Class XII

PHYSICS CH 6&7

Class 12 - Physics

Section A

1. If the rotational velocity of dynamo armature is doubled, then induced emf will become: **[1]**

a) two times
b) half
c) unchanged
d) four times

2. A straight line conductor of length 0.4 m is moved with a speed of 7 ms^{-1} perpendiculars to the magnetic field of intensity 0.9 Wbm^{-2}. The induced emf across the conductor is **[1]**

a) 5.24 V
b) 25.2 V
c) 2.52 V
d) 1.26 V

3. A magnet is dropped with its north pole towards a closed circular coil placed on a table then **[1]**

a) no current will be induced in the coil.
b) looking from above, the induced current in the coil will be anti-clockwise.
c) the magnet will fall with uniform acceleration.
d) as the magnet falls, its acceleration will be reduced.

4. The working of a dynamo is based on the principle of **[1]**

a) Chemical effect of current
b) Electromagnetic induction
c) Magnetic effect of current
d) Heating effect of current

5. An inductor may store energy in **[1]**

a) its magnetic field
b) its electric field
c) both in electric and magnetic fields
d) its coils

6. A circular ring of diameter 20 cm has a resistance of 0.01 Ω. The charge that will flow through the ring if it is turned from a position perpendicular to a uniform magnetic field of 2.0 T to a position parallel to the field is about: **[1]**

a) 0.063 C
b) 63 C
c) 0.63 C
d) 6.3 C

7. Whenever a magnet is moved either towards or away from a conducting coil, an e.m.f is induced, the magnitude of which is independent of **[1]**

a) the number of turns in the coil
b) the resistance of the coil
c) the speed with which, the magnet is moved
d) the strength of the magnetic field

8. Two coils are placed closed to each other. The mutual inductance of the pair of coils depends upon: **[1]**

a) the currents in the two coils
b) the rates at which currents are changing in

the two coils

c) relative position and orientation of the two coils

d) the material of the wires of the coils

9. A loop of wire enclosing an area A is placed in a region where the magnetic field is perpendicular to the plane of the loop. The magnitude of B varies in time according to the expression B = $B_{max}e^{-at}$, where a is some constant. That is, at $t = 0$ the field is B_{max}, and for $t > 0$, the field decreases exponentially. Induced emf in the loop as a function of time is **[1]**

a) $AB_{max}e^{-at}$

b) $aAB_{max}e^{-at}$

c) $aAB_{max}e^{-atB}$

d) aAe^{-at}

10. When current changes from +2A to -2A in 0.05 sec, an emf of 8V is induced in a coil. The coefficient of self inductance of the coil is: **[1]**

a) 0.8 H

b) 0.1 H

c) 0.2 H

d) 0.4 H

11. A transmitting station transmits radiowaves of wavelength 360 m. Find the inductance of the coil required with a condenser of capacity 1.20 pF in the resonant circuit. **[1]**

a) 3.07×10^{-8} H

b) 2.25×10^{-8} H

c) 1.25×10^{-8} H

d) 1.9×10^{-8} H

12. The voltage across a resistor, an inductor, and a capacitor connected in series to an ac source are 20 V, 15 V and 30 V respectively. The resultant voltage in the circuit is **[1]**

a) 5 V

b) 25 V

c) 20 V

d) 65 V

13. A resistor of 100 Ω and a capacitor of $10\mu F$ are connected in series to a 220 V 50 Hz ac source. Voltage across the resistor and capacitance are **[1]**

a) 66 V, 210 V

b) 66 V, 110 V

c) 60 V, 280 V

d) 56 V, 210 V

14. A conductor of 10 Ω is connected across a 6 V ideal source. The power supplied by the source to the conductor is **[1]**

a) 1.8 W

b) 7.2 W

c) 2.4 W

d) 3.6 W

15. Which of the following statements about a series LCR circuit connected to an ac source is correct? **[1]**

a) At resonance, the voltage drop across the inductor is more than that across the capacitor.

b) At resonance, the voltage drop across the capacitor is more than that across the inductor.

c) If the net reactance (X_L - X_C) of circuit becomes equal to its resistance, then the current leads the voltage by 45^o.

d) If the frequency of the source is increased, the impedance of the circuit first decreases and then increases.

