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Electromagnetic Induction & Alternating Current

Magnetic Flux

1. At a given place , horizontal and vertical component of earth's magnetic field B_H and B_V are along x- and y- axes, respectively, a shown in the figure. What is the total flux of earth' magnetic field associated with an area S, if the area S is in the

(a) x-y pane, (b) y-z plane ?

Lenz's Law

2. A conducting circular loop having a radius of 5.0 cm, I placed perpendicular to a magnetic field of 0.05 T, it is removed from the field in 0.05 s. find the average emf produced in the loop during this time.

3. A circular loop of radius 'a' turns is kept in a horizontal plane, A uniform magnetic field B exists in a vertical direction as shown in the figure. Find the emf induced in loop if the loop is rotated with a uniform angular velocity ω about:

(a) an axis passing through the center and perpendicular to the pane of the loop.

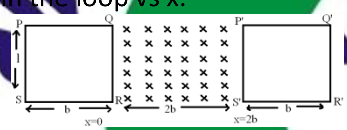
(b) a diameter

PROBLEMS(SUBJECTIVE)

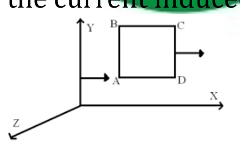
1. A rectangular flat loop of wire with dimensions ℓ and b has N turns and a total resistance R. The loop moves with constant velocity v from position PQRS to p'q'r'S' through a region of constant magnetic field B as shown in figure

(a) Plot the graph of the flux inked with loop v x. (where x is the distance moved by the loop)

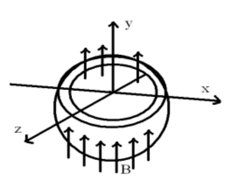
(b) Plot the graph of the emf induced in the loop vs x.



2. In the co – ordinate system shown in the figure magnetic field is directed along negative z – axis and its magnitude varies a $B = B_o/x$, where B_o is a position constant. A square loop ABCD of side 'a' and resistance per unit length 'λ' is moved with constant seed v with it plane parallel to x – y plane. Initially side AB was on the y – axis. Find the current induced in the loop as a function of time.



3. An elastic circular conducting loop, is at the equator of an air filled balloon, a hemispherical cross section of which is shown in figure. The sphere has a radius of 0.60 m. There is a uniform magnetic field B in the region of 5.0×10^{-2} s, the balloon is direction to a radius of 0.30 m. What is the average emf induced in the coil during this time.



4. A closed circular coil having a diameter of 50 cm made of 200 turns of wire with a total resistance of 10Ω is placed with its plane at right angle to a magnetic field of strength 10^{-2} tesla. Calculate the

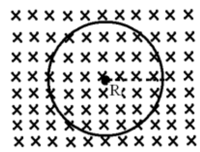
quantity of electric charge passing through it when the coil I turned through 180^o about an axis in its plane.

5. A ring of radius R, made up of a conducting wire cross section 'a' is paced in a magnetic died perpendicular to the plane. The magnetic field varies with time as B – B_o in $2\pi ft$, where B_o is a constant.

(a) find the induced emf in the ring.

(b) find the resistance of the ring if the resistivity of the material is ρ

(c) What is instantaneous power lo due to current in the ring? (Ignore the self induced currents in the ring.)



OBJETIVE

1. A coil of are 500 cm^2 having 1000 turns is place such that the plane of the coil is perpendicular to a magnetic field of magnitude 4×10^{-5} weber/m^2. If it I rotated by 180^o about an axis passing through one of its diameter in 0.1 sec, find the average induced emf.

(A) zero (B) 30 mV. (C) 40 mV (D) 50 mV

2. A ring of radius 10 cm is laced in a circular magnetic field, which is varying at the rate of 10 tesla/sec. The electric field at any point on the circumference of the ring is

(A) 1 N/C (B) 1.5 N/C (C) 0.5 N/C (D) zero

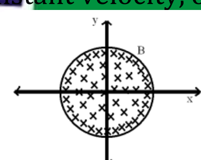
3. A loop is kept o that its centre lies at the origin of the coordinate system. A magnetic field has the induction B pointing along Z axis as shown in the figure. Then

(A) no emf and current will be induced in the loop if it rotates about Z axis

(B) emf is induced but no current flows if the loop is a fiber when it rotates about y axis

(C) emf is induced and induced current flows in the loop if the loop is made of copper

(D) if the loop moves along Z axis with constant velocity, on current flown in it.



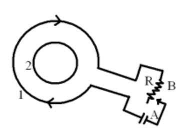
4. Shown in the figure is a small circular loop that is co – axial with the bigger circular loop., If the slider moves from A to B, then

(A) current flow in both the loop will be in opposite direction.

(B) clockwise current flows in loop 1 and anti – clockwise current flows in loop 2

(C) no current flows in loop 2.

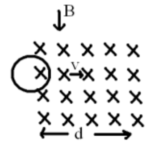
(D) clockwise current flows in loop 2.



