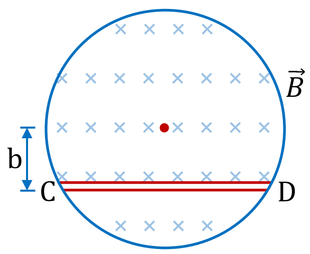
12. Two parallel vertical metallic rails *AB* and *CD* are separated by 1 *m*. They are connected at the two ends by resistance R_1 and R_2 as shown in the figure. A horizontally metallic bar *L* of mass 0.2 *kg* slides without friction, vertically down the rails under the action of gravity. There is a uniform horizontal magnetic field of 0.6*T* perpendicular to the plane of the rails, it is observed that when the terminal velocity is attained, the power dissipated in R_1 and R_2 are 0.76 *W* and 1.2 *W* respectively. Find the terminal velocity of bar *L* and value R_1 and R_2.



PEM144

Induced Electric Field

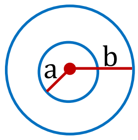
13. A uniform magnetic field $\vec{B}$ fills a cylindrical volumes of radius *R*. A metal rod *CD* of length *l* is placed inside the cylinder along a chord of the circular cross-section as shown in the figure. If the magnitude of magnetic field increases in the direction of field at a constant rate dB/dt, find the magnitude and direction of the *EMF* induced in the rod.



PEM082

Self-Inductance and Mutual Inductance

14. Two concentric and coplanar circular coils have radii a and $b(>>a)$ as shown in figure. Resistance of the inner coil is R. Current in the outer coil is increased from 0 to i, then find the total charge circulating the inner coil.



PEM092

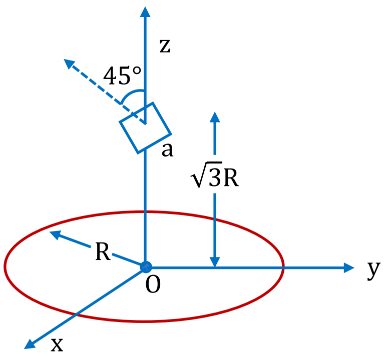
15. An inductor of inductance 2.00 H is joined in series with a resistor of resistance 200 Ω and a battery of emf 2.00 V. At t = 10 ms, find the rate (in mW) at which energy is being stored in magnetic field. (Given e^{-1} = 0.37)

PEM105

16. A semicircular loop of radius r is placed on the axis of a current carrying circular ring of radius R ($R >> r$), at a distance $R\sqrt{3}$ from the centre of the ring. The plane of the loop is making an angle of 53° with the plane of the ring. If the coefficient of mutual induction between them is $\dfrac{3\mu_0\pi r^2}{16\times nR}$, then find n:-

PEM031

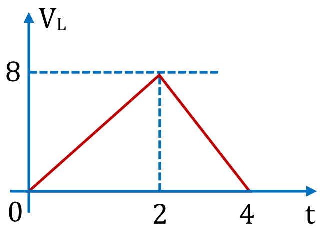
17. A circular wire loop of radius R is placed in the x-y plane centred at the origin O. A square loop of side a ($a<<R$) having two turns is placed with its centre at z = $\sqrt{3}\,R$ along the axis of the circular wire loop, as shown in figure. The plane of the square loop makes an angle of 45° with respect to the z-axis. If the mutual inductance between the loops is given by $\dfrac{\mu_0 a^2}{2^{p/2}R}$, then the value of p is :-



PEM145

A–C Circuits

18. The potential difference across a 4H inductor vary with time as shown. The current is Zero at t = 0, then the current (A) at time t = 2s

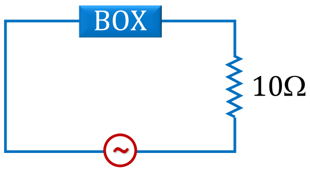


PAC055

19. An L–C–R series circuit having 220 V ac source, inductance L = 25 mH and resistance R = 100Ω. If voltage across inductor is just double of voltage across resistor then the angular frequency of source is N, then find $\frac{N}{100}$.

PAC065

20. In the circuit power factor of box is 0.5 and power factor of circuit is $\frac{\sqrt{3}}{2}$. If current leads the voltage; the value of resistance (Ω) of resistor inside the box will be :



PAC062

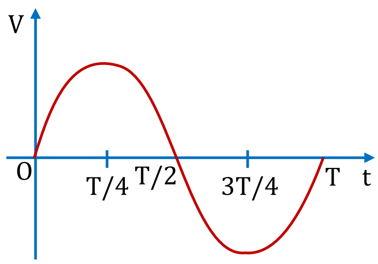
21. Find the value of an inductance which should be connected in series with a capacitor of 5μF, a resistance of 10Ω and an ac source of 50 Hz so that the power factor of the circuit is unity.

PAC069

22. A series LCR circuit containing a resistance of 120Ω has angular resonance frequency 4×10^5 rad s^{-1}. At resonance the voltages across resistance and inductance are 60 V and 40 V respectively. Find the values of L and C. At what frequency the current in the circuit lags the voltage by 45°?

PAC099

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



PAC100

24. A series R-C combination is connected to an AC voltage of angular frequency ω = 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 :-

PAC101

25. A box P and a coil Q are connected in series with an ac source of variable frequency. The emf of source is 10 V. Box P contains a capacitance of 1 μF in series with a resistance of 32Ω while coil Q has a self-inductance 4.9 mH and a resistance of 68Ω series. The frequency is adjusted so that the maximum current flows in P and Q. Find the impedance of P and Q at this frequency. Also find the voltage across P and Q respectively.

PAC102

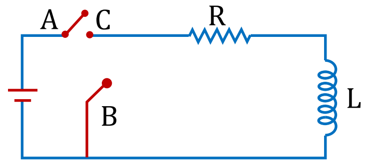
Damped and Forced Oscillation

26. The position of a particle varies according to the law $x = A\cos(\omega t - \varphi)$ under the force $F = F_0 \cos \omega\, t$. What is the average power of this force?

PAC085

EXERCISE - JEE (Main) PYQ

1. In the circuit shown here, the point 'C' is kept connected to point 'A' till the current flowing through the circuit becomes constant. Afterward, suddenly, point 'C' is disconnected from point 'A' and connected to point 'B' at time $t = 0$. Ratio of the voltage across resistance and the inductor at $t = L/R$ will be equal to:

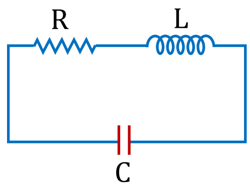


[JEE (Main) 2014]

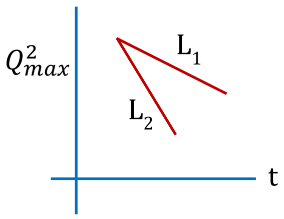
(1) -1 (2) $\frac{1-e}{e}$ (3) $\frac{e}{1-e}$ (4) 1

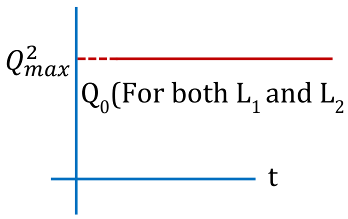
PAC015

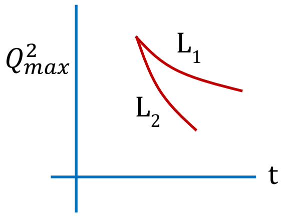
2. An LCR circuit is equivalent to a damped pendulum. In an LCR circuit the capacitor is charged to Q_0 and then connected to the L and R as shown below. If a student plots graphs of the square of maximum charge (Q^2_{Max}) on the capacitor with time (t) for two different values L_1 and L_2 ($L_1 > L_2$) of L, then which of the following represents this graph correctly ? (plots are schematic and not drawn to scale)

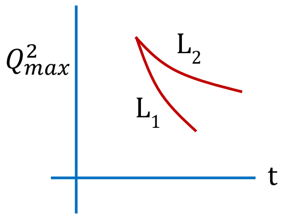


[JEE (Main) 2015]

(1)


(2)


(3)


(4)


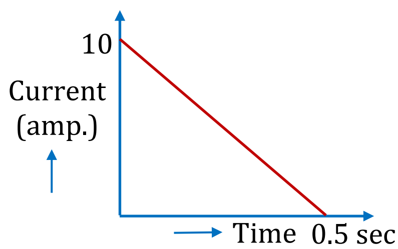
PAC016

3. An arc lamp requires a direct current of 10A at 80V to function. If it is connected to a 220V (rms), 50Hz AC supply, the series inductor needed for it to work is close to: **[JEE (Main) 2016]**

(1) 0.065 H (2) 80 H (3) 0.08 H (4) 0.044 H

PAC017

4. In a coil of resistance 100 Ω, a current is induced by changing the magnetic flux through it as shown in the figure. The magnitude of change in flux through the coil is:-



[JEE (Main) 2017]

(1) 250 Wb (2) 275 Wb

(3) 200 Wb (4) 225 Wb

PEM017

5. For an RLC circuit driven with voltage of amplitude v_m and frequency $w_0 = \frac{1}{\sqrt{LC}}$ the current exhibits resonance. The quality factor, Q is given by : **[JEE (Main) 2018]**

(1) $\frac{\omega_0 R}{L}$ (2) $\frac{R}{(\omega_0 C)}$ (3) $\frac{CR}{\omega_0}$ (4) $\frac{\omega_0 L}{R}$

PAC018

6. A power transmission line feeds input power at 2300 V to a step down transformer with its primary windings having 4000 turns. The output power is delivered at 230 V by the transformer. If the current in the primary of the transformer is 5A and its efficiency is 90%, the output current would be : **[JEE (Main) 2019]**