16. What are the dimensions of impedance? **[1]**

a) $ML^3T^{-3}I^{-2}$

b) $M^{-1}L^2T^3I^2$

c) $ML^2T^{-3}I^{-2}$

d) $M^{-1}L^3T^3I^2$

17. An inductor may store energy in **[1]**

a) its magnetic field

b) its electric field

c) both in electric and magnetic fields

d) its coils

18. A 50 mH coil carries a current of 2A. The energy stored in the coil is: **[1]**

a) 0.1 J

b) 10 J

c) 0.5 J

d) 0.05 J

19. A series combination of resistor R and capacitor C is connected to an ac source of angular frequency ω. Keeping the voltage same, if the frequency is changed to $\frac{\omega}{3}$, the current becomes half of the original current. Then the ratio of the capacitive reactance and resistance at the former frequency is **[1]**

a) $\sqrt{3}$

b) $\sqrt{6}$

c) $\sqrt{2}$

d) $\sqrt{0.6}$

20. An ac voltage $v = v_0 \sin \omega t$ is applied to a series combination of a resistor R and an element X. The instantaneous current in the circuit is $I = I_0 \sin\left(\omega t + \frac{\pi}{4}\right)$. Then which of the following is correct? **[1]**

a) X is an inductor and $X_L = \sqrt{2}R$

b) X is an inductor and $X_L = R$

c) X is a capacitor and $X_C = \sqrt{2}\ R$

d) X is a capacitor and $X_C = R$

21. **Assertion (A):** If the number of turns of a coil is increased, it becomes more difficult to push a bar magnet towards the coil. **[1]**

Reason (R): The difficulty faced is according to the Lenz's law.

a) Both A and R are true and R is the correct explanation of A.

b) Both A and R are true but R is not the correct explanation of A.

c) A is true but R is false.

d) A is false but R is true.

22. **Assertion (A):** An electric lamp is connected in series with a long solenoid of copper with an air core and then connected to an ac source. If an iron rod is inserted in the solenoid, the lamp will become dim. **[1]**

Reason (R): If an iron rod is inserted in the solenoid, the inductance of solenoid increases.

a) Both A and R are true and R is the correct explanation of A.

b) Both A and R are true but R is not the correct explanation of A.

c) A is true but R is false.

d) A is false but R is true.

23. **Assertion (A):** The alternating current lags behind the e.m.f. by a phase angle of $\frac{\pi}{2}$, when ac flows through an inductor. **[1]**

Reason (R): The inductive reactance increases as the frequency of ac source decreases.

a) Both A and R are true and R is the correct explanation of A.

b) Both A and R are true but R is not the correct explanation of A.

c) A is true but R is false.

d) A is false but R is true.

24. **Assertion (A):** Capacitor serves as a block for dc and offers an easy path to ac. **[1]**

Reason (R): Capacitive reactance is inversely proportional to frequency.

a) Both A and R are true and R is the correct explanation of A.

b) Both A and R are true but R is not the correct explanation of A.

c) A is true but R is false.

d) A is false but R is true.

25. What is the self-inductance of a coil, in which magnetic flux of 40 milliwebers is produced when 2 A current flows through it? **[1]**

26. When current in a coil changes with time, how is the back emf induced in the coil related to it? **[1]**

27. What is induced magnetism? **[1]**

28. What is meant by mutual induction? **[1]**

29. A coil of inductance 0.5 H is connected to an 18 V battery. Calculate the rate of growth of current. **[1]**

30. A circuit element is connected across an ac source. It is observed that the voltage across the element leads the current flowing through it by a phase angle $\frac{\pi}{2}$. Identify the circuit element. **[1]**

31. An a.c. source is rated at 220 V, 50 Hz. What is the time taken for the voltage to change from its peak value to zero? **[1]**