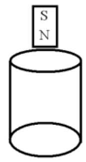
5. A conducting loop is pulled in and taken out with a constant velocity in a regionof constant (steady) magnetic field of induction B a shown in the figure. Then, the current involved in the loop is (d>r)

(A) clockwise (B) anti-clockwise

(C) zero (D) all of these



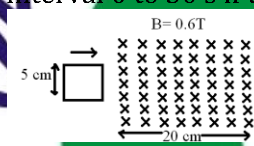
6. When a magnet is released from rest along the axis of a hollow conducting cylinder situated vertically a shown in the figure,



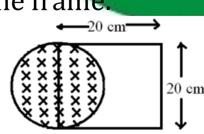
(A) the direction of induced current in the cylinder is anti – clockwise as seen from the above
(B) the magnet moves with an acceleration less than $g = 9.8\ m/s^2$
(C) the cylinder get heated
(D) the magnet attains a terminal speed inside the cylinder if the cylinder is very long.

EXERCISE – I

1. What are the dimensions of magnetic flux?
2 The magnetic flux through a coil changes from 12 mWb to 6 mWb in 0.01 s. What is the average induced emf?
3. A square loop of side 22 cm is change to a circle in time 0.4 s. The magnetic flied present is 0.27 T. Find the average emf induced in the circular loop?
4.Fig. shown a square loop of side 5 cm being moved toward right at a constant speed of 1 cm/s. The front edge enter the 0 cm wide magnetic field at t=0. Find the emf induced in the loop at
(a) t = 2s (b) t = 10 s (c) t = 22 s and (d) t = 30 s.
Find the total heat produced during the interval 0 to 30 s if the resistance of the loop is 4.5mΩ.



5. 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 4.o Ω is bent into a square frame and is placed with one side along a diameter of the cylindrical region. If the magnetic field increases at a constant rate of 0.010 T/s, find the current induced in the frame.



6. The magnetic field in the cylindrical region shown in the figure. Increase at a constant rate of 20.0 mT/s. Each side of the square loop abcd and defa has a length of 1.00 cm and a resistance of 4.00 Ω find the current (magnitude and sense) in the wire and if
(a) the witch S_1 is closed but S_2 is open,
(b) S_1 is open but S_2 is closed,
(c) both S_1 and S_2 are open and
(d) both S_1 and S_2 are closed.

7.A long solenoid of radius 2 cm has 100 turns/cm and carries a current of 5A. A coil of radius 1 cm having 100 turns and a total resistance of 20 Ω is placed inside the solenoid coaxially. The coil is connected to a galvanometer. If the current in the solenoid is reversed in direction, find the charge that through the galvanometer

8. A rectangular coil is placed in a region having a uniform a magnetic field B, perpendicular to the plane of the coil. An e.m.f. will not be induced in the coil if the:

(A) magnetic field increase uniformly

(B) coil is rotated about an axis perpendicular to the plane of the coil and passing through it centre O, the coil remaining in the same plane

(C) coil is rotated about the axis OX.

(D) magnetic field is suddenly switched off.

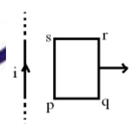
9. A rectangular coil pqrs is moved away from an infinite, straight wire carrying a current as shown in figure. Which of the following statement is correct?

(A) There is no induced current in coil pqrs

(B) The induced current in coil pqrs is in the clockwise sense

(C) The induced current in the coil pqrs is in anticlockwise direction

(D) none of the above



10. The normal drawn to the surface of a conductor make an angle θ with the direction of field B. The flux ϕ passing through the area A is given by

(A) ϕ =BA (B) ϕ=B.A (C) ϕ=B/A (D) ϕ= B×A

11.The magnetic flux linked with a coil is $\phi = (8t^2 + 3t + 5)$ Wb. The induced emf in the fourth second wil be

(A)145 V (B) 139 V (C) 67 V (D) 16 V

12. A circular loop of radius r, having N turns of a wire, is placed in a uniform and constant magnetic fie B. The normal of the loop makes an angle θ with the magnetic field. Its normal rotates with an angular velocity ω such that the angle θ is constant. Choose the correct statement from the following.

(A) emf in the loop is $NB\omega r^2/2\ \cos\theta$

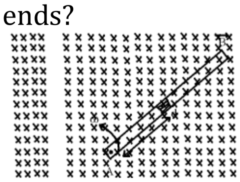
(B) emf induced in the loop is zero.

(C) emf must be induced as the loop crosses magnetic lines.

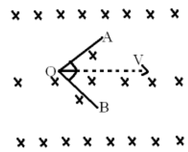
(D) emf must not be induced as flux does not change time.

MOTIONAL Emf

1. A copper rod of length 'L' rotates at an angular velocity 'ω' in a uniform magnetic field B as shown. What I the induced emf across it ends?



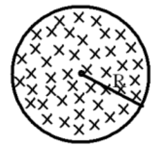
2. An angle ∠AOB made of a conducting wire moves along its bisector through a magnetic field B as suggested by figure. Find the emf inducted between the two free ends if the magnetic field is perpendicular to the pane of the angle.