(1) 25 A (2) 50 A (3) 35 A (4) 45 A

PAC019

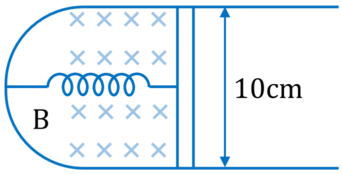
7. A copper wire is wound on a wooden frame, whose shape is that of an equilateral triangle. If the linear dimension of each side of the frame is increased by a factor of 3, keeping the number of turns of the coil per unit length of the frame is the same, then the self inductance of the coil :

(1) Decreases by a factor of $9\sqrt{3}$ (2) Increases by a factor of 3 **[JEE (Main) 2019]**

(3) Decreases by a factor of 9 (4) Increases by a factor of 27

PEM018

8. A thin strip, 10 cm long is on a U shaped wire of negligible resistance and it is connected to a spring of spring constant 0.5 Nm^{-1} (see figure). The assembly is kept in a uniform magnetic field of 0.1 T. If the strip is pulled from its equilibrium position and released, the number of oscillations it performs before its amplitude decreases by a factor of e is N. If the mass of the strip is 50 grams, its resistance is 10Ω and air drag is negligible, N will be close to :



[JEE (Main) 2019]

(1) 50000 (2) 5000 (3) 10000 (4) 1000

PAC020

9. The displacement of a damped harmonic oscillator is given by

$x(t) = e^{-0.1t}\cos(10\pi t + \phi)$. Here t is in seconds.

The time taken for its amplitude of vibration to drop to half of its initial value is close to :

[JEE (Main) 2019]

(1) 13 s (2) 7 s (3) 27 s (4) 4 s

PAC021

10. A 750 Hz, 20 V (rms) source is connected to a resistance of 100 Ω, an inductance of 0.1803 H and a capacitance of 10 μF, all in series. The time in which the resistance (heat capacity 2J/°C) will get heated by 10°C. (Assume no loss of heat to the surroundings) is close to : **[JEE (Main) 2020]**

(1) 418 s (2) 245 s (3) 348 s (4) 365 s

PAC022

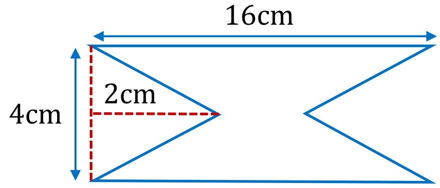
11. A series L-R circuit is connected to a battery of emf V. If the circuit is switched on at $t = 0$, then the time at which the energy stored in the inductor reaches $\left(\frac{1}{n}\right)$ times of its maximum value, is :

[JEE (Main) 2020]

(1) $\frac{L}{R}\ln\left(\frac{\sqrt{n}-1}{\sqrt{n}}\right)$ (2) $\frac{L}{R}\ln\left(\frac{\sqrt{n}}{\sqrt{n}+1}\right)$ (3) $\frac{L}{R}\ln\left(\frac{\sqrt{n}}{\sqrt{n}-1}\right)$ (4) $\frac{L}{R}\ln\left(\frac{\sqrt{n}+1}{\sqrt{n}-1}\right)$

PAC023

12. At time $t = 0$ magnetic field of 1000 Gauss is passing perpendicularly through the area defined by the closed loop shown in the figure. If the magnetic field reduces linearly to 500 Gauss, in the next $5s$, then induced EMF in the loop is : **[JEE (Main) 2020]**



(1) 36 μV (2) 48 μV (3) 56 μV (4) 28 μV

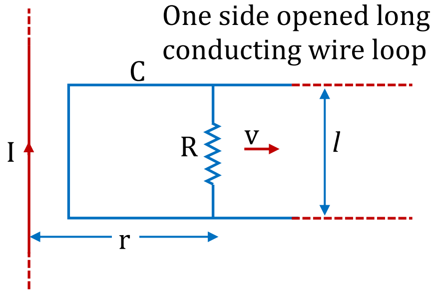
PEM019

13. A uniform magnetic field B exists in a direction perpendicular to the plane of a square loop made of a metal wire. The wire has a diameter of 4 mm and a total length of 30 cm. The magnetic field changes with time at a steady rate $dB/dt = 0.032\ Ts^{-1}$. The induced current in the loop is close to (Resistivity of the metal wire is $1.23 \times 10^{-8}\ \Omega m$) **[JEE (Main) 2020]**

(1) 0.61 A (2) 0.34 A (3) 0.43 A (4) 0.53 A

PEM020

14. An infinitely long straight wire carrying current I, one side opened rectangular loop and a conductor C with a sliding connector are located in the same plane, as shown in the figure. The connector has length l and resistance R. It slides to the right with a velocity v. The resistance of the conductor and the self inductance of the loop are negligible. The induced current in the loop, as a function of separation r, between the connector and the straight wire is : **[JEE (Main) 2020]**



(1) $\frac{\mu_0}{\pi}\frac{Ivl}{Rr}$ (2) $\frac{\mu_0}{2\pi}\frac{Ivl}{Rr}$ (3) $\frac{2\mu_0}{\pi}\frac{Ivl}{Rr}$ (4) $\frac{\mu_0}{4\pi}\frac{Ivl}{Rr}$

PEM021

15. A LCR circuit behaves like a damped harmonic oscillator. Comparing it with a physical spring-mass damped oscillator having damping constant 'b', the correct equivalence would be:

[JEE (Main) 2020]

(1) $L \leftrightarrow m, C \leftrightarrow \frac{1}{k}, R \leftrightarrow b$ (2) $L \leftrightarrow \frac{1}{b}, C \leftrightarrow \frac{1}{m}, R \leftrightarrow \frac{1}{k}$

(3) $L \leftrightarrow m, C \leftrightarrow k, R \leftrightarrow b$ (4) $L \leftrightarrow k, C \leftrightarrow b, R \leftrightarrow m$

PAC024

16. An inductor coil stores 64 J of magnetic field energy and dissipates energy at the rate of 640 W when a current of 8A is passed through it. If this coil is joined across an ideal battery, find the time constant of the circuit in seconds : **[JEE (Main) 2021]**

(1) 0.4 (2) 0.8 (3) 0.125 (4) 0.2

PAC025

17. An ac circuit has an inductor and a resistor of resistance R in series, such that $X_L = 3R$. Now, a capacitor is added in series such that $X_C = 2R$. The ratio of new power factor with the old power factor of the circuit is $\sqrt{5}:x$. The value of x is ____. **[JEE (Main) 2021]**

PAC026

18. Given below are two statements :

Statement-I : The reactance of an ac circuit is zero. It is possible that the circuit contains a capacitor and an inductor.

Statement-II : In ac circuit, the average power delivered by the source never becomes zero.

In the light of the above statements, choose the correct answer from the options given below : **[JEE (Main) 2022]**

(1) Both Statement I and Statement II are true.
(2) Both Statement I and Statement II are false.
(3) Statement I is true but Statement II in false.
(4) Statement I is false but Statement II is true.

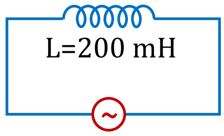
PAC027

19. A resistance of 40 Ω is connected to a source of alternating current rated 220 *V*, 50 *Hz*. Find the time taken by the current to change from its maximum value to *rms* value : **[JEE (Main) 2022]**

(1) 2.5 *ms* (2) 1.25 *ms* (3) 2.5 *s* (4) 0.25 *s*

PAC028

20. As shown in the figure an inductor of inductance 200 *mH* is connected to an *AC* source of emf 220 *V* and frequency 50 *Hz*. The instantaneous voltage of the source is 0 *V* when the peak value of current is $\frac{\sqrt{a}}{\pi}A$. The value of a is ______.



[JEE (Main) 2022]

PAC029

21. A square shaped coil of area 70 cm^2 having 600 turns rotates in a magnetic field of 0.4 wbm^{-2}, about an axis which is parallel to one of the side of the coil and perpendicular to the direction of field. If the coil completes 500 revolution in a minute, the instantaneous emf when the plane of the coil is inclined at 60° with the field, will be ___ V. (Take $\pi = \frac{22}{7}$) **[JEE (Main) 2023]**

PEM146

22. An oscillating LC circuit consists of a 75 *mH* inductor and a $1.2\mu F$ capacitor. If the maximum charge to the capacitor is $2.7\mu C$. The maximum current in the circuit will be ___*mA*. **[JEE (Main) 2023]**

PEM147

23. A series LCR circuit is connected to an ac source of 220V, 50*Hz*. The circuit contain a resistance R = 100Ω and an inductor of inductive reactance X_L = 79.6 Ω. The capacitance of the capacitor needed to maximize the average rate at which energy is supplied will be _______ μF.

[JEE (Main) 2023]

PAC103

24. A series combination of resistor of resistance 100Ω, inductor of inductance 1*H* and capacitor of capacitance 6.25μF is connected to an ac source. The quality factor of the circuit will be ________.

