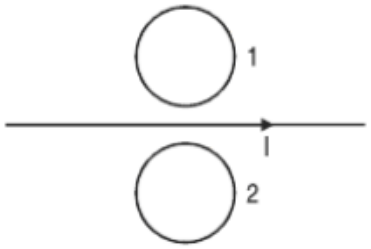
UNIT-4 ELECTROMAGNETIC INDUCTION AND ALTERNATING CURRENTS

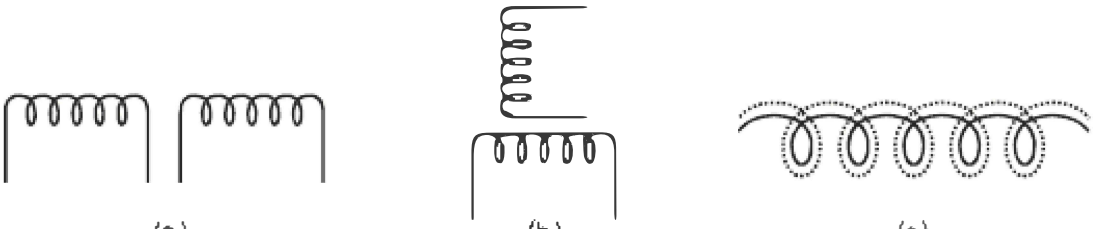
VERY SHORT ANSWER QUESTIONS (I Mark)

1. Why core of a transformer is laminated?

2. What is the direction of induced currents in metal rings 1 and 2 seen from the top when current I in the wire is increasing steadily?



3. In which of the following cases will the mutual inductance be (i) minimum (ii) maximum?



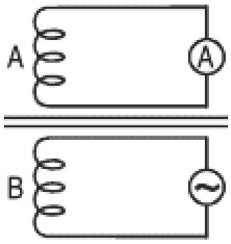
4. In a series *L–C–R* circuit, voltages across inductor, capacitor, and resistor are V_L, V_C and V_R respectively. What is the phase difference between (i) V_L and V_R (ii) V_L and V_C?

5. Why can't transformer be used to step up or step down dc voltage?

6. In an a.c. circuit, instantaneous voltage and current are $V = 200 \sin 300 t$ volt and $i = 8 \cos 300t$ ampere respectively. What is the average power dissipated in the ci cuit?

7. Sketch a graph that shows change in reactance with frequency of a series LCR circuit.

8. A coil A is connected to an A.C. ammeter and another coil B to A source of alternating e.m.f. What will be the reading in ammeter if a copper plate is introduced between the coils as shown.

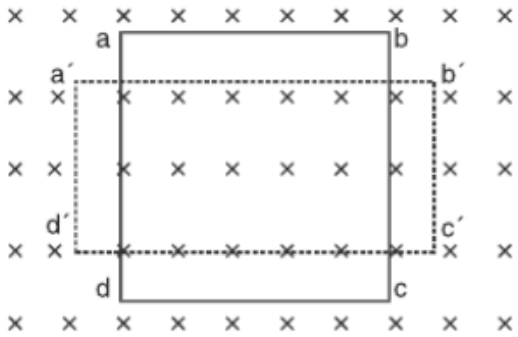


9. In a circuit instantaneously voltage and current are $V = 150 \sin 314$ volt and $i = 12 \cos 314\, t$ ampere respectively. Is the nature of circuit is capacitive or inductive?

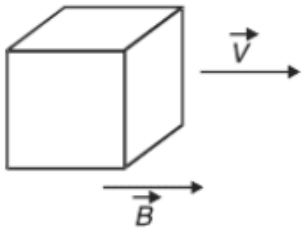
10. In a series L–C–R circuit $V_L = V_C \neq V_R$. What is the value of power factor?

11. In an inductor L, current passed I_0 and energy stored in it is U. If the current is now reduced to $I_0/2$, what will be the new energy stored in the inductor?