TIME – VARYING MAGNETIC FIELD

3.Consider a cylindrical magnetic field which increases with time. Find out the electric field at a distance r from centre for

(i) $r < R$, (ii) $r > R$.

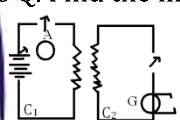


ENERGY STORED IN THE MAGNETIC FIELD OF AN INDUCTOR

4. An average induced emf of 0.20 V appears in a coil when the current in it is changed from 5.0 A in one direction to 5.0 A in the opposite direction in 0.20 s. Find the self-inductance of the coil.

MUTUAL INDUCTANCE

5. In figure when key is pressed the ammeter A reads I ampere. The charge passing in the galvanometer circuit of total resistance R is Q. Find the mutual inductance of the two coils.



6. A solenoid S_1 is laced inside another solenoid S_2. The radii of the inner and the outer solenoids are r_1 and r_2, respectively, and the number of turns per unit lengths are n_1 and n_2 respectively. Consider a length ℓ of each solenoid and calculate the mutual

8.The coefficient of mutual induction between the primary and secondary of a transformer is 5 H. Calculate the induced emf in the secondary when 3 ampere current in the primary is cut off in 2.5×10^{-4} second.

PROBLEMS

SUBJECTIVE

1. A connecting rod AB of mass m slides without friction over two long conducting rails separated by a distance ℓ.
Initially, the rod is moving with a velocity v_0 to the right. Find:
(a) The distance covered by the rod until it comes to rest.
(b) The amount of heat generated in the resistance R during the process.
2. A conducting rod of length ℓ attached to a rod of insulating material of length L is rotated with constant angular speed in a plane normal to the uniform magnetic field B, a shown in the figure. Find the emf produced across the ends of the conducting rod

3. There are two coils (1 and 2) coaxially separated 'X'. The radii of the coils are 'a' and 'b', ($b \gg a$, $x > b$). In the coil 2, a current I flows for a moment. Find the charge flown through coil 1 during that time interval. The resistance per unit length of coil 1 is λ.

4. Two flat conducting strips of length 'ℓ' width 'b' (perpendicular to the plane of paper) are separated by a ma gap 'a' ($a \ll b, \ell$). The right ends of the strips are shorted, and a battery of

voltage V_o is connected across the left end. The current is assumed to flow only parallel to the L – dimension of the strips.

5. A thin hollow cylinder of radius a is surrounded co – axially by another hollow cylinder of radius b, where b > a. Both the cylinders form part on an electric and a current I flows through them a shown in the figure. Find the
(a) self inductance per unit length.
(b) magnitude of the pressure exerted on each cylinder and state whether. The force on each cylinderis tending to durst apart or to collapse the cylinder

6. A rectangular frame ABCD made of a uniform metal wire ha a straight connection between E and F made of the same wire as shown in figure AEFD is a square of side 1 m and EB = FC = 0.5m. The entire circuit is placed in a steadily increasing uniform magnetic field directed into the plane of the paper and normal to it. The rate of change of the magnetic field is 1 Ts^{-1}. The resistance per unit length of the wire is ……….Find the magnitude and direction of the currents in the segment AE, BE and EF.

OBJECTIVE

1. A conducting bar pulled with a constant speed v on a smooth conducting rail. The region has a steady magnetic field of induction B as shown in the figure. If the speed of the bar is doubled then the rate of heat dissipation will be
(A) constant. (B) quarter of the initial value (C) four fold. (D) doubled.

2. If all the linear dimensions of a cylindrical coil are doubled, the inductance of the coil will be (assuming complete winding over the core)
(A) doubled (B) four fold (C) eight times (D) remains unchanged

EXERCISE – II

1. a rod of length ℓ is translating at velocity v making an angle θ with the length as shown. If its resistance is R, than find emf and current in the rod?

2. Consider the situation shown in the figure. If the wire being slid is replaced by a semicircular wire. Find whether the current induced will increase of decrease.

3. A current in a coil of inductance 5 H decreases at the rate 2 As^{-1}. Find the induced emf?

4. A conducting square loop of side $a\sqrt{2}$ is rotated in a uniform magnetic field B about P in the plane of the paper as shown in the figure. Find the induced emf between P and Q and indicate the relative polarity of the points P and Q
5. A conducting rod makes contact with a partial circuit and completes the circuit as shown. The circuit area is perpendicular to a magnetic field with B = 0.25 T, how large force is needed. If the resistance of the total circuit is 5……….to move the rod as indicated with a constant speed of 4 m/s apart from the force F = 1/80N already acting on it in the direction shown?

6. A metallic cylindrical rod PQ of resistance R slides without friction on a rectangular circuit composed of perfectly conducing wires fixed on inclined plane as shown in the figure. A vertical magnetic field …..exist in the region of the above mentioned setup. Find the velocity of the rod PQ when it starts moving without any acceleration?