[JEE (Main) 2023]

PAC104

EXERCISE - JEE (Advanced) PYQ

PARAGRAPH FOR QUESTION NO. 1 AND 2

A point charge Q is moving in a circular orbit of radius R in the x-y plane with an angular velocity ω. This can be considered as equivalent to a loop carrying a steady current $\frac{Q\omega}{2\pi}$. A uniform magnetic field along the positive z-axis is now switched on, which increases at a constant rate from 0 to B in one second. Assume that the radius of the orbit remains constant. The application of the magnetic field induces an emf in the orbit. The induced emf is defined as the work done by an induced electric field in moving a unit positive charge around a closed loop. It is known that for an orbiting charge, the magnetic dipole moment is proportional to the angular momentum with a proportionality constant γ. **[JEE (Advanced) 2013]**

1. The change in the magnetic dipole moment associated with the orbit, at the end of the time interval of the magnetic field change is

(A) $-\gamma BQR^2$ (B) $-\gamma\frac{BQR^2}{2}$ (C) $\gamma\frac{BQR^2}{2}$ (D) γBQR^2

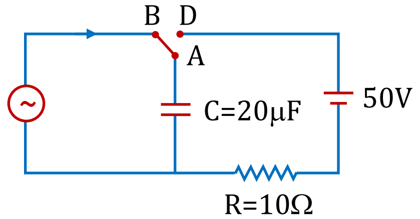
PEM032

2. The magnitude of the induced electric field in the orbit at any instant of time during the time interval of the magnetic field change is

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

PEM033

3. At time $t = 0$, terminal A in the circuit shown in the figure is connected to B by a key and an alternating current $I(t) = I_0\cos(\omega t)$, with $I_0 = 1A$ and $\omega = 500\ rad\ s^{-1}$ starts flowing in it with the initial direction shown in the figure. At $t = \frac{7\pi}{6\omega}$, the key is switched from B to D. Now onwards only A and D are connected. A total charge Q flows from the battery to charge the capacitor fully. If $C = 20\ \mu F$, $R = 10\ \Omega$ and the battery is ideal with emf of $50\ V$, identify the correct statement (s). **[JEE (Advanced) 2014]**



(A) Magnitude of the maximum charge on the capacitor before $t = \frac{7\pi}{6\omega}$ is $1 \times 10^{-3} C$.

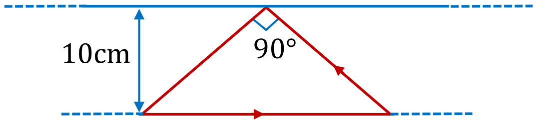
(B) The current in the left part of the circuit just before $t = \frac{7\pi}{6\omega}$ is clockwise.

(C) Immediately after A is connected to D, the current in R is $10A$

(D) $Q = 2 \times 10^{-3}\ C$

PAC040

4. A conducting loop in the shape of right-angled isosceles triangle of height 10 *cm* is kept such that the 90° vertex is very close to an infinitely long conducting wire (see the figure). The wire is electrically insulated from the loop. The hypotenuse of the triangle is parallel to the wire. The current in the triangular loop is in counterclockwise direction and increased at constant rate of 10 $A\ s^{-1}$. Which of the following statement(s) is(are) true? **[JEE (Advanced) 2016]**



(A) The induced current in the wire is in opposite direction to the current along the hypotenuse.

(B) There is a repulsive force between the wire and the loop.

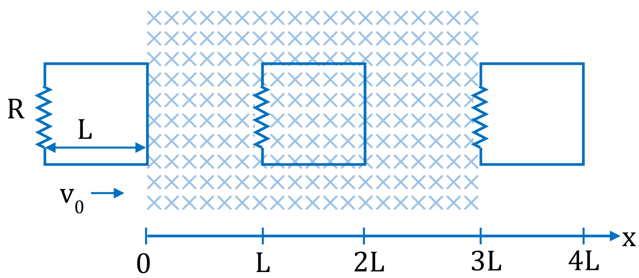
(C) If the loop is rotated at a constant angular speed about the wire, an additional emf of $\left(\frac{\mu_0}{\pi}\right)$ volt is induced in the wire.

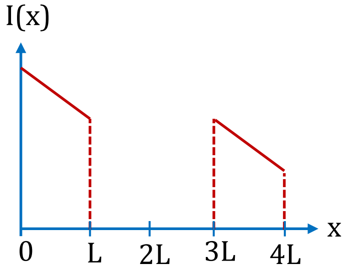
(D) The magnitude of induced emf in the wire is $\left(\frac{\mu_0}{\pi}\right)$ volt.

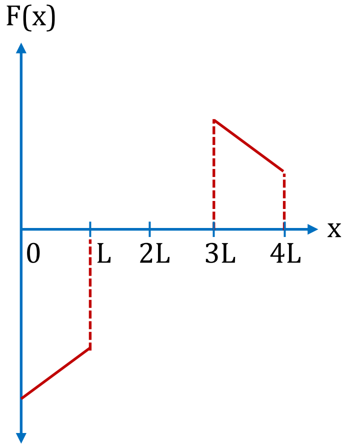
PEM034

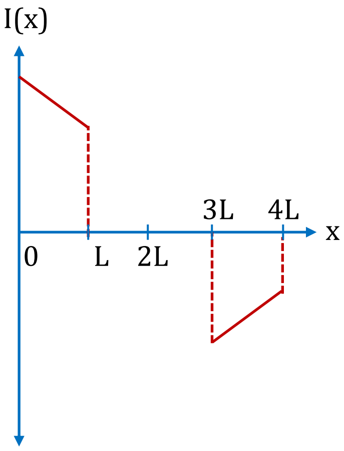
5. A rigid wire loop of square shape having side of length L and resistance R is moving along the x-axis with a constant velocity v_0 in the plane of the paper. At $t = 0$, the right edge of the loop enters a region of length $3L$ where there is a uniform magnetic field B_0 into the plane of the paper, as shown in the figure. For sufficiently large v_0, the loop eventually crosses the region. Let x be the location of the right edge of the loop. Let $v(x)$, $I(x)$ and $F(x)$ represent the velocity of the loop, current in the loop, and force on the loop, respectively, as a function of x. Counter-clockwise current is taken as positive. Which of the following schematic plot(s) is(are) correct? (Ignore gravity)

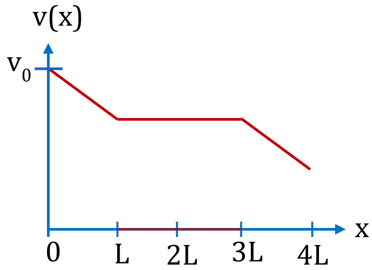
[JEE (Advanced) 2016]



(A) 

(B) 

(C) 

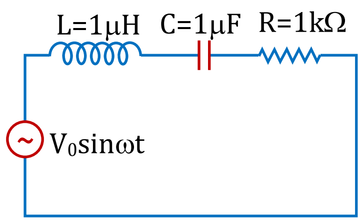
(D) 

PEM035

6. Two inductors L_1 (inductance 1 mH, internal resistance 3 Ω) and L_2 (inductance 2mH, internal resistance 4Ω), and a resistor R (resistance 12 Ω) are all connected in parallel across a 5V battery. The circuit is switched on at time t = 0. The ratio of the maximum to the minimum current (I_{max}/I_{min}) drawn from the battery is. **[JEE (Advanced) 2016]**

PAC041

7. In the circuit shown, L = 1 μH, C = 1 μF and R = 1 $k\Omega$. They are connected in series with an *A.C.* source V=V_0 sin ωt as shown. Which of the following options is/are correct ? **[JEE (Advanced) 2017]**



(A) The frequency at which the current will be in phase with the voltage is independent of R.

(B) At ω ~ 0 the current flowing through the circuit becomes nearly zero.

(C) At ω >> 10^6 *rad-s*$^{-1}$, the circuit behaves like a capacitor.

(D) The current will be in phase with the voltage if ω = 10^4 *rad-s*$^{-1}$.

PAC042

8. The instantaneous voltages at three terminals marked X, Y and Z are given by

$$V_X = V_0 \sin \omega t \;;\; V_Y = V_0 \sin\left(\omega t + \frac{2\pi}{3}\right) \text{ and } V_Z = V_0 \sin\left(\omega t + \frac{4\pi}{3}\right)$$

An ideal voltmeter is configured to read *rms* value of the potential difference between its terminals. It is connected between points X and Y and then between Y and Z. The reading(s) of the voltmeter will be:- **[JEE (Advanced) 2017]**

(A) $V_{XY}^{rms} = V_0$

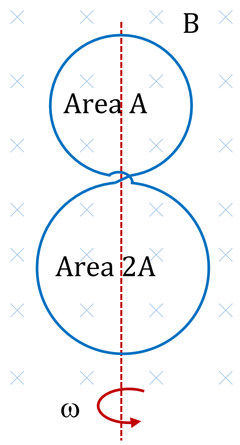
(B) $V_{YZ}^{rms} = V_0\sqrt{\frac{1}{2}}$

(C) Independent of the choice of the two terminals

(D) $V_{XY}^{rms} = V_0\sqrt{\frac{3}{2}}$

PAC043

9. A circular insulated copper wire loop is twisted to form two loops of area A and $2A$ as shown in the figure. At the point of crossing the wires remain electrically insulated from each other. The entire loop lies in the plane (of the paper). A uniform magnetic field $\vec{B}$ points into the plane of the paper. At $t = 0$, the loop starts rotating about the common diameter as axis with a constant angular velocity ω in the magnetic field. Which of the following options is/are correct? **[JEE (Advanced) 2017]**



(A) The rate of change of the flux is maximum when the plane of the loops is perpendicular to plane of the paper

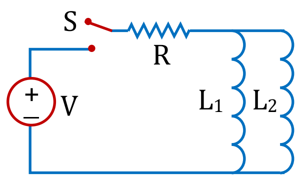
(B) The net emf induced due to both the loops is proportional to cos ωt

(C) The emf induced in the loop is proportional to the sum of the areas of the two loops

(D) The amplitude of the maximum net emf induced due to both the loops is equal to the amplitude of maximum emf induced in the smaller loop alone

PEM036

10. A source of constant voltage V is connected to a resistance R and two ideal inductors L_1 and L_2 through a switch S as shown. There is no mutual inductance between the two inductors. The switch S is initially open. At $t = 0$, the switch is closed and current begins to flow. Which of the following options is/are correct? **[JEE (Advanced) 2017]**



(A) The ratio of the currents through L_1 and L_2 is fixed at all times ($t > 0$).