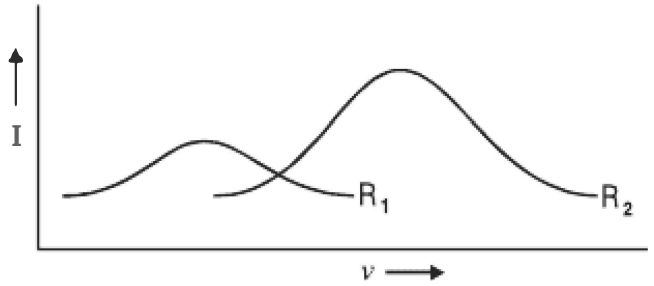
12. A rectangle loop *a b c d* of a conducting wire has been changed into a square loop *a′ b′ c′ d′* as shown in figure. What is the direction of induced current in the loop?



13. Twelve wires of equal lengths are connected in the form of a skeleton of a cube, which is moving with a velocity $\vec{V}$ in the direction of magnetic field $\vec{B}$. Find the *emf* in each arm of the cube.



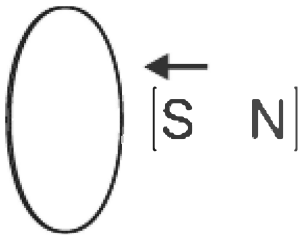
14. Current versus frequency (I – ν) graphs for two different series L–C–R circuits have been shown in adjoining diagram. R_1 and R_2 are resistances of the two circuits. Which one is greater–R_1 or R_2?



15. Why do we prefer carbon brushes than copper in an a.c. generator?

16. What are the values of capacitive and inductive reactance in a dc circuit?

17. Give the direction of the induced current in a coil mounted on an insulating stand when a bar magnet is quickly moved along the axis of the coil from one side to the other as shown in figure.

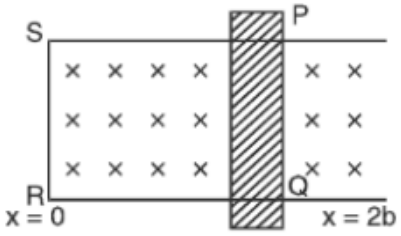


Ans : If observer is situated at the side from which bar magnet enters the loop. The direction of current is clockwise when magnet moves towards the loop and direction of current is anticlockwise when magnet moves away from the loop.

18. In figure, the arm PQ is moved from x = o to x = 2b with constant speed V. Consider the magnet field as shown in figure. Write

    (i) direction of induced current in rod

    (ii) polarity induced across rod.

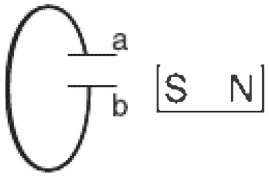


19. A wire moves with some speed perpendicular to a magnetic field. Why is emf induced across the rod?

Ans : Lorentz force acting on the free charge carrier of conducting wire hence polarity developed across it.

20. Predict the polarity of the capacitor in the situation described in the figure below.

Ans : Plate a will be negative with respect to 'b'.



21. A circular coil rotates about its vertical diameter in a uniform horizontal magnetic field. What is the average emf induced in the coil? **Ans :** Zero

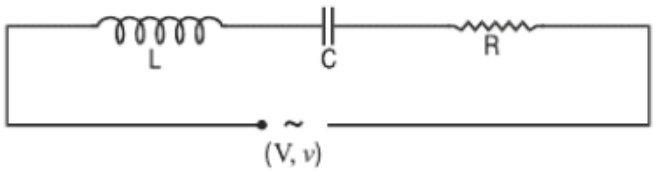
22. Define RMS Value of Current.

SHORT ANSWER QUESTIONS (2 Marks)

1. An ac source of rms voltage V is put across a series combination of an inductor L, capacitor C and a resistor R. If V_L, V_C and V_R are the rms voltage across *L*, *C* and *R* respectively then why is $V \neq V_L + V_C + V_R$? Write correct relation among V_L, V_C and V_R.