7. A square wire frame with idea and a straight conductor carrying a constant current I are located in the same plane as shown in the figure. The inductance and the resistance of the frame are equal to and R respectively. The frame was turned through 180^0 about the axis OO' which is located at a distance b from the carrying conductor. Find the electric charge which passes through the current frame.

8. A thin non conducting horizontal disc of mass m having total charger q distributed uniformly over its surface, can rotate freely about its own axis. Initially when the disc is stationary a magnetic field B directed perpendicular to the plane is switched on at t = 0. Find the angular velocity ω acquired by disc as a function of time, if B = kt, where t is time.

9. A rod of length b moves with a constant velocity v in the magnetic field of a straight long conductor that carries a current I as shown in the figure. The emf induced in the rod is
(A) (B) (C) (D)

10. A conducting loop of resistance R and radius r has its center at the origin of the co – ordinate system in a magnetic field of induction B. When it is rotated about y – axis through 90^o, the charge flown in the coil is directly proportional to
(A) B (B) R (C) r^2 (D) r

11. Shown in the figure is a circular loop of radius r and negligible resistance. A variable magnetic field of induction $B = e^{-t}$ is established inside the coil. If the key (K) is closed at t = 0. The electrical power developed at the instant is equal to
(A) $\frac{\pi r^2}{R}$ (B) $\frac{10r^3}{R}$ (C) $\frac{\pi^2 r^4}{R}$ (D) $\frac{10r^4}{R}$

12. The mutual inductance in figure is
(A) zero (B) (C) (D)

DECAY OF CURRENT IN AN INDUCTOR

1. A solenoid has an inductance of 10 henry and a resistance of 2……………..It is connected to a 10 V battery. How long will it take for the magnetic energy to reach ¼ of its maximum value?

LC OSCILLATIONS

2. An inductor of inductance 2 mH is connected across a charged capacitor of 5 F. Let q denote the instance charge on the capacitor, and I the current in the circuit.
Maximum value of q is Q = 200 C
(a) When q = 100 C, what is the value of $|di/dt|$
(b) When q = 200 C, what is the value of i?

PROBLEMS

1. A solenoid of resistance 50 ……..and inductance 80 henryare connected to a 200 V battery. How long will it take for the current to reach 50% of its final equilibrium value? Calculate the maximum energy stored.

2. Find the current provide by the source immediately after the switch I closed at t = 0 an also at t = ∞.

3.When current (I) in R – L series is constant where L is a sure inductor. The following statements are given

(i) voltage across R is RI.
(ii) voltage across L I equal to voltage across R.
(iii) voltage across L is supply voltage.

(iv) magnetic energy store is $\frac{1}{2}$ LI^2.

(A) (i), (ii) and (iv) are true. (B) (i), (ii) and (iv) are true.
(C) (i) and (iv) are true. (D) (i), (ii), (iii) and (iv) are true.

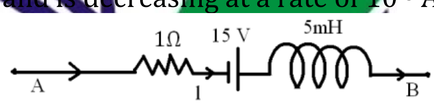
OBJECTIVE

1. A coil of inductance L = 300 mH and is connected to a constant voltage source. Current in the resistance R = 140 m…………… coil will reach to 50% of it steady state value after t is equal to
(A) 15 s (B) 0.75 s (C) 0.15 s (D) 1.5 s
2. A constant current flows in series an R – L circuit. Then
(A) V_R = 0 and V_L……………0(V = potential difference)
(B) Energy wasted per second in the resistor is equal to energy gained by the inductor per second
(C) V_{AB} = I R (numerically)
(D) V_R…………0 and V_L = 0

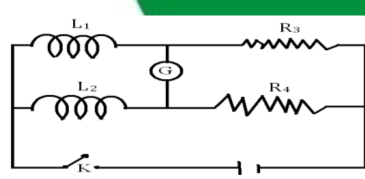
EXERCISE – III

1. An inductor of inductance 20 mH having resistance 10 ˋ……is joined to an ideal battery of emf 5.0 V. Find the rate of change of the induced emf at
(A) t =0, (B) t = 10 ms, (C) t = 1.0 s.

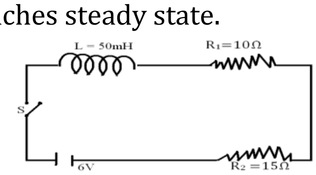
2. The network shown in the figure is part of a complete circuit. What is the potential difference $V_B - V_A$, When the current I is 5A and is decreasing at a rate of 10^3 A/s?



3. Two inductors of self inductance L_1 and L_2 and of resistance R_1 and R_2 (not shown in the diagram) respectively, are connected in the circuit as shown in the figure. At the instant t = 0, key K is closed, obtain the condition for which the galvanometer will show zero defection at all times after the key is closed.



4. In the circuit shown, the switch is operated to complete the circuit at time t = 0. Calculate the time required for current in R_1 to become half of the steady state current. What I the energy stored in the inductor when the current reaches steady state.