32. An alternating current from a source is given by i = 10 sin 314 t. What is the effective value of current and frequency of source? **[1]**

33. Find the value of current through an inductance of 2.0 H and negligible resistance, when connected to an a.c. source of 150 V and 50 Hz. **[1]**

34. Which device will you use to step up a.c. voltage? Can we use the same device to set up d.c. voltage? **[1]**

35. The electric mains in a house a: 220 V, 50 Hz. Write down the equation for instantaneous voltage. **[1]**

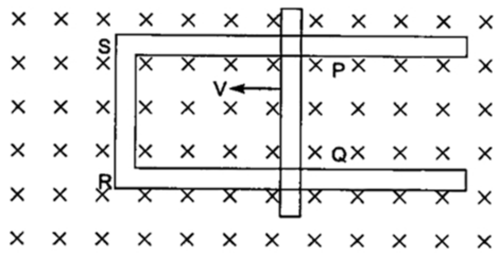
Section B

36. **[2]**
   a. Define the SI unit of self-inductance.
   b. The self-inductance of a solenoid is L. If the number of turns per unit length in it is doubled and the area of cross-section is halved, find the new inductance of the solenoid.

37. A wheel with 10 metallic spokes each 0.5 m long is rotated with a speed of 120 rev/min in a plane normal to the horizontal component of earth's magnetic field. If the magnitude of the field is 0.4 G at the place, what is the induced emf between the axle and the rim of the wheel? Note that 1 G = 10^{-4}T **[2]**

38. A coil when connected across a 10 V d.c. apply draws a current of 2 A. When it is connected across a 10V - 50 Hz a.c. supply, the same coil draws a current of 1 A. Explain why it draws lesser current in the second case. Hence determine the self inductance of the coil. (Take π = 3) **[2]**

39. Figure shows a rectangular loop conducting PQRS in which the arm PQ is free to move. **[2]**



A uniform magnetic field acts in the direction perpendicular to the plane of the loop. Arm PQ is moved with a velocity v towards the arm RS. Assuming that the arms QR, RS and SP have negligible resistances and the moving arm PQ has the resistance r, obtain the expression for

i. the current in the loop
ii. the force and

iii. the power required to move the arm PQ.

40. There are two coils A and B separated by some distance. If a current of 2 A flows through A, a magnetic flux of 10^{-2} Wb passes through B (no current through B). If no current passes through A and a current of 1 A passes through B, what is the flux through A? **[2]**

41. Prove that high frequency a.c. can pass through a pure capacitor easily but not through a pure inductor. **[2]**

42. A reactive element in an AC circuit causes the current flowing **[2]**

i. to lead in phase by $\pi/2$ w.r.t. the applied voltage.
ii. to lag in phase by $\pi/2$ w.r.t. the applied voltage.
Identify the element in each case.

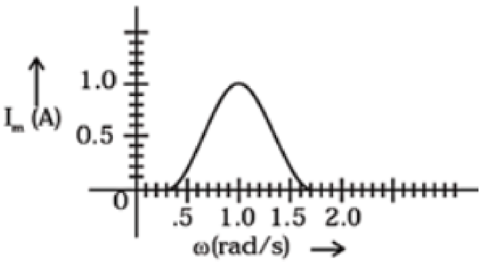
43. A resistance of 2 ohms, a coil of inductance 0.01 H are connected in series with a capacitor, and put across a 200 volt, 50 Hz supply. Calculate: **[2]**

i. the capacitance of the capacitor so that the circuit resonates.
ii. the current and voltage across the capacitor at resonance.(take $\pi = 3$)

44. A student connects a long air cored coil of manganin to a 100 V dc source and records a current of 1.5 A. When the same coil is connected across 100 V, 50 Hz ac source, the current is reduced to 1.0 A. **[2]**

i. Give reason for this observation.
ii. Calculate the value of inductance of the coil.