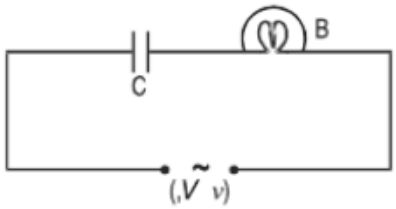
2. A bar magnet is falling with some acceleration 'a' along the vertical axis of a coil as shown in fig. What will be the acceleration of the magnet (whether $a > g$ or $a < g$ or $a = g$) if (*a*) coil ends are not connected to each other? (b) coil ends are connected to each other?

3. The series L–C–R circuit shown in fig. is in resonance state. What is the voltage across the inductor?

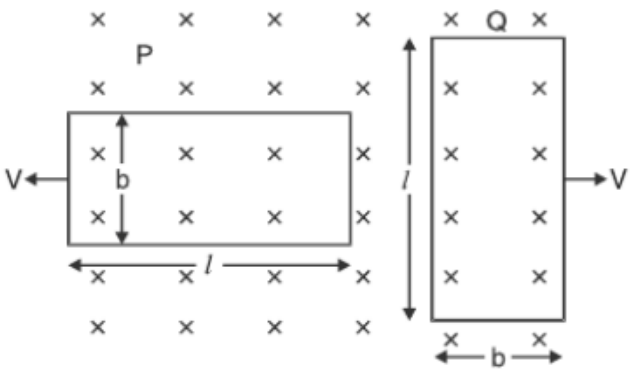


4. The divisions marked on the scale of an a.c. ammeter are not equally spaced. Why?

5. Circuit shown here uses an airfield parallel plate capacitor. A mica sheet is now introduced between the plates of capacitor. Explain with reason the effect on brightness of the bulb B.



6. In the figure shown, coils P and Q are identical and moving apart with same velocity V. Induced currents in the coils are I_1 and I_2. Find I_1/I_2.



7. A 1.5 μ F c apacitor is charged to 5 7V. The charging battery is then disconnected, and a 12 mH coil is connected in series with the capacitor so that LC Oscillations occur. What is the maximum current in the coil? Assume that the circuit has no resistance.

8. The self inductance of the motor of an electric fan is 10H. What should be the capacitance of the capacitor to which it should be connected in order to impart maximum power at 50Hz?

9. How does an inductor behave in a DC circuit after the current reaches to steady state? Justify.

10. How does an inductor behave in a AC circuit at very high frequency? Justify.

11. An electric bulb is commected in series with an inductor and an AC source. When switch is closed and after sometime an iron rod is inserted into the interior of inductor. How will the brightness of bulb be affected? Justify your answer.

Ans : Decreases, due to increase in inductive reactance.

12. Show that in the free oscillation of an LC circuit, the sum of energies stored in the capacitor and the inductor is constant with time.

Ans : Hint : $U=\frac{1}{2}LI^2+\frac{1q^2}{2c}$

13. Show that the potential difference across the LC combination is zero at the resonating frequency in series LCR circuit

Ans : Hint P.d. across L is = IX_L

P.D. across C is – IX_C

$$V = IX_L - IX_C$$

at resonance $X_L = X_C$

$$V = O.$$

14. How does an capacitor behave in a DC circuit after the steady state? Explain your answer.

Ans : Capacitor acts as an open key.

15 For circuits used for transmitting electric power, a low power factor implies large power loss in transmission. Explain.

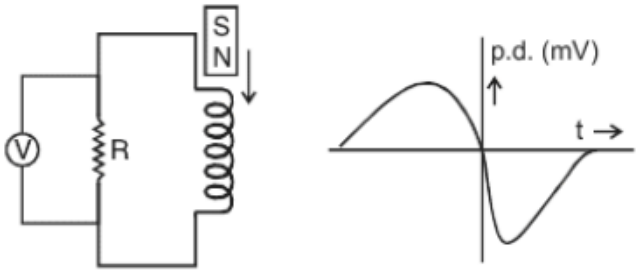
$$P = VI \cos \phi$$

Or $$\frac{P}{V\cos\theta}$$

if Cos θ is Low I will be high ⇒ La ge power loss.