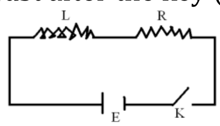
5. A conducting rod PQ of mass m is free to slide on frictionless rails in the horizontal pane as shown in the figure. At t = 0 the rod is given an initial velocity v_0. Find the variation of x with respect to time. Neglect the resistance of the rod, rails and the inductor L. Assume that the rod remains within the magnetic field …………

6. In figure shown the steady state current through the inductor will be

(A) zero (B) 1A (C) 1.25 A (D) cannot be determined

4μF 4Ω 5V 3mH 1Ω

7. Shown in the figure is an R – L circuit. Just after the key (K) is closed,



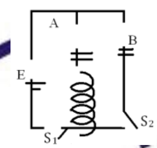
(A) the current in the circuit is zero

(B) no potential drop across the resistor exists

(C) potential drop across the inductor is E

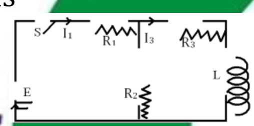
(D) no heat is dissipated in the circuit

8. Two uncharged identical capacitors A and B, each of capacitance C, and an inductor L are arranged as shown in the adjacent figure. At = 0, the switch S_1 is closed S_2 remain open. At time $t = t_0 = \sqrt{LC}\frac{\pi}{2}$, switch S_2 is closed while S_1 is opened. Then, the charge on capacitor A after time t_0 is



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

9. In the circuit shown in the figure, E = 10 V, $R_1 = 2\Omega$, $R_2 = 3\Omega$,R = 6Ωand L = 5 henry. The current I_1 jut after pressing the witch S is



(A) (10/4) amp (B) (10/5) amp

(C) (10/12) amp (D) (10/6) amp

POWER

1. A series LCR circuit containing a resistance of 120Ωhas angular resonance frequency 4×10^5 rad s^{-1}. At resonance, the voltage 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^o?

CHOKE COIL

1. A metal coil of area 5×10^{-3} m^2, number of turns 100, and resistance 1.6Ω is lying horizontally at the bottom of the vessel. A uniform, time – varying magnetic field is set up to pass vertically through the coil at the time t = 0. The field is first increased from zero to 0.8 T at a constant rate between 0 and 0.2 s and then decreased to zero at the same rate between 0.2 and 0.4 s. This cycle is repeated 12000 times. Draw the variation of current though the coil and power dissipated as a function of time for the first two cycles, by clearly indicating the magnitudes of the quantities on the axis. Neglect the inductance of the coil.

PROBLEMS

SUBJECTIVE

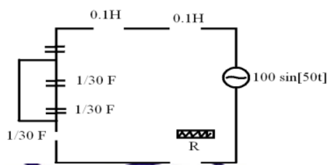
1. A 20 volts, 5 watt lamp is used on a.c. main of 200 volts 50 cps. Calculate the value of

(A) Capacitance

(B) Inductance to be put in series to run the lamp
(C) How much pure resistance should be included in pace of the above device so that the lamp can run on its voltage.
2. When a 15 V dc source is applied across a choke coil, then a current of 5 Amp flows in it. If the same coil is connected to a 15 V, 50 rad/s ac source, a current of 3 Amp flows in the circuit and it resonance frequency if a 2500 μf capacitor is connected in series with the coil.

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

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



OBJECTIVE

1. A sinusoidal voltage $V_o \sin \omega t$ is applied across a series combination of resistance R and inductor L The amplitude of the current in the circuit is

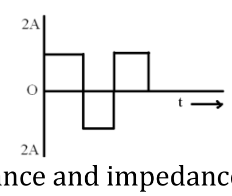
(A) $\frac{V_o}{\sqrt{R^2 + \omega^2 L^2}}$ (B) $\frac{V_o}{\sqrt{R^2 - \omega^2 L^2}}$
(C) $\frac{V_o}{\sqrt{R^2 + \omega^2 L^2}}$ (D) V_o/R

2. An ideal choke takes a current of 8 A when connected to an a.c. source of 100 volt and 50 Hz pure resistor under the same conditions take a current of 10 A. If the two are connected in series to an a.c. supply of 100 V and 40 Hz, than the current in the series combination of above resistor and inductor is
(A) 10 A (B) 8 A (C) $5\sqrt{2}$ amp (D) $10\sqrt{2}$ amp

3. An ac source of angular frequency ω is fed across a resistor R and a capacitor C in series. The current registered is I. If now the frequency of source is changed to ω/3 (but maintaining the same voltage), the current in the circuit is found to be halved. The ratio of reactance to resistance at the original frequency ω will be
(A) $\sqrt{3/5}$ (B) $\sqrt{5/3}$ (C) 3/5 (D) 5/3

EXECISE – VI

1. Calculate the rms value of alternating current shown in the adjacent figure.



2. Distinguish between resistance, reactance and impedance for an AC circuit.

3. The peak value of an alternating current is 5 A and its frequency is 60 Hz. Find its rms value, Find it rms when its frequency is changes 50 Hz and comment on your answer?

