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Question Bank (Class – XII, Physics, Set – 3)

Chapter 6: Electromagnetic Induction

Chapter 7: Alternating Current and Electrical Machines

Number of Questions: 50

1. A square of side L metres lies in the xy-plane in a region, where the magnetic field is given by $\mathbf{B} = B_0(2\hat{\mathbf{i}} + 3\hat{\mathbf{j}} + 4\hat{\mathbf{k}})$ T, where B_0 is constant. The magnitude of flux passing through the square is ***(NCERT Exemplar)***

(a) $2B_0L^2$ Wb (b) $3B_0L^2$ Wb
(c) $4B_0L^2$ Wb (d) $\sqrt{29}\,B_0L^2$ Wb

2. A conducting rod of length l is falling with a constant velocity v perpendicular to a uniform horizontal magnetic field B. The potential difference between its two ends will be

(a) $2Blv$ (b) Blv
(c) $\frac{1}{2}Blv$ (d) $B^2l^2v^2$

3. The magnitude of the earth's magnetic field at a place is B_0 and the angle of dip is δ. A horizontal conductor of length L lying in magnetic North-South moves eastwards with a velocity v. The emf induced across the conductor is

(a) zero
(b) $B_0Lv\sin\delta$
(c) B_0Lv
(d) None of the above

4. Amongst the following physical parameter, which is equivalent to self-induction?

(a) Inertia of mass
(b) Inertia of energy
(c) Inertia of moment
(d) Inertia of current

5. An infinitely long cylinder is kept parallel to a uniform magnetic field B directed along positive Z-axis. The direction of induced current as seen from the Z-axis will be

(a) clockwise of the positive Z-axis
(b) anti-clockwise of the positive Z-axis
(c) zero, no current is induced
(d) along the magnetic field

6. A circular coil of mean radius of 7 cm and having 4000 turns is rotated at the rate of 1800 rev/min in the earth's magnetic field ($B = 0.5$ G), the maximum emf induced in coil will be

(a) 1.158 V (b) 0.57 V
(c) 0.29 V (d) 5.8 V

7. The mutual inductance M_{12} of coil 1 with respect to coil 2

(a) increases, when they are brought nearer
(b) depends on the current passing through the coils
(c) increases, when one of them is rotated about an axis
(d) is different from M_{21} of coil 2 with respect to coil 1

8. The magnetic potential energy stored in a certain inductor is 25 mJ, when the current in the inductor is 60 mA. This inductor is of inductance

(a) 1.389 H (b) 138.88 H
(c) 0.138 H (d) 13.89 H

9. There are two long co-axial solenoids of same length l. The inner & outer coils have radii r_1 & r_2 and number of turns per unit length n_1 & n_2, respectively. The ratio of mutual inductance to the self-inductance of the inner coil is

(a) $\frac{n_2}{n_1}\cdot\frac{r_1}{r_2}$ (b) $\frac{n_2}{n_1^2}\cdot\frac{r_2^2}{r_1^2}$ (c) $\frac{n_2}{n_1}$ (d) $\frac{n_1}{n_2}$

10. The self-inductance of a coil having 500 turns is 50 mH. The magnetic flux through the cross-sectional area of the coil while current through it is 8 mA, is found to be

(a) 4×10^{-4} Wb (b) 0.04 Wb
(c) 4μ Wb (d) 40 m Wb

11. If emf induced in a coil is 2 V by changing the current in it from 8 A to 6 A in 2×10^{-3} s, then the coefficient of self-induction is

(a) 2×10^{-3} H (b) 10^{-3} H
(c) 0.5×10^{-3} H (d) 4×10^{-3} H

12. A long solenoid has 1000 turns. When a current of 4 A flows through it, the magnetic flux linked with each turn of the solenoid is 4×10^{-3} Wb. The self-inductance of the solenoid is

(a) 3 H (b) 2 H
(c) 1 H (d) 4 H

13. In electromagnetic induction, the induced charge in a coil is independent of ..... .

(a) flux change
(b) time taken to change the flux
(c) resistance
(d) None of the above

14. When the magnetic flux linked with a conducting wire loop changes with time, an ..... is induced in the cable.

(a) potential difference (b) electric field
(c) current (d) emf

15. The self-inductance of a coil is L. Keeping the length and area same, the number of turns in the coil is increased to four times. The self-inductance of the coil will be ..... .

(a) $\frac{L}{4}$ (b) L
(c) $4L$ (d) $16L$

16. In electromagnetic induction, the induced charge in a coil is independent of ..... .

(a) flux change
(b) time taken to change the flux
(c) resistance
(d) None of the above

17. If the resistance of a conductor is infinite. The power required to move a conductor in a uniform magnetic field is ..... .