45. In series LCR circuit, the plot of I_{max} vs ω is shown in Figure. Find the bandwidth and mark in the figure. **[2]**



Section C

46. The current flowing in the two coils of self-inductance L_1 = 16 mH and L_2 = 12 mH are increasing at the same rate. If the power supplied to the two coils are equal, then find the ratio of **[3]**

i. induced voltages
ii. the currents and
iii. the energies stored in the two coils at a given instant.

47. A coil of cross-sectional area A lies in a uniform magnetic field B with its plane perpendicular to the field. In this position the normal to the coil makes an angle of 0° with the field. The coil rotates at a uniform rate to complete one rotation in time T. Find the average induced emf in the coil during the interval when the coil rotates: **[3]**

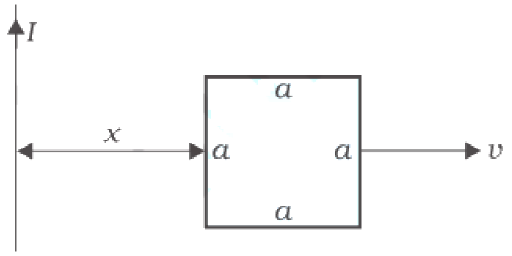
i. from 0° to 90°position
ii. from 90° to 180° position
iii. from 180° to 270° and
iv. from 270° to 360°

48. a. Obtain an expression for the mutual inductance between a long straight wire and a square loop of side a as shown in Figure. **[3]**

b. 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 in the loop at the instant when x = 0.2 m.

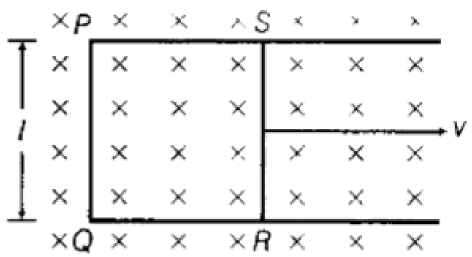
Take a = 0.1 m and assume that the loop has a large resistance.



49. i. Define the term self-inductance and write its S.I. unit. **[3]**

ii. Obtain the expression for the mutual inductance of two long co-axial solenoids S_1 and S_2 wound one over the other, each of length L and radii r_1 and r_2 and n_1 and n_2 number of turns per unit length, when a current I is set up in the outer solenoid S_2.

50. Figure shows a rectangular conducting loop PQRS in which arm RS of length I is movable. The loop is kept in a uniform magnetic field B directed downward perpendicular to the plane of the loop. The arm RS is moved with a uniform speed v. **[3]**



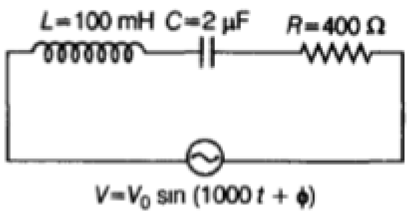
Deduce an expression for

i. the emf induced across the arm RS

ii. the external force required to move the arm and

iii. the power dissipated as heat.

51. i. Find the value of the phase difference between the current and the voltage in the series L-C-R circuit shown below. Which one leads in phase: current or voltage? **[3]**



ii. Without making any other change, find the value of the additional capacitor C', to be connected in parallel with the capacitor C, in order to make the power factor of the circuit unity.

52. A resistor of resistance R, an inductor of inductance L and a capacitor of capacitance C all are connected in series with an a.c. supply. The resistance of R is 16 ohm and for a given frequency, the inductive reactance of L is 24 ohm and capacitive reactance of C is 12 ohm. If the current in the circuit is 5 amp, find: **[3]**

a. the potential difference across R, L and C

b. the impedance of the circuit

c. the voltage of a.c. supply

d. phase angle

53. A source of ac voltage $V = V_0 \sin \omega t$, is connected across a pure inductor of inductance L. Derive the expressions for the instantaneous current in the circuit. Show that average power dissipated in the circuit is zero. **[3]**

54. An ideal inductor of $\frac{5}{\pi}$ H inductance is connected to a 200 V, 50 Hz ac supply. **[3]**
   a. Calculate the rms and peak value of current in the inductor.
   b. What is the phase difference between current through the inductor and the applied voltage? How will it change if a small resistance is connected in series with this inductor in the circuit?