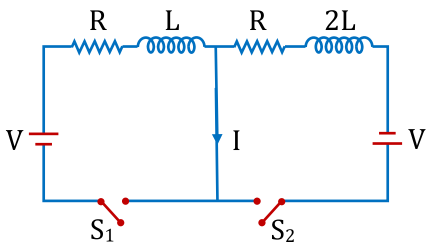
(B) After a long time, the current through L_1 will be $\frac{V}{R}\frac{L_2}{L_1 + L_2}$.

(C) After a long time, the current through L_2 will be $\frac{V}{R}\frac{L_1}{L_1 + L_2}$.

(D) At $t = 0$, the current through the resistance R is $\frac{V}{R}$.

PAC044

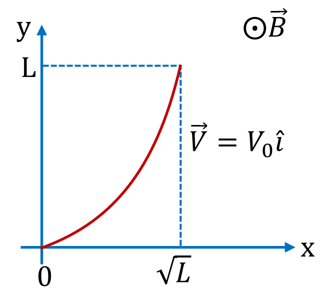
11. In the figure below, the switches S_1 and S_2 are closed simultaneously at $t = 0$ and a current starts to flow in the circuit. Both the batteries have the same magnitude of the electromotive force (*emf*) and the polarities are as indicated in the figure. Ignore mutual inductance between the inductors. The current I in the middle wire reaches its maximum magnitude I_{max} at time $t = \tau$. Which of the following statement(s) is (are) true? **[JEE (Advanced) 2018]**



(A) $I_{max} = \dfrac{V}{2R}$ (B) $I_{max} = \dfrac{V}{4R}$ (C) $\tau = \dfrac{L}{R}\ell n2$ (D) $\tau = \dfrac{2L}{R}\ell n2$

PAC045

12. A conducting wire of parabolic shape, initially $y = x^2$, is moving with velocity $\vec{V} = V_0\hat{i}$ in a non-uniform magnetic field $\vec{B} = B_0\left(1+\left(\dfrac{y}{L}\right)^{\beta}\right)\hat{k}$, as shown in figure. If V_0, B_0, L and b are positive constants and $\Delta\phi$ is the potential difference developed between the ends of the wire, then the correct statement(s) is/are: **[JEE (Advanced) 2019]**



(A) $|\Delta\phi|$ remains the same if the parabolic wire is replaced by a straight wire, $y = x$ initially, of length $\sqrt{2}L$.

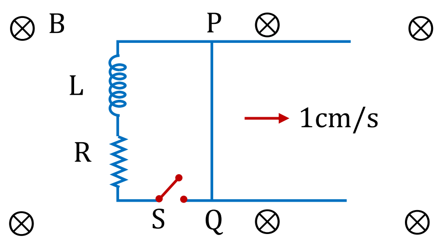
(B) $|\Delta\phi|$ is proportional to the length of the wire projected on the y-axis.

(C) $|\Delta\phi| = \dfrac{1}{2}B_0V_0L$ for $b = 0$.

(D) $|\Delta\phi| = \dfrac{4}{3}B_0V_0L$ for $b = 2$.

PEM037

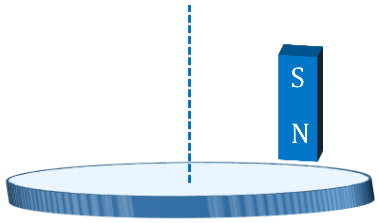
13. A 10 cm long perfectly conducting wire PQ is moving with a velocity 1cm/s on a pair of horizontal rails of zero resistance. One side of the rails is connected to an inductor L = 1 mH and a resistance $R = 1\Omega$ as shown in figure. The horizontal rails, L and R lie in the same plane with a uniform magnetic field $B = 1T$ perpendicular to the plane. If the key S is closed at certain instant, the current in the circuit after 1 millisecond is $x \times 10^{-3}A$, where the value of x is______.
[Assume the velocity of wire PQ remains constant (1 cm/s) after key S is closed.
Given : e^{-1} = 0.37 , where e is base of the natural logarithm]
[JEE (Advanced) 2019]



PEM038

14. A light disc made of aluminum (a nonmagnetic material) is kept horizontally and is free to rotate about its axis as shown in the figure. A strong magnet is held vertically at a point above the disc away from its axis. On revolving the magnet about the axis of the disc, the disc will (figure is schematic and not drawn to scale)-

[JEE (Advanced) 2020]



(A) rotate in the direction opposite to the direction of magnet's motion

(B) rotate in the same direction as the direction of magnet's motion

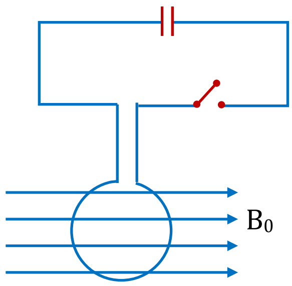
(C) not rotate and its temperature will remain unchanged

(D) not rotate but its temperature will slowly rise

PEM039

15. A circular coil of radius R and N turns has negligible resistance. As shown in the schematic figure, its two ends are connected to two wires and it is hanging by those wires with its plane being vertical. The wires are connected to a capacitor with charge Q through a switch. The coil is in a horizontal uniform magnetic field B_0 parallel to the plane of the coil. When the switch is closed, the capacitor gets discharged through the coil in a very short time. By the time the capacitor is discharged fully, magnitude of the angular momentum gained by the coil will be (assume that the discharge time is so short that the coil has hardly rotated during this time)-

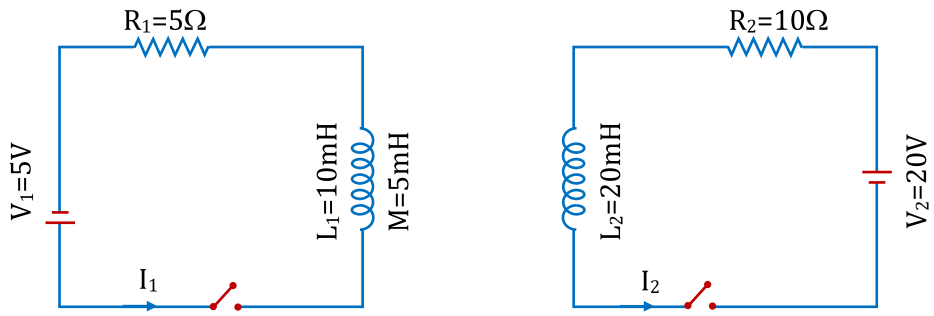
[JEE (Advanced) 2020]



(A) $\frac{\pi}{2} NQB_oR^2$ (B) πNQB_0R^2 (C) $2\pi NQB_0R^2$ (D) $4\pi NQB_0R^2$

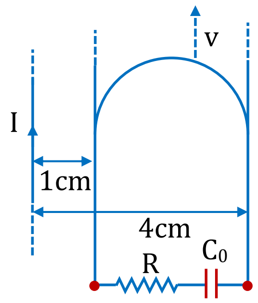
PEM040

16. The inductors of two LR circuits are placed next to each other, as shown in the figure. The values of the self-inductance of the inductors, resistances, mutual-inductance and applied voltages are specified in the given circuit. After both the switches are closed simultaneously, the total work done by the batteries against the induced EMF in the inductors by the time the currents reach their steady state values is_______ mJ. **[JEE (Advanced) 2020]**



PAC046

17. A long straight wire carries a current, $I = 2$ ampere. A semi-circular conducting rod is placed beside it on two conducting parallel rails of negligible resistance. Both the rails are parallel to the wire. The wire, the rod and the rails lie in the same horizontal plane, as shown in the figure. Two ends of the semi-circular rod are at distances $1cm$ and $4\ cm$ from the wire. At time $t = 0$, the rod starts moving on the rails with a speed $v = 3.0\ m/s$ (see the figure).



A resistor $R = 1.4\ \Omega$ and a capacitor $C_0 = 5.0\ \mu F$ are connected in series between the rails. At time $t = 0$, C_0 is uncharged. Which of the following statement(s) is(are) correct ?

[$\mu_0 = 4\pi \times 10^{-7}$ SI units. Take ln 2 = 0.7] **[JEE (Advanced) 2021]**

(A) Maximum current through R is 1.2×10^{-6} ampere.

(B) Maximum current through R is 3.8×10^{-6} ampere.

(C) Maximum charge on capacitor C_0 is 8.4×10^{-12} coulomb.

(D) Maximum charge on capacitor C_0 is 2.4×10^{-12} coulomb.

PAC047

QUESTION STEM FOR QUESTION NOS. 18 AND 19

In a circuit, a metal filament lamp is connected in series with a capacitor of capacitance $C\ \mu F$ across a $200V$, $50Hz$ supply. The power consumed by the lamp is $500W$ while the voltage drop across it is $100V$. Assume that there is no inductive load in the circuit. Take *rms* values of the voltages. The magnitude of the phase-angle (in degrees) between the current and the supply voltage is j. Assume, $\pi\sqrt{3} \approx 5$. **[JEE (Advanced) 2021]**

18. The value of C is ____.

PAC048

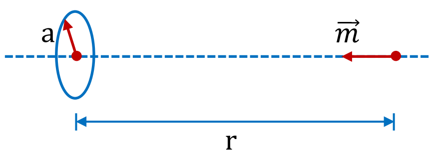
19. The value of j is ____.