16. An applied Voltage signal consists of a superposition of DC Voltage and an AC Voltage of high frequency. The circuit consists of an inductor and a capacitor in series. Show that the DC signal will appear across C where as AC signal will appear across L.

17. A bar magnet M is dropped so that is falls vertically through the coil C. The graph obtained for voltage produced across the coil Vs time is shoin figure



(i) Explain the shape of the graph

(ii) Why is the negative peak longer than the positive peak?

18. What is the Significance of Q-factor in a series LCR resonant circuit?

19. How does mutual inductance of a pair of coils kept coaxially at a distance in air change when

(i) the distance between the coils is increased?

(ii) an iron rod is kept between them?

SHORT ANSWER QUESTIONS (3 Marks)

1. Obtain an expression for the self inductance of a straight solenoid of length l and radius r ($l >> r$).

2. Distinguish between : (i) resistance and reactance (ii) reactance and impedance.

3. In a series L–C–R circuit X_L, X_C and R are the inductive reactance, capacitive reactance and resistance respectively at a certain frequency f. If the frequency of a.c. is doubled, what will be the values of reactances and resistance of the circuit?

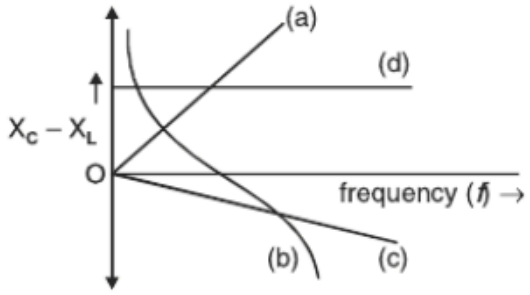
4. What are eddy currents? Write their any four applications.

5. In a series L–R circuit, $X = R$ and power factor of the circuit is P_1. When capacitor with capacitance C such that $X_L = X_C$ is put in series, the power factor becomes P_2. Find P_1/P_2.

6. Instantaneous value of a.c. through an inductor L is $e = e_0 \cos \omega t$. Obtain an expression for instantaneous current through the inductor. Also draw the phasor diagram.

7. In an inductor of inductance L, current passing is I_0. Derive an expression for energy stored in it. In what forms is this energy stored?

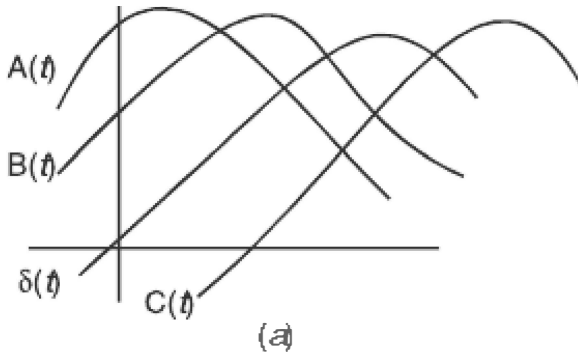
8. Which of the following curves may represent the reactance of a series LC combination.



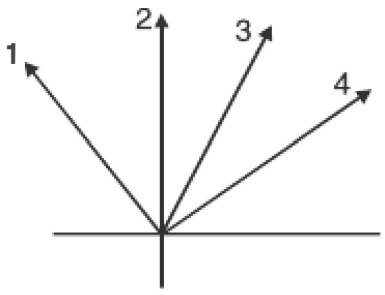
[Ans. : (b)]

9. A sinusoidal e.m.f. device operates at amplitude E_0 and frequency ν across a purely (1) resistive (2) capacitive (3) inductive circuit. If the frequency of driving source is increased. How would (a) amplitude E_0 and (b) amplitude I_0 increase, decrease or remain same in each case?