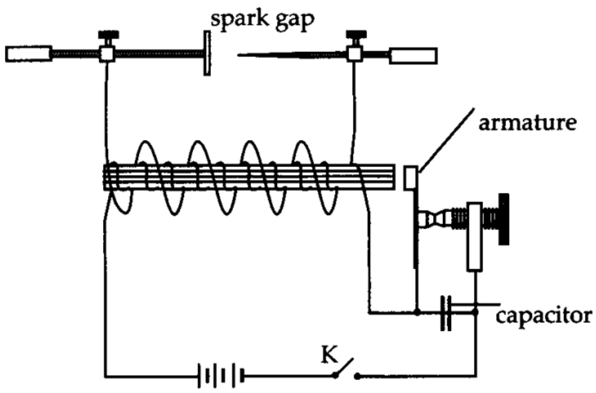
55. Given three elements X, Y and Z to be connected across an ac source. With only X connected across the ac source, voltage and current are found to be in the same phase. With only element Y in the circuit, the voltage lags behind the the current in phase by $\frac{\pi}{2}$, while with the element Z in the circuit, the voltage leads the current in phase by $\frac{\pi}{2}$. **[3]**
   a. Identify the elements X, Y and Z.
   b. When all these elements are connected in series across the same source, (i) determine the power factor, and (ii) find out the condition when the circuit is in resonant state.

Section D

56. **Read the text carefully and answer the questions:** **[5]**

Spark coil: The principle of electromagnetic induction was discovered by Michael Faraday in 1831. Induction coils were used widely in electrical experiments and for medical therapy during the last half of the 19th century. Marconi used a spark coil designed by Heinrich Rhumkorff in his early experiments.

An induction coil or **spark coil** is used to produce high-voltage pulses from a low-voltage (d.c.) supply. To create the flux changes necessary to induce voltage in the secondary coil, the direct current in the primary coil is repeatedly interrupted by a vibrating mechanical contact called interrupter.



The spark scoil consists of two coils of insulated wire wound around a common iron core. One coil, called the primary coil, is made from relatively few (tens or hundreds) turns of coarse wire. The other coil, the secondary coil typically consists of up to a million turns of fine wire (up to 40 gauge).

When the primary current is suddenly interrupted, the magnetic field rapidly collapses. This causes a high voltage pulse to be developed across the secondary terminals due to electromagnetic induction. Because of the large number of turns in the secondary coil, the secondary voltage pulse is typically many thousands of volts. This voltage is sufficient to create an electric spark, to jump across an air gap separating the secondary's output terminals. For this reason, this induction coils are also called spark coils.

To operate the coil continually, the d.c. supply current must be repeatedly connected and disconnected. To do that, a magnetically activated vibrating arm called an interrupter is used which rapidly connects and breaks the current flowing into the primary coil. The interrupter is mounted on the end of the coil next to the iron core. When the power is turned on, the produced magnetic field attracts the armature.

An arc which may form at the interrupter contacts is undesirable. To prevent this, a capacitor of 0.5 to 15 μF.

(a) The heart of the radio transmitters of Marconi was a

a) Van de Graff generator. b) RF tuning coil.

c) toroid. d) spark coil

(b) Spark coil is a type of

a) electrical transformer. b) large capacitor.

c) static electricity generator. d) electrical generator.

(c) Which of the following statements is correct?

a. Spark coil consists of two coils of insulated wire. Primary coil, is made from relatively few turns of fine wire. The secondary coil consists of up to a million turns of coarse wire.
b. Spark coil consists of two coils of insulated wire. Primary coil, is made from a (tens or million turns of coarse wire. The secondary coil consists of up to a few turns of fine wire.
c. Spark coil consists of two coils of insulated wire. Primary coil, is made from relatively few turns of coarse wire. The secondary coil consists of up to a million turns of fine wire.
d. Spark coil consists of two coils of insulated wire. Both primary and secondary coil, is made from a million turns of fine wire.

a) Statement (d) is correct. b) Statement (a) is correct.

c) Statement (b) is correct. d) Statement (c) is correct.