PAC049

QUESTION STEM FOR QUESTION NOS. 20 AND 21

A special metal S conducts electricity without any resistance. A closed wire loop, made of S, does not allow any change in flux through itself by inducing a suitable current to generate a compensating flux. The induced current in the loop cannot decay due to its zero resistance. This current gives rise to a magnetic moment which in turn repels the source of magnetic field or flux. Consider such a loop, of radius a, with its center at the origin. A magnetic dipole of moment m is brought along the axis of this loop from infinity to a point at distance r (>> a) from the center of the loop with its north pole always facing the loop, as shown in the figure below.

The magnitude of magnetic field of a dipole m, at a point on its axis at distance r, is $\frac{\mu_0}{2\pi}\frac{m}{r^3}$, where μ_0 is the permeability of free space. The magnitude of the force between two magnetic dipoles with moments, m_1 and m_2, separated by a distance r on the common axis, with their north poles facing each other, is $\frac{km_1m_2}{r^4}$, where k is a constant of appropriate dimensions. The direction of this force is along the line joining the two dipoles. **[JEE (Advanced) 2021]**



20. When the dipole m is placed at a distance r from the center of the loop (as shown in the figure), the current induced in the loop will be proportional to :

(A) $\frac{m}{r^3}$ (B) $\frac{m^2}{r^2}$ (C) $\frac{m}{r^2}$ (D) $\frac{m^2}{r}$

PEM041

21. The work done in bringing the dipole from infinity to a distance r from the center of the loop by the given process is proportional to :

(A) $\frac{m}{r^5}$ (B) $\frac{m^2}{r^5}$ (C) $\frac{m^2}{r^6}$ (D) $\frac{m^2}{r^7}$

PEM042

22. A series LCR circuit is connected to a 45 sin (ωt) Volt source. The resonant angular frequency of the circuit is 10^5 rad s^{-1} and current amplitude at resonance is I_0. When the angular frequency of the source is $\omega = 8 \times 10^4$ rad s^{-1}, the current amplitude in the circuit is 0.05 I_0. If $L = 50\ mH$, match each entry in List-I with an appropriate value from List-II and choose the correct option.

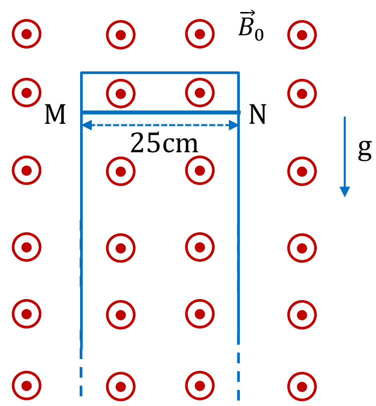
	List-I		List-II
(P)	I_0 in mA	(1)	44.4
(Q)	The quality factor of the circuit	(2)	18
(R)	The bandwidth of the circuit in rad s^{-1}	(3)	400
(S)	The peak power dissipated at resonance in Watt	(4)	2250
		(5)	500

[JEE (Advanced) 2023]

(A) $P \to 2, Q \to 3, R \to 5, S \to 1$ (B) $P \to 3, Q \to 1, R \to 4, S \to 2$
(C) $P \to 4, Q \to 5, R \to 3, S \to 1$ (D) $P \to 4, Q \to 2, R \to 1, S \to 5$

PAC105

23. A thin conducting rod MN of mass 20 gm, length 25 cm and resistance 10 Ω is held on frictionless, long, perfectly conducting vertical rails as shown in the figure. There is a uniform magnetic field $B_0 = 4T$ directed perpendicular to the plane of the rod-rail arrangement. The rod is released from rest at time $t = 0$ and it moves down along the rails. Assume air drag is negligible. Match each quantity in List-I with an appropriate value from List-II, and choose the correct option.
[Given: The acceleration due to gravity $g = 10\ ms^{-2}$ and $e^{-1} = 0.4$]



	List-I		List-II
(P)	At $t = 0.2s$, the magnitude of the induced emf in Volt	(1)	0.07
(Q)	At $t = 0.2s$, the magnitude of the magnetic force in Newton	(2)	0.14
(R)	At $t = 0.2s$, the power dissipated as heat in Watt	(3)	1.20
(S)	The magnitude of terminal velocity of the rod in ms^{-1}	(4)	0.12
		(5)	2.00

[JEE (Advanced) 2023]

(A) $P \to 5, Q \to 2, R \to 3, S \to 1$ (B) $P \to 3, Q \to 1, R \to 4, S \to 5$
(C) $P \to 4, Q \to 3, R \to 1, S \to 2$ (D) $P \to 3, Q \to 4, R \to 2, S \to 5$

PEM155

JEE (Main) Practice Paper

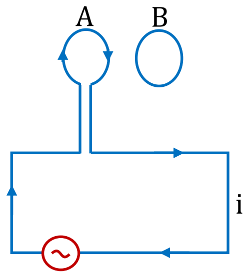
This paper is for yourself practice and assessment the discussion of this paper is optional though you can see PDF solutions or video solutions or solutions in hardcopy whichever is provided.

SECTION–A

- This section contains **TWENTY** questions.
- Each question has **FOUR** options (1), (2), (3) and (4). **ONLY ONE** of these four options is correct.
- For each question, darken the bubble corresponding to the correct option in the ORS.
- For each question, marks will be awarded in one of the following categories:

Full Marks : +4, if only the bubble corresponding to the correct option is darkened.
Zero Marks : 0, if none of the bubbles is darkened.
Negative Marks : −1 in all other cases.

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



(1) there will be repulsion between *A* and *B* if *i* is increased
(2) there will be attraction between *A* and *B* if *i* is increased
(3) there will be neither attraction nor repulsion when *i* is changed
(4) attraction or repulsion between *A* and *B* depends on the direction of current. It does not depend whether the current is increased or decreased.

PEM001

2. A rectangular coil of single turn, having area *A*, rotates in a uniform magnetic field *B* with an angular velocity ω about an axis perpendicular to the field. If initially the plane of coil is perpendicular to the field, then the average induced e.m.f. when it has rotated through 90° is :-

(1) $\frac{\omega BA}{\pi}$ (2) $\frac{\omega BA}{2\pi}$ (3) $\frac{\omega BA}{4\pi}$ (4) $\frac{2\omega BA}{\pi}$

PEM002

3. In figure (a) a solenoid produces a magnetic field whose strength increases into the plane of the page. An induced emf is established in a conduction loop surrounding the solenoid, and this emf lights bulbs *A* and *B*. In figure (b) point *P* and *Q* are shorted. After the short is inserted

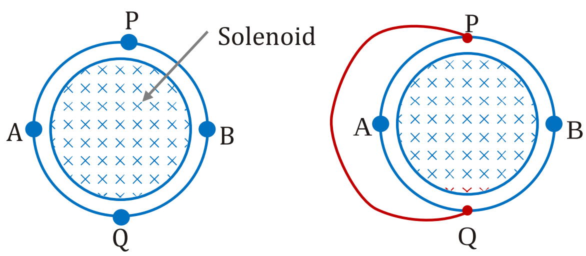


Fig. (a) **Fig. (b)**

(1) Bulb *A* goes out, bulb *B* gets brighter
(2) Bulb *B* goes out, bulb *A* gets brighter
(3) Bulb *A* goes out, bulb *B* gets dimmer
(4) Bulb *B* goes out, bulb *A* gets dimmer

PEM003

4. A coil (which can be modelled as a series circuit) has been designed for high Q performance at a rated voltage and a specified frequency. If the frequency of operation is doubled and the coil is operated at the same rated voltage, then the Q factor and the active power P consumed by the coil will be affected as below

(1) P is doubled, Q is halved

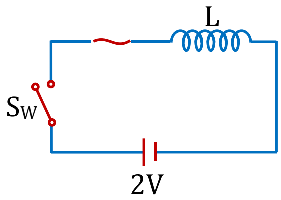
(2) P is halved, Q is doubled

(3) P remains constant but Q increases 4 times

(4) P decreases 4 times but Q is doubled

PAC106

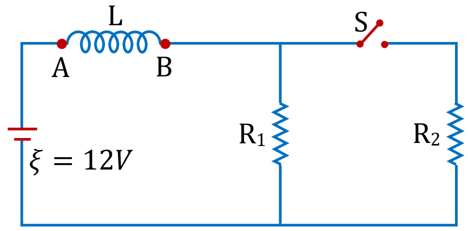
5. In the circuit shown, the cell is ideal. The coil has an inductance of $4H$ and zero resistance. F is a fuse of zero resistance and will blow when the current through it reaches $5A$. The switch is closed at $t = 0$. The fuse will blow :



(1) just after $t = 0$ (2) after $2s$ (3) after $5s$ (4) after $10s$

PAC001

6. The circuit shown has been operating for a long time. The instant after the switch in the circuit labeled S is opened, what is the voltage across the inductor V_L and which labeled point (A or B) of the inductor is at a higher potential? Take $R_1 = 4.0\ \Omega$, $R_2 = 8.0\ \Omega$, and $L = 2.5\ H$.