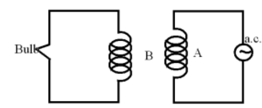
4. Why is a choke coil needed in the use of fluorescent tubes with AC mains? Why cannot we use an ordinary resistor instead of choke coil?

5. A coil of resistance 300Ω and inductance 1.0 herny is connected across an voltage source of frequency 300/2π Hz. Calculate the phase difference between the voltage and current in the circuit.

6. 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 facto of the circuit is unity.

8. In a series RC circuit, R = 500Ω,C = 2 μF; V = 28 sin (377t). The power consumed is
(A) 14100 W (B) 141 W (C) 10 W (D) 14.1 W

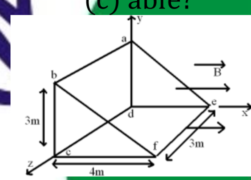
9. A coil B is connected to low voltage bulb L and placed near another coil A. Why does the bulb get dimmer if the coil B is moved upward?



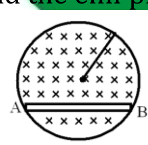
10 In an AC circuit, the value of AC I I = 4 in (100πt + π/6) A. The initial value of current is
(A) 4 A (B) 3 A (C) 2 A (D) 1 A

ASSIGNEMETS
SECTION – I
PART – A

1. In the adjacent figure, a uniform magnetic field of 0.4 T is directed along x – axis. The field I increased to 0.45 T. What I the change in magnetic flux through the surface
(a) abcd; (b) bcf; (c) abfe?



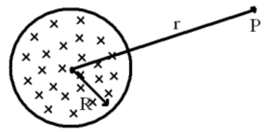
2. A metal rod AB of length L is placed in a magnetic field B as shown in the figure. If the rate of change of B with respect to time is dB/dt, find the emf produced across AB.



3. A square – shaped copper coil has edges of length 50 cm and contains 50 turns/ It is placed perpendicular to a 1.0 T magnetic field. It I removed from the magnetic field in 0.5 and restored in its original place in the next 0.25 s. Find the magnitude of the average emf induced in the loop during
(a) its removal, (b) it restoration, (c) its entire motion in the field.

4. A plane loop, shaped as two squares of sides a = 1 m and b = 0.4 m is introduced into a uniform magnetic field perpendicular to the plane of the loop. The magnetic field varies as B = 10^{-3} sin 100t. Find the amplitude of current induced in the loop if resistance per unit length is r = 5……..m^{-1}. (The inductance is negligible)

5.For the situation described in the figure, the magnetic field change according to
B += ($2t^2$-$4t^2$+0.8) T. Find the force on an electron located at r = R = 10cm at t=.0 sec?



6.An average emf of 0 V I induced in an inductor when the current in it is changed from .5 am in one direction to the same value in the opposite direction in 0.1. Find the elf – inductance of the inductor.

7.A long solenoid of diameter 0.1 m has 2×10^4 turns per meter. At the centre of the solenoid, a 100 turn coil of radius 0.01 m is laced with its axis coinciding with the solenoid axis.The current in the solenoid is decreased at a constant rate from +2 A to – A in 0.05 sec. Find the emf induced in the coil. Also fin the total charge flowing through the coil during the time when the resistance of the coil in $10\pi^2\Omega$.

8.An LR circuit having a time constant of 50 m I connected with an ideal battery of emf ϵ. Find the time elapsed before

a) the current reaches half its maximum value.

b) the power dissipated in heat reaches half its maximum value and.

c) the magnetic field energy stored in the circuit reaches half its maximum value.

9.The current in a coil of self inductance 2.0 H is increasing according to $I = 2\sin t^2$ Amp. Find the amount of energy spent during the period when the current changes from zero to Amp.

10.A 0.1 H inductor and a 12Ω resistance connected in series to a 20V. 50 Hz ac source. Calculate the current in the circuit and the phase angle between the current and the source voltage.

11. A slider PQ of mass m and length ℓ slider down two smooth conduction fixed bar et inclined at an angle θ to the horizontal. The top ends of the bar are connected by a capacitor of capacity C. The system is paced in a uniform magnetic field, in the direction perpendicular to the inclined plane formed by the Bar. The resistance of the bars and the sliding conductor are negligible. Find the acceleration of the slider.