(d) Why most of the primary's flux couples with the secondary in spark coil?

a) Since the primary coil is wound on the secondary coil b) Since the core is thick

c) Since the primary coil is of thick wire d) Since the core is common

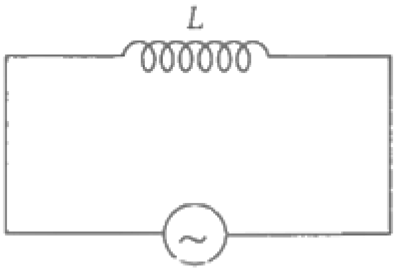
(e) What is the function of interrupter in a spark coil?

a) To rapidly connect and break the current flowing into the primary coil b) to control the formation of spark

c) To rapidly connect and break the current flowing into the secondary coil d) to stop the formation of spark

57. **Read the text carefully and answer the questions:** **[5]**

Let a source of alternating e.m.f. $E = E_0 \sin\omega t$ be connected to a circuit containing a pure inductance L. If I is the value of instantaneous current in the circuit, then $I = I_0 \sin\left(\omega t - \frac{\pi}{2}\right)$. The inductive reactance limits the current in a purely inductive circuit and is given by $X_L = \omega L$.



(a) A 100 hertz a.c. is flowing in a 14 mH coil. The reactance is

a) 7.5 Ω b) 15 Ω

c) 10 Ω | d) 8.8 Ω

(b) In a pure inductive circuit, resistance to the flow of current is offered by

a) resistor and inductor | b) capacitor
c) inductor | d) resistor

(c) In an inductive circuit, by what value of phase angle does alternating current lags behind e.m.f.?

a) 90^o | b) 75^o
c) 45^o | d) 120^o

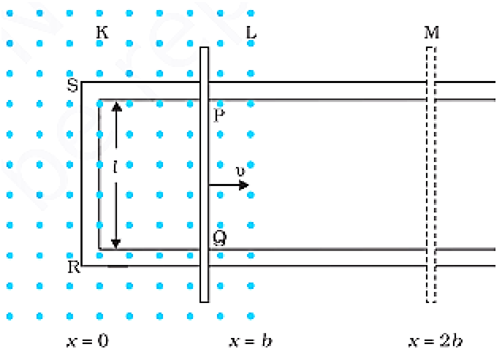
(d) How much inductance should be connected to 200 V, 50 Hz a.c. supply so that a maximum current of 0.9 A flows through it?

a) 5 H | b) 10 H
c) 1 H | d) 4.5 H

(e) The maximum value of current when the inductance of 2 H is connected to 150 volts, 50 Hz supply is

a) 0.721 A | b) 0.337 A
c) 1.521 A | d) 2.522 A

58. The arm PQ of the rectangular conductor is moved from x = 0, outwards. The uniform magnetic field is perpendicular to the plane and extends from x = 0 to x = b and is zero for x > b. Only the arm PQ possesses substantial resistance r. Consider the situation when the arm PQ is pulled outwards from x = 0 to x = 2b, and is then moved back to x = 0 with constant speed v. Obtain expressions for the flux, the induced emf, the force necessary to pull the arm and the power dissipated as Joule heat. Sketch the variation of these quantities with distance. **[5]**



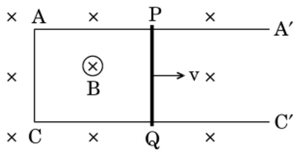
59. i. With the help of a labelled diagram, explain the working of a step-up transformer. Give reasons to explain the following : **[5]**

a. The core of the transformer is laminated.
b. Thick copper wire is used in windings.

ii. A conducting rod PQ of length 20 cm and resistance 0.1Ω rests on two smooth parallel rails of negligible resistance AA' and CC'. It can slide on the rails and the arrangement is positioned between the poles of a permanent magnet producing uniform magnetic field B = 0.4 T. The rails, the rod and the magnetic field are in three mutually perpendicular directions as shown in the figure. If the ends A and C of the rails are short-circuited, find the