(1) $V_L = 12\ V$; Point A is at the higher potential

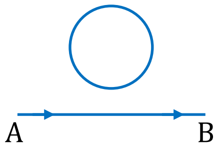
(2) $V_L = 12\ V$; Point B is at the higher potential

(3) $V_L = 6V$; Point A is at the higher potential

(4) $V_L = 6V$; Point B is at the higher potential

PAC002

7. In the arrangement shown in given figure, current from A to B is increasing in magnitude. Induced current in the loop will



(1) have clockwise direction (2) have anticlockwise direction

(3) be zero (4) oscillate between clockwise and anticlockwise

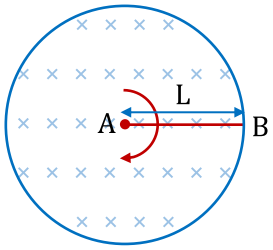
PEM005

8. 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:

(1) 100Ω, 0.93 H (2) 200Ω, 1.0 H (3) 10Ω, 0.86H (4) 200Ω, 0.55 H

PAC003

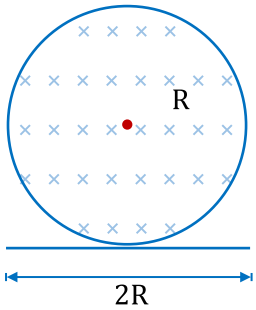
9. A copper rod AB of length L, pivoted at one end A, rotates at constant angular velocity ω, at right angles to a uniform magnetic field of induction B. The e.m.f developed between the mid point C of the rod and end B is



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

PEM006

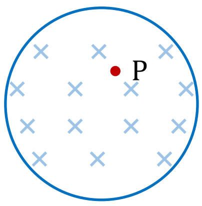
10. A uniform but time varying magnetic field is present in a circular region of radius R. The magnetic field is perpendicular and into the plane of the loop and the magnitude of field is increasing at a constant rate α. There is a straight conducting rod of length $2R$ placed as shown in figure. The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



(1) $\pi R^2\alpha$ (2) $\frac{\pi R^2\alpha}{2}$ (3) $\frac{R^2\alpha}{\sqrt{2}}$ (4) $\frac{\pi R^2\alpha}{4}$

PEM007

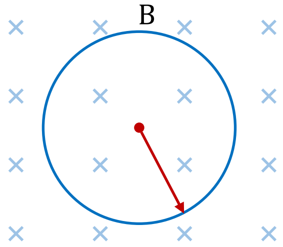
11. Figure shows a uniform magnetic field B confined to a cylindrical volume and is increasing at a constant rate. The instantaneous acceleration experienced by an electron placed at P is



(1) zero (2) towards right (3) towards left (4) upwards

PEM008

12. A non conducting ring (of mass m, radius r and charge Q) is placed on a rough horizontal surface (in a region with transverse magnetic field). The field is increasing with time at the rate R and coefficient of friction between the surface and the ring is μ. For ring to remain in equilibrium, μ should be greater than :-



(1) $\frac{QrR}{mg}$ (2) $\frac{QrR}{2mg}$ (3) $\frac{QrR}{3mg}$ (4) $\frac{2QrR}{mg}$

PEM009

13. The e.m.f. induced in a coil of wire, which is rotating in a magnetic field, does not depend on

(1) the angular speed of rotation (2) the area of the coil

(3) the number of turns on the coil (4) the resistance of the coil

PEM010

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

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

(2) relative position and orientation of the two coils

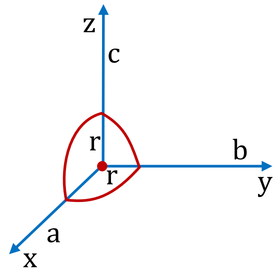
(3) the materials of the wires of the coils

(4) the currents in the two coils

PEM011

15. A wire is bent into 3 circular segments of radius $r = 10\ cm$ as shown in figure. Each segment is a quadrant of a circle, ab is lying in the xy plane, bc is lying in the yz plane and ca is lying in the zx plane.

If a magnetic field B points in the positive x direction, what is the magnitude of the emf developed in the wire, when B increases at the rate of $3\ mT/s$?



(1) $4.8 \times 10^{-5}\ V$ (2) $2.4 \times 10^{-5}\ V$ (3) $1.2 \times 10^{-5}\ V$ (4) $3.6 \times 10^{-5}\ V$

PEM012

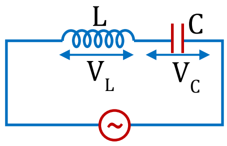
16. Four particles undergo damped harmonic motion. Values of the spring constant k, the damping constant b and the mass m are given below. Which leads to the smallest rate of loss of mechanical energy at the initial moment?

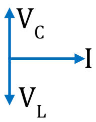
(1) $k = 100N/m,\ m = 50g,\ b = 8g/s$ (2) $k = 150N/m,\ m = 50g,\ b = 5g/s$

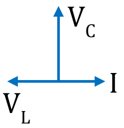
(3) $k = 150N/m,\ m = I0g, b = 8g/s$ (4) $k = 200N/m,\ m = 8g,\ b = 6g/s$

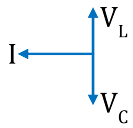
PAC004

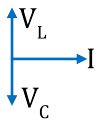
17. The current I, potential difference V_L across the inductor and potential difference V_C across the capacitor in circuit, as shown in the figure, are best represented vectorially as



(1) 

(2) 

(3) 

(4) 

PAC005

18. 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

(1) capacitive (2) inductive (3) purely resistive (4) data insufficient

PAC006

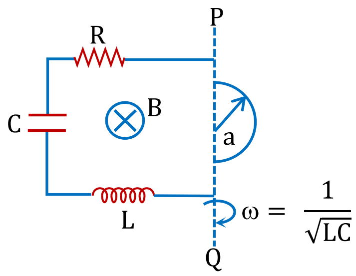
19. An current is given by $I = I_0 + I_1 \sin \omega t$ then its rms value will be

(1) $\sqrt{I_0^2 + 0.5 I_1^2}$ (2) $\sqrt{I_0^2 + 0.5 I_0^2}$ (3) 0 (4) $I_0/\sqrt{2}$

PAC007

20. A semi-circular wire is given angular velocity $\omega = \dfrac{1}{\sqrt{LC}}$, with the help of an external agent. A uniform magnetic field B exists in space and is directed into the plane of the figure. (circuit part remains at rest)

(Left part is at rest). then the **incorrect** statement for given arrangement is:



(1) The rms value of current in the circuit is $\dfrac{\pi B a^2}{R\sqrt{2LC}}$

(2) The rms value of current in the circuit is $\dfrac{\pi B a^2}{2R\sqrt{2LC}}$

(3) The maximum energy stored in the capacitor is $\dfrac{\pi^2 B^2 a^4}{8R^2 C}$

(4) The maximum power delivered by the external agent is $\dfrac{\pi^2 B^2 a^4}{8LCR}$

PAC107

SECTION–B

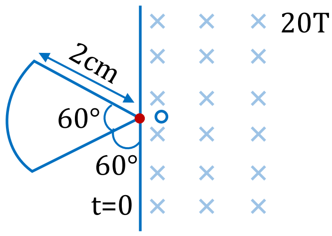
- This section will have **TEN questions**. Candidate can choose to attempt any 5 questions out of these 10 questions. In case if candidate attempts more than 5 questions, first 5 attempted questions will be considered for marking.
- The answer to each question is a **NUMERICAL VALUE.**
- For each question, enter the correct numerical value (Answer should be rounded off to the nearest integer).
- Answer to each question will be evaluated according to the following marking scheme:

Full Marks	:	+4,	if only correct answer is given.
Zero Marks	:	0,	if no answer is given.
Negative Marks	:	–1	for incorrect answer.

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

PEM013

2. A uniform magnetic field 20 T exists on right side of the boundary in a gravity free space as shown in figure. The given circular arc of radius 2 cm made of conducting wire of total resistance 4Ω is rotated around point O at a constant angular speed 2 rad per second. Power required (μW) to maintain the constant angular velocity between time interval $t = \frac{\pi}{6}$ s to $t = \frac{\pi}{3}$ s is :-



PEM014

3. 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 (A) in the loop will be nearly (Take : $\pi^2 = 10$)

PEM015

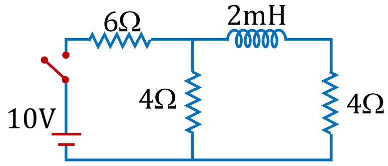
4. In a series LCR circuit, half power frequencies (frequency at which power dissipated is half the maximum power dissipated in the circuit) are found to be 90 rad/s and 40 rad/s. Find the value of $\frac{\omega_0}{10}$, where ω_0 is the resonance frequency.

PAC108

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

PAC010

6. In the given circuit, if the ratio of i_1 to i_2 is k, where i_1 is the initial (at $t = 0$) current and i_2 is steady state (at $t = \infty$) current through the battery, then $100k$ is



PAC011

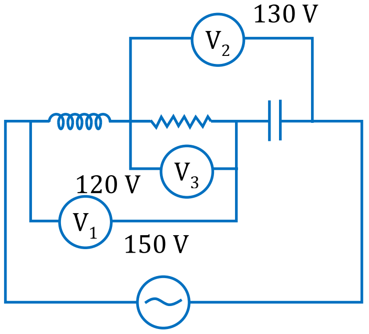
7. An LCR series circuit with 100Ω resistance is connected to an ac source of 200 V and angular frequency 300 rad/s. When only the capacitance is removed, the current lags behind the voltage by 60°. When only the inductance is removed, the current leads the voltage by 60°. Calculate the power (W) dissipated in the LCR circuit.

PAC012

8. The radius of a coil decreases steadily at the rate of 10^{-2} m/s. A constant and uniform magnetic field of induction 10^{-3} Wb/m^2 acts perpendicular to the plane of the coil. If the radius of the coil (in cm) is $\frac{n}{\pi}$ cm, when the induced e.m.f. in the coil is $1\mu V$, then the value of n is

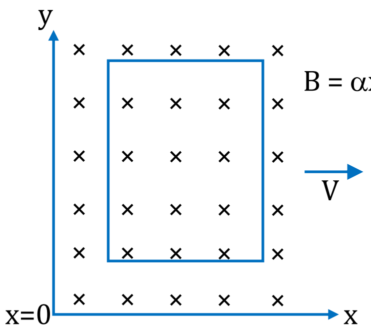
PEM016

9. The rms readings of voltmeters V_1, V_2, V_3 are 150V, 130V and 120V respectively. If applied ac rms voltage = x and power factor of the circuit is y. Find $\frac{x \times y}{20}$.