PART – B
Objective
(Multi Choice Single Correct)

1.When a piece of wire is passed through the between the pole pieces of a horse shoe magnet in 0.1 s, then an emf of 4×10^{-3} V is induced in it. The magnetic flux between the pole pieces will be

(A) 4×10^{-4} Wb (B) 0.1 Wb (C) 10 Wb (D) 4×10^{2} Wb

2. A conducting rod of length I is fixed at the center and rotated with an angular velocity ω. The emf induced across the two end is

(A) $\frac{BI\omega^2}{2}$ (B) $\frac{BI\omega^2}{4}$ (C) $\frac{BI\omega^2}{8}$ (D) zero

3. A metal rod length I is fixed at one end rotated with an angular velocity ω. The emf induced between the end of the rod is

(A) $BI^2\omega$ (B) $BI^2\omega/2$ (C) $\frac{BI^2\omega}{4}$ (D) 0

4. The number of turns in an air core solenoid of length 25 cm and radius 4 cm 1000. It self inductance will be

a) $5\times4\times10^{-3}$ H b) 5×10^{-4} H c) 2.5×10^{-4} H d) 2.5×10^{-3} H

5.A uniform current of 2A flows in a coil of self inductance 10 Henry. The rate of change of current in the coil in order to produce an induced emf of 100V in it will be.]
a) 100 As^{-1} b) 10 As^{-1} c) 5As^{-1} d) 1 As^{-1}

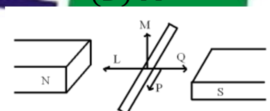
6. Mutual inductance between two concentric coils having radii r_1 (of primary) and r_2 (of secondary) will be if N_1 and N_2 are number of turns in primary and secondary coils ($r_1>r_2$)
a)

7.A 10 ohm resistance coil has 1000 turns. It is placed in a magnetic field of magnetic induction 5×10^{-4} tesla in 0.1 sec. If the area of cross – section is 1 m^2, then the induced emf is
a) 5 volt b) 0.5 volt c) 0.05 volt d) 0.005 volt.
8.A coil of 20×20 cm^2 and 10 turns, the magnetic field of induction 1 tesla. The peak value of the induced emf is approximately
(A) 452 volt (B) 226 volts (C) 113 volt (D) 339 volts

9. A coil of resistance 10 ohm and inductance 5 henry is connected to a battery of 100 volt. Then, the energy stored in the is
(A) 250 joule (B) 250 ergs (C) 125 joule (D) 125 ergs

10. In a coil of area 10 cm^2 and 10 turns, the magnetic field I directed perpendicular to the a plane and is changing at a rate of 10^8 gauss/sec. The resistance of the coil is 220 ohm. The current in the coil is
(A) 5 amp. (B) 0.5 amp (C) 0.05 amp. (D) 5×10^8 amp.

11. an electric potential difference will be induced between the ends of the conductor shown in the figure when the conductor moves in the direction
(A) p (B) Q (C) L (D) M



12.A coil having an area A_o is spaced in a magnetic field which changes field which changes form B_o to $4B_o$ in time interval. The emf induced in the coil will be
(A) $3A_0B_0/t$ (B)$4A_0B_0/t$ (C)$3B_0/A_0$ t
(D)$4B_0/A_0t$

13. A circuit has a self inductance of 1 henry and carries a current of 2 A. To prevent sparking when the circuit is switch off, a capacitor which can withstand 400 V is used. The least capacitance of the capacitor connected across the switch must be equal to
(A) 50 μF (B) 25 μF (C) 100 μF (D) 12.5 μF

14. If the angular speed of rotation of an armature of alternating current generator is doubled, then the induced electromotive force will be:
(A) doubled (B) four times (C) not change (D) halved

15. Two coils of self inductances L_1 and L_2 are placed so close to each other that the effective flux of one coil is completely linked with other. Then, the mutual inductance M between them is given by
(A) $M = \sqrt{L}_1L_2$ (B) $M = L_1 - L_2$ (C) $M = L_1/L_2$ (D) $M = L_1 + L_2$]

16. A metal disc of radius R rotates with an angular velocity ω about an axis perpendicular to be plane passing through its center in a magnetic field of induction B acting perpendicular to the plane of the disc. The induced emf between the rim and the axis of the disk is

(A) $-B\pi R^2$ (B) $\frac{-2B\pi^2R^2}{\omega}$ (C) $B\pi R^2\omega$ (D) $\frac{-BR^2\omega}{2}$

17. An electric bub is designed to operate at 12 V C, It is connected to AC and gives same brightness. Then peak AC voltage is

(A) 12 V (B) 24 V (C) $12\sqrt{2}$ V (D) $12/\sqrt{2}$ V

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

(A) – π/6 rad (B) – π/3 rad (C) π/6 rad (D) π/3 rad

19. In a series combination, R = 300Ω, L = 1.0 H, C = 20 μF and ω = 100 rad/sec. The Impedance of the circuit will be

(A) 400 Ω (B) 1300 Ω (C) 500 Ω (D) 900 Ω

MULTI CHOICE MULTI CORRECT

1. A small magnet M is allowed to fall through a fixe horizontal conducting ring R. Let g be the acceleration due to gravity. The acceleration of M will be

(A) < g when it is above R and moving towards R
(B) > g when it is above R and moving towards R
(C) < g when it is below R and moving away from R
(D) > g when it is below R and moving away from R