10. The figure shows, in (a) a sine curved $\delta(t) = \sin \omega t$ and three other sinusoidal curves $A(t)$, $B(t)$ and $C(t)$ each of the form $\sin(\omega t - \phi)$. (a) Rank the three curves according to the value of ϕ, most positive first and most negative last (b) Which curve corresponds to which phase as in (b) of the figure? (c) which curve leads the others? [**Ans. :** (a) C, B, A; (b) 1, A; 2, B; (c) A]



(a)



(b)

11. In an LC circuit, resistance of the circuit is negligible. If time period of oscillation is T then :

(i) at what time is the energy stored completely electrical

(ii) at what time is the energy stored completely magnetic

(iii) at what time is the total energy shared equally between the inductor and capacitor.

Ans : (i) t = 0, T/2, 3T/2,.....

(ii) t = T/4, 3T/4, 5T/4.....

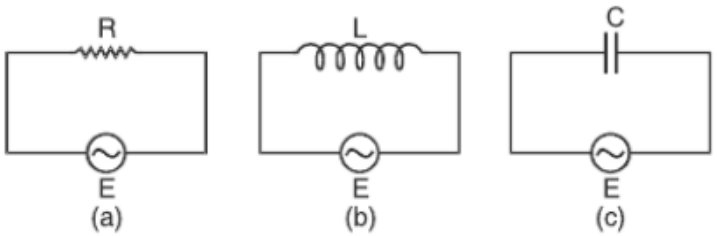
(iii) $t = \frac{T}{8}, \frac{3T}{8}, \frac{5T}{8}, \ldots\ldots$

12. An alternating voltage of frequency f is applied across a series LCR circuit. Let f_r be the resonance frequency for the circuit. Will the current in the circuit lag, lead or remain in phase with the applied voltage when (i) $f > f_r$ (ii) $f < f_r$? Explain your answer in each case.

Ans : (i) Current will Lag because.
$V_L > V_C$ Hence $V_L - V_C > O$

(i) Current will lead, because.
$V_L < V_C$ Hence $v_L - V_C < O$

13. Figure (a), (b), (c) Show three alternating circuits withe equal currents. If frequency of alternating emf be increased, what will be the effect on current in the three cases? Explain.



Ans : (i) No effect, R is not affected by frequency.

(ii) Current will decrease as X_L increase.

(iii) Current will increase as X_C decrease.

LONG ANSWER QUESTIONS (5 Marks)

1. Draw a labelled diagram to explain the principle and working of an a.c. generator. Deduce the expression for emf generated. Why cannot the current produced by an a.c. generator be measured with a moving coil ammeter?

2. Explain, with the help of a neat and labelled diagram, the principle, construction and working of a transformer.

3. An L – C circuit contains inductor of inductance L and capacitor of capacitance C with an initial charge q_0. The resistance of the circuit is negligible. Let the instant the circuit is closed be $t = 0$.

   (i) What is the total energy stored initially?

   (ii) What is the maximum current through inductor?

   (iii) What is frequency at which charge on the capacitor will oscillate?

   (iv) If a resistor is inserted in the circuit, how much energy is eventually dissipated as heat?

4. An a.c. $i = i_0 \sin \omega t$ is passed through a series combination of an inductor (L), a capacitor (C) and a resistor (R). Use the phasor diagram to obtain expressions for the (a) impedance of the circuit and phase angle between voltage across the combination and current passed in it. Hence show that the current

   (i) leads the voltage when $\omega < \dfrac{1}{\sqrt{LC}}$

   (ii) is in phase with voltage when $\omega = \dfrac{1}{\sqrt{LC}}$.

5. Write two differences in each of resistance, reactance and impedance for an ac circuit. Derive an expression for power dissipated in series LCR circuit.