PAC109

10. A square loop of length $L = 0.2$ m and resistance $R = 80$ $m\Omega$ lies with one of its length along the x-axis as shown in the figure. It moves with speed $V = 10$ m/s in the positive x-direction in a magnetic field which is into the page and has a magnitude that varies with x according to $B = \alpha x$ where $\alpha = 0.2$ Tm^{-1}. The magnitude of induced current is I ampere. Then the value of $10I$ is.
(Neglect self inductance of the loop)



PEM148

JEE (Advanced) Practice Paper

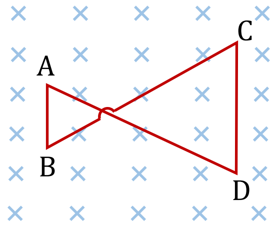
This paper is for yourself practice and assessment the discussion of this paper is optional though you can see PDF solutions or video solutions or solutions in hardcopy whichever is provided.

SECTION–I

- This section contains **FOUR** questions.
- Each question has **FOUR** options (A), (B), (C) and (D). **ONLY ONE** of these four options is correct.
- For each question, darken the bubble corresponding to the correct option in the ORS.
- For each question, marks will be awarded in one of the following categories:

Full Marks : +3 if only the bubble corresponding to the correct option is darkened.
Zero Marks : 0 if none of the bubbles is darkened.
Negative Marks : –1 in all other cases.

1. 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*

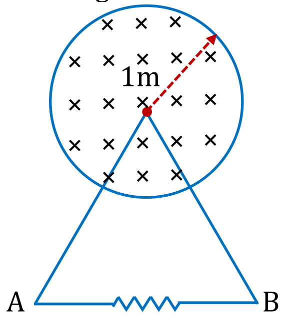
PEM022

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

(A) 6/5 (B) 5/6 (C) $\frac{4}{3\sqrt{3}}$ (D) $\frac{3\sqrt{3}}{4}$

PAC030

3. A uniform magnetic field of intensity $B = \frac{6}{\pi}\sin 2t$ directed into the plane of the paper exists in the cylindrical region of radius 1 *m*. A loop of resistance 10Ω folded in the form of equilateral triangle of side length 2*m* is placed as shown in figure. Find the maximum potential drop in wire *AB*.



(A) 2 (B) 4 (C) 6 (D) 8

PEM149

4. An AC source producing e.m.f. $V = V_0$ (sin ωt + sin 3 ωt) is connected in series with a capacitor and a resistor. The current in the circuit is found to be $i = i_1 \sin(\omega t + \phi_1) + i_2 \sin(3\omega t + \phi_2)$. Then

(A) $i_1 > i_2$ (B) $i_1 = i_2$

(C) $i_1 < i_2$ (D) any of the above may be true

PAC110

SECTION-II

- This section contains **FIVE** questions.
- Each question has **FOUR** options for correct answer(*s*). **ONE OR MORE THAN ONE** of these four option(*s*) is (are) correct option(*s*).
- For each question, choose the correct option(*s*) to answer the question.
- Answer to each question will be evaluated according to the following marking scheme:

Full Marks : +4 if only (all) the correct option(*s*) is (are) chosen.

Partial Marks : +3 if all the four options are correct but ONLY three options are chosen.

Partial Marks : +2 if three or more options are correct but ONLY two options are chosen, both of which are correct options.

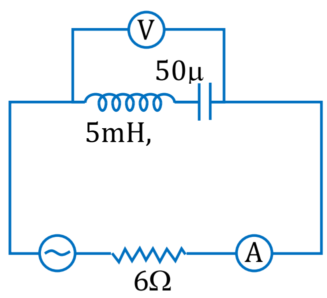
Partial Marks : +1 if two or more options are correct but ONLY one option is chosen and it is a correct option.

Zero Marks : 0 if none of the options is chosen (i.e. the question is unanswered).

Negative Marks : –2 in all other cases.

For Example : If first, third and fourth are the **ONLY** three correct options for a question with second option being an incorrect option; selecting only all the three correct options will result in +4 marks. Selecting only two of the three correct options (e.g. the first and fourth options), without selecting any incorrect option (second option in this case), will result in +2 marks. Selecting only one of the three correct options (either first or third or fourth option), without selecting any incorrect option (second option in this case), will result in +1 marks. Selecting any incorrect option(*s*) (second option in this case), with or without selection of any correct option(*s*) will result in –2 marks.

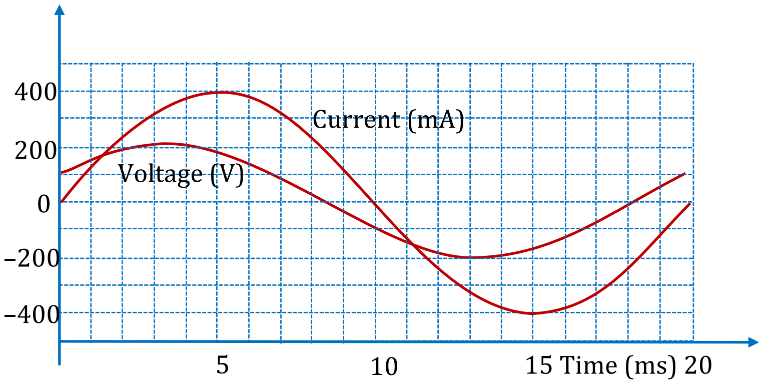
5. In the circuit shown in the figure, the A.C. source gives a voltage $V = 20 \cos(2000\,t)$ volt. Neglecting source resistance, the voltmeter and ammeter readings will be :–



(A) 0*V*, 2*A* (B) 0 *V*, 1.4*A* (C) 5.6 *V*, 1.4 *A* (D) 1.68 *V*, 0.47 *A*

PAC111

6. The given graph shows variation with time in the source voltage and steady state current drawn by a series RLC circuit. Which of the following statements is/are correct?



(A) Current lags the voltage.

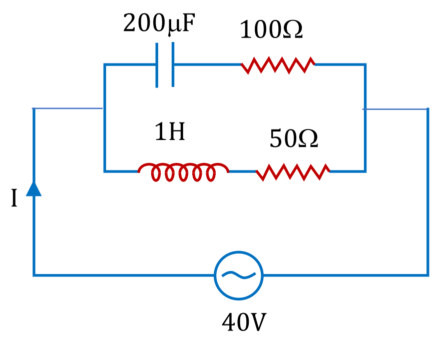
(B) Resistance in the circuit is $250\sqrt{3}\,\Omega$.

(C) Reactance in the circuit is 250Ω.

(D) Average power dissipation in the circuit is $20\sqrt{3}\ W$.

PAC112

7. In the given circuit, the AC source has ω = 50 rad/s. Considering the inductor and capacitor to be ideal, the **CORRECT** choice (s) is(are) :-



(A) The voltage across 100Ω resistor = $20\sqrt{2}V$

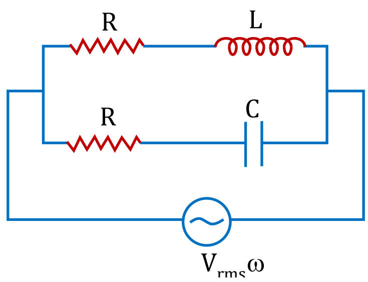
(B) The voltage across 50Ω resistor = $20\sqrt{2}V$

(C) The current through the circuit, I is $\frac{2}{\sqrt{10}}A$

(D) The current through the circuit, I is $1.2A$

PAC113

8. In this given circuit, the value of $R=\sqrt{\frac{L}{C}}$. Consider the following statements and choose the correct option:



(i) RMS value of current through a.c. source is $\frac{V_{rms}}{2R}$

(ii) Impedance of circuit is independent of ω

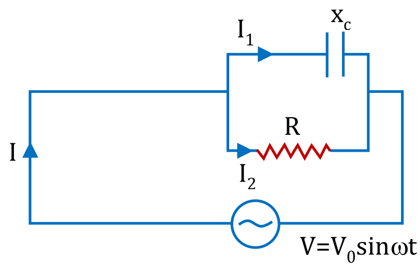
(iii) Impedance of circuit depends upon ω

(iv) RMS value of current through a.c. source is $\frac{V_{rms}}{\sqrt{R^2+\omega^2L^2}}$

(A) only (iii) and (iv) are correct
(B) only (ii) is correct
(C) only (i) and (ii) are correct
(D) only (iv) is correct

PAC114

9. In the given a.c. circuit:



(A) current I_2 and V are is same phase

(B) current I_1 lags I_2 by 90°

(C) I leads I_2 by $\theta < 90°$

(D) I leads I_1 by $\theta < 90°$

PAC115

SECTION–III

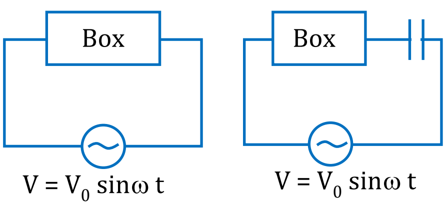
- This section contains **ONE** paragraphs.
- Based on each paragraph, there are **THREE** questions.
- Each question has **FOUR** options (A), (B), (C) and (D) **ONE OR MORE THAN ONE** of these four option(s) is(are) correct.
- For each question, darken the bubble(s) corresponding to all the correct option(s) in the ORS.
- Answer to each question will be evaluated according to the following marking scheme:

Full Marks : +4 if only (all) the correct option(s) is (are) chosen.
Partial Marks : +3 if all the four options are correct but ONLY three options are chosen.
Partial Marks : +2 if three or more options are correct but ONLY two options are chosen, both of which are correct options.
Partial Marks : +1 if two or more options are correct but ONLY one option is chosen and it is a correct option.
Zero Marks : 0 if none of the options is chosen (i.e. the question is unanswered).
Negative Marks : –2 in all other cases.