2. A square loop ABCD of edge ‘a’ move to the right with a velocity v, parallel to AB. Thee I a uniform magnetic field of magnitude B, directed into the paper, in the region between PQ and RS only. I, II and III are three positions of the loop.
Then

The current induced in the loop has magnitude Bav in all three positions
(A) The induced current is zero in positions II
(B) The induced current is anticlockwise in position I
(C) The induced current is clockwise in position III

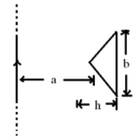
3. In Q. No. 2 in position I of the loop
(A) The induced emf will increase linearly a the loop enters the field
(B) The induced emf will increase from 0 to Bav sharply as the edge BD crosses PQ
(C) The induced emf will have a constant value Bav
(D) The loop will experience a force to the left after entering field partially

NUMERICAL BASED TYPE

1. The coefficient of mutual inductance of the two coils I 0.5 H. If the current is increased form 2 to3 A in 0.1 sec. in one of them, then find the induced e.m.f. in the second coil in volts.
2. Two different coils have self inductance L_1 = 8 mH, and L_2 = 2mH. The current in both the coils is increased at the same constant rater. At that instant the induced voltage in the first coil is V_1. Corresponding value for the second coil at the same instant is V_2. Them, find ratio ofV_1 to V_2.
3. A uniform wound solenoidal coil of self – inductance 1.8×10^{-4} henry an resistance 6…….is cut into two identical coils. They are now connected in parallel across a 12 volt battery of

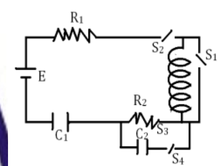
negligible resistance. Find the current draw by the circuit in amp. (neglecting the mutual inductance between the cut arts of the solenoid)

4. A very long straight conductor and an isosceles triangular conductor lie in a plane and separated from each other as shown in the figure. If the coefficient of their mutual induction is $K \times 1.22 \times 10^{-8}$ H, then find K.(Given a = 10 cm; b = 20 cm and h = 10 cm)



LINKED COMPREHENSION TYPE

With reference to the circuit shown in the figure, four events are defined as:
Event A : switch S_1 is closed
Event B : switch S_2 is closed
Event C : switch S_3 is closed
Event D : switch S_4 is closed



Assuming that one or more of these events can take place simultaneously, answer the following questions

1.Current driven by battery immediately after (A + B +C) events only

(A) $\frac{E}{R_1 + R_2}$ (B) $\frac{E}{R_1}$ (C) zero (D) infinite

2.Voltage across Capacitor C_1 immediate after (A + C) events only

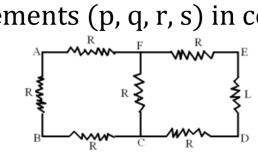
(A) E (B) zero (C) $\frac{ER_2}{R_1 + R_2}$ (D) $\frac{ER_1}{R_1 + R_2}$

3.Voltage across inductor is zero:

(A) After long time irrespective of any events
(B) Only when event B takes place irrespective of any other event
(C) Immediate after event (B + C + D)
(D) Only when event A does not happen

MATRIX – MATCH TYPE

Each question contains given in two columns which have to be matched. Statements (A, B, C, D,) in column I have to be matched with statements (p, q, r, s) in column II.



1.Consider and LR circuit shown in the figure wherein an inductor I getting discharged. It is given that L = 27.5 Henry. R = 1Ω and initially current in the inductor is 20 amperes.

Column – I	Column – II
A) After how much time will the potential difference across L drop to $1/e^2$ times the initial value?	(p) 15 (q) 5

B) What is the initial potential drop across FC?

C)What is the ratio of total heat dissipated in the resistor EF to that in AB. (r) 16

(s) 20

D) What is the initial potential drop across BC. (t) 7

SECTION – II

1.A magnet drops down along the axis of a vertical copper tube. It velocity as it falls down the tube

(A) increases (B) remain constant

(C) decreases

(D) first increases and then almost remains constant.

2. The lenz's law is equivalent to the law of conservation of

(A) energy (B) momentum (C) charge (D) mass

3. An inductor may store energy in

(A) its coil (B) its magnetic field

(C) its electric field

(D) both in electric and magnetic fields

5. Two circular, similar, coaxial loops carry equal currents in the same direction. If the loops are brought nearer.

(A) current will increase in each loop

(B) current will each loop

(C) current will same in each loop

(D) current will increase in one and decrease in the loop

6. When the number of turns in a coil is doubled without any change in the length of the coil, its self inductance becomes

(A) four times (B) doubled (C) halved (D) squared

7. If I = t^2 (0<t<T), them rms value of current is

(A) $T^2/\sqrt{2}$ (B) $T^{2/2}$ (C) $T^2/\sqrt{5}$ (D) none of the above

9. A pure inductor with AC source gives current lag from emf of

(A) π (B) π/2 (C) π/4 (D) π/3

10. If power factor is ½ in a series RL circuit with R = 100.. If AC mains, 50 Hz I used, then L is

(A) √3/π Henry (B)π Henry (C) √3 Henry (D)None