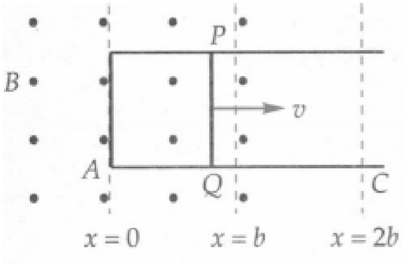
a. external force required to move the rod with uniform velocity v = 10 cm/s, and

b. power required to do so.



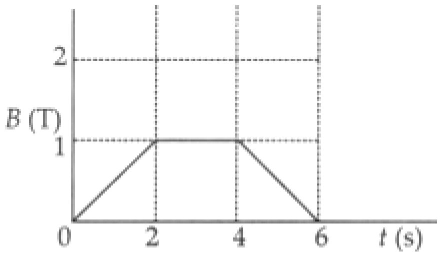
60. i. When a bar magnet is pushed towards (or away) from the coil connected to a galvanometer, the pointer in the galvanometer deflects. Identify the phenomenon causing this deflection and write the factors on which the amount and direction of the deflection depends. State the laws describing this phenomenon. **[5]**

ii. Sketch the change in flux, emf and force when a conducting rod PQ of resistance R and length l moves freely to and fro between A and C with speed v on a rectangular conductor placed in uniform magnetic field as shown in the figure.



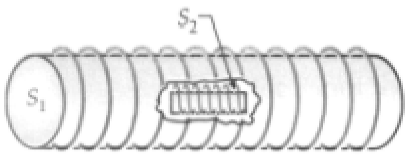
61. i. State Faraday's laws of electromagnetic induction. **[5]**

ii. The magnetic field through a circular loop of wire 12 cm in radius and 8.5 Ω, resistance, changes with time as shown in the figure. The magnetic field is perpendicular to the plane of the loop. Calculate the induced current in the loop and plot it as a function of time.



iii. Show that Lenz's law is a consequence of the conservation of energy.

62. The figure shows a short solenoid of length 4 cm, radius 2.0 cm and a number of turns 100 lyings inside on the axis of a long solenoid, 80 cm length and number of turns 1500. What is the flux through the long solenoid if a current of 3.0 A flows through the short solenoid? Also, obtain the mutual inductance of the two solenoids. **[5]**



63. a. Derive an expression for the impedance of a series L-C-R circuit connected to an AC supply of variable frequency. **[5]**

b. Explain briefly how the phenomenon of resonance in the circuit can be used in the tuning mechanism of a radio or a TV set?

64. A series L-C-R circuit is connected to an AC source. Using the phasor diagram, derive the expression for the impedance of the circuit. Plot a graph to show the variation of current with frequency of the source, explaining the nature of its variation. **[5]**

65. i. Draw a schematic arrangement for winding of primary and secondary coil in a transformer when the two coils are wound on top of each other. **[5]**

ii. State the underlying principle of a transformer and obtain the expression for the ratio of secondary to primary voltage in terms of the

a. number of secondary and primary windings and

b. primary and secondary currents.

iii. Write the main assumption involved in deriving the above relations.

iv. Write any two reasons due to which energy losses may occur in actual transformers.

66. i. Draw a labelled diagram of a step-down transformer. State the principle of its working. **[5]**

ii. Express the turn ratio in terms of voltages.

iii. Find the ratio of primary and secondary currents in terms of turn ratio in an ideal transformer.

iv. How much current is drawn by the primary of a transformer connected to 220 V supply when it delivers power to a 110 V - 550 W refrigerator?

67. In the following circuit, calculate: **[5]**

i. the capacitance of the capacitor, if the power factor of the circuit is unity,

ii. the Q-factor of this circuit. What is the significance of the Q-factor in ac circuit? Given the angular frequency of the ac source to be 100 rad/s. Calculate the average power dissipated in the circuit.