For Example: If first, third and fourth are the **ONLY** three correct options for a question with second option being an incorrect option; selecting only all the three correct options will result in +4 marks. Selecting only two of the three correct options (e.g. the first and fourth options), without selecting any incorrect option (second option in this case), will result in +2 marks. Selecting only one of the three correct options (either first or third or fourth option), without selecting any incorrect option (second option in this case), will result in +1 marks. Selecting any incorrect option(s) (second option in this case), with or without selection of any correct option(s) will result in –2 marks.

PARAGRAPH FOR QUESTION NO. 10 to 12

When a box is connected with a source $V = V_0 \sin \omega t$, then power factor of circuit is $\frac{1}{\sqrt{2}}$. If a capacitor is connected in series with the box, then power factor of circuit becomes unity. (Assume that box contains only series combination of elements)



10. Box may contain resistance in series with an:

(A) capacitor
(B) inductor
(C) another resistance
(D) none of the above

PAC116

11. Impedance of box with same source is:

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

PAC117

12. In box ratio of resistance and reactance is:

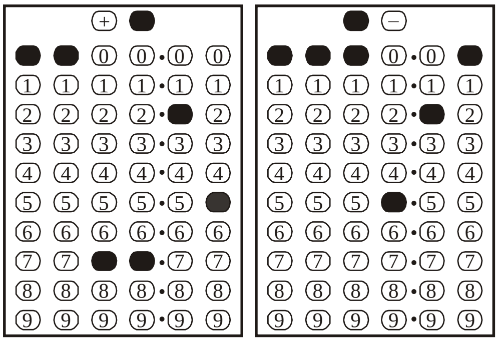
(A) equal to 1 (B) greater than 1 (C) less than 1 (D) none of above

PAC118

SECTION-IV

- This section contains **FIVE** questions.
- The answer to each question is a **NUMERICAL VALUE**.
- For each question, enter the correct numerical value (in decimal notation, truncated/rounded-off to the **second decimal place**; e.g. 6.25, 7.00, –0.33, –.30, 30.27, –127.30, if answer is 11.36777..... then both 11.36 and 11.37 will be correct) by darken the corresponding bubbles in the ORS.

For Example : If answer is –77.25, 5.2 then fill the bubbles as follows:



- Answer to each question will be evaluated according to the following marking scheme:

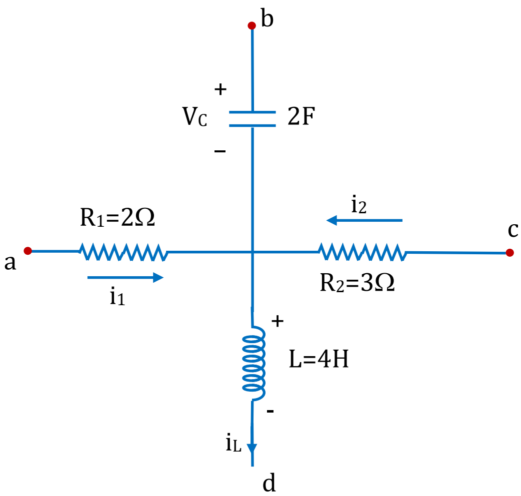
Full Marks : +3 if ONLY the correct numerical value is entered as answer.

Zero Marks : 0 in all other cases.

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

PEM030

14. In the figure shown $i_1 = 10e^{-2t}\,A$, $i_2 = 4A$ and $V_C = 3e^{-2t}\ V$. If $V_L = ae^{-bt}$ then find $\left|\frac{a}{b}\right|$:-

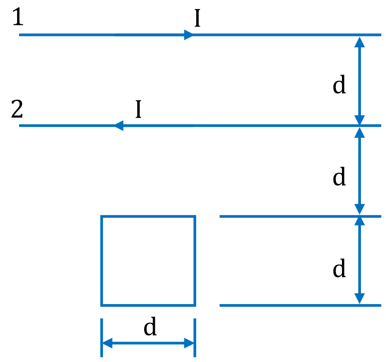


PAC119

15. In a circuit with Q factor = 5000 and oscillation frequency 2×10^5 rad/s, the current amplitude decreases by a factor of e in a time interval Δt. Find Δt (in sec).

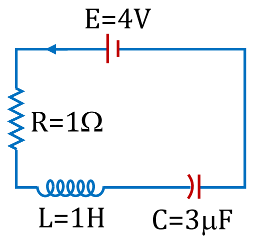
PAC035

16. Two infinite parallel wires separated by a distance d carry equal currents I in opposite directions, with I increasing at the rate $\frac{dI}{dt} = 2A/s$. A square loop of wire of length d on a side lies in the plane of the wires at a distance $d = 2\pi(m)$ from one of the parallel wires, as illustrated in figure. Find the *emf* induced (in V) in the square loop. If your answer is $n\mu_0 \ell n \frac{4}{3}$ write value of n.



PEM150

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



PAC037

ANSWER KEY

EXERCISE - O

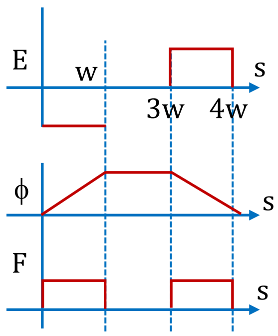
Que.	1	2	3	4	5	6	7	8	9	10
Ans.	C	A	D	C	C	B	C	B	B	D
Que.	11	12	13	14	15	16	17	18	19	20
Ans.	A	C	D	D	C	A	B	A	C	B
Que.	21	22	23	24	25	26	27	28	29	30
Ans.	A	A	A	C	C	C	A	A	A	A
Que.	31	32	33	34	35	36	37	38	39	40
Ans.	D	A	A	C	A	C	A	A	B	D
Que.	41	42	43	44	45	46	47	48	49	50
Ans.	B	C	B	A	B	A	B	A	A	A
Que.	51	52	53	54	55	56	57	58	59	60
Ans.	B	A	B	C	A	A	A	B	D	D
Que.	61	62	63	64	65	66	67	68	69	70
Ans.	A	D	D	B	A	B	A	D	A	D
Que.	71	72	73	74	75	76	77	78	79	80
Ans.	A	C	D	B	C	B	C	B	A	D
Que.	81	82	83	84	85	86	87	88	89	90
Ans.	D	A	B	A	D	C	AC	ABCD	AC	AB
Que.	91	92	93	94	95	96	97	98	99	100
Ans.	ABC	BD	AD	AB	BC	ACD	AB	ABD	ABCD	ACD
Que.	101	102	103	104	105	106	107	108	109	110
Ans.	AC	AD	BC	ACD	CD	ACD	BC	BD	ABD	C
Que.	111	112	113	114	115	116	117	118	119	120
Ans.	B	D	C	D	A	C	B	A	B	A

EXERCISE - S

1. 6.5 *V* **2.** 0.75 *T* **3.** 2 **4.** 32

5. $\lambda V_y B_0$ **6.** 2 **7.** 4 **8.** 1.7×10^{-5} *V*

9.



10. 5 **11.** (a) zero, (b) $vB(bc)$, positive at *c*, (c) zero (d) $vB(bc)$, positive at a

12. $V = 1\ ms^{-1}, R_1 = 0.5\ \Omega,\ R_2 = 0.30\ \Omega$ **13.** $\left(\frac{1}{2}\frac{dB}{dt}\sqrt{R^2 - \frac{l^2}{4}}\right)$ **14.** $\left(\frac{\mu_0 i a^2 \pi}{2Rb}\right)$

15. 4.6 **16.** 10 **17.** 7 **18.** 2

19. 80 **20.** 5 **21.** $\frac{20}{\pi^2} \cong 2H$

22. $0.2\ mH,\ \frac{1}{32}\ \mu F,\ 8 \times 10^5\ \text{rad}/s$ **23.** $20\ A, \pi/4,$ **24.** 4

25. $77\Omega, 97.6\Omega, 7.7\ V, 9.76\ V$ **26.** $\frac{F_0 A\omega}{2}\sin\phi$

EXERCISE - JEE (Main) PYQ

Que.	1	2	3	4	5	6	7	8	9	10
Ans.	1	3	1	1	4	4	2	2	2	3
Que.	11	12	13	14	15	16	17	18	19	20
Ans.	3	3	1	2	1	4	1	3	1	242
Que.	21	22	23	24						
Ans.	44	9	40	4						

EXERCISE - JEE (Advanced) PYQ

Que.	1	2	3	4	5	6	7	8	9	10
Ans.	B	B	CD	BD	CD	8	AB	CD	AD	ABC
Que.	11	12	13	14	15	16	17	18	19	20
Ans.	BD	ABD	0.63	B	B	55	AC	100	60	A
Que.	21	22	23							
Ans.	C	B	D							

JEE (Main) Practice Paper

Section-A	Q.	1	2	3	4	5	6	7	8	9	10
	A.	1	4	1	4	4	4	1	4	4	4
	Q.	11	12	13	14	15	16	17	18	19	20
	A.	2	2	4	2	2	2	4	1	1	1
Section-B	Q.	1	2	3	4	5	6	7	8	9	10
	A.	2	16	2	6	3	125	400	5	6	10

JEE (Advanced) Practice Paper

Section-I	Q.	1	2	3	4	
	A.	A	D	A	C	
Section-II	Q.	5	6	7	8	9
	A.	C	ABCD	ABC	B	AC
Section-III	Q.	10	11	12		
	A.	B	A	A		
Section-IV	Q.	13	14	15	16	17
	A.	16	8	0.05	2	6