(a) infinite (b) zero
(c) 1 W (d) None of these

18. Calculate the inductance of an air core solenoid containing 300 turns, if length of solenoid is 12π cm and its cross-sectional area is 4 cm^2.

(a) 12×10^{-5} H (b) 10×10^{-5} H
(c) 20×10^{-5} H (d) 30×10^{-5} H

19. A copper disc of radius 0.1 m is rotated about its centre with 20 rev/s in a uniform magnetic field of 0.1 T with its plane perpendicular to the field. The emf induced across the radius of the disc is

(a) $\frac{\pi}{20}$ V (b) $\frac{\pi}{10}$ V
(c) 20π mV (d) None of these

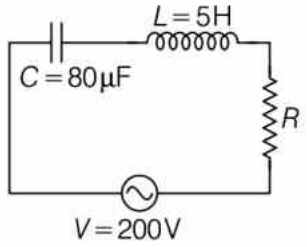
20. Amongst the following physical parameter, which is equivalent to self-induction?

(a) Inertia of mass
(b) Inertia of energy
(c) Inertia of moment
(d) Inertia of current

21. The core of a transformer is laminated to reduce ……
(a) flux leakage
(b) output power
(c) hysteresis
(d) eddy current

22. A copper disc of radius 0.1 m is rotated about its centre with 20 rev/s in a uniform magnetic field of 0.1 T with its plane perpendicular to the field. The emf induced across the radius of the disc is
(a) $\frac{\pi}{20}$ V (b) $\frac{\pi}{10}$ V
(c) 20π mV (d) None of these

23. Figure shows a series L-C-R circuit, connected to a variable frequency 200 V source. $C = 80\ \mu F$ and $R = 40\ \Omega$. The source frequency which drives the circuit at resonance is



(a) 25 Hz (b) $\frac{25}{\pi}$ Hz
(c) 50 Hz (d) $\frac{50}{\pi}$ Hz

24. A power transmission line feeds input power at 2300 V to a step-down transformer with its primary windings having 4000 turns. What should be the number of turns in the secondary in order to get output power at 230 V?
(a) 600 (b) 550
(c) 400 (d) 375

25. In a L-C-R series circuit, the potential difference between the terminals of the inductance is 60 V, between the terminals of the capacitor is 30 V and that across the resistance is 40 V. Then, supply voltage will be equal to the
(a) 50 V (b) 70 V
(c) 130 V (d) 10 V

26. In an L-C circuit, angular frequency at resonance is ω. What will be the new frequency when inductor's inductance is made two times and capacitor's capacitance is made four times?
(a) $\frac{\omega}{2\sqrt{2}}$ (b) $\frac{\omega}{\sqrt{2}}$
(c) 2ω (d) $\frac{2\omega}{\sqrt{2}}$

27. Which of the following statements is/are incorrect about capacitor?
(a) The current in a capacitive circuit is $i = i_m \sin\left(\omega t - \frac{\pi}{2}\right)$.
where, the amplitude of the oscillating current is $i_m = \frac{V_m}{\omega C}$
(b) For a purely capacitive circuit $\left(\frac{1}{\omega C}\right)$ plays the role of resistance. It is called capacitive reactance and denoted by $X_C = \frac{1}{\omega C}$
(c) The current reaches its maximum value earlier than the voltage by one-fourth of a period.
(d) In case of a capacitor, the average power, $P_c = \left\langle \frac{i_m V_m}{2} \sin(2\omega t) \right\rangle = 0$
Since, $<\sin(2\omega t)> = 0$ over a complete cycle.

28. The output of a step-down transformer is measured to be 24 V, when connected to a 12 W light bulb. The value of the peak current is
(a) $(1/\sqrt{2})$ A (b) $\sqrt{2}$ A
(c) 2 A (d) $2\sqrt{2}$ A

29. When the frequency of an AC circuit is doubled, then the capacitive reactance will be …….
(a) halved
(b) doubled
(c) squared
(d) Tripled

30. $110\ V_{rms}$ is applied across a series circuit having resistance 11 Ω and impedance 22 Ω. The power consumed is
(a) 275 W
(b) 366 W
(c) 550 W
(d) 1100 W

31. In an L-C-R circuit if impedance is 2 times of resistance, then find phase difference.
(a) Zero (b) 30°
(c) 60° (d) 45°

32. An L-C-R series circuit, connected to a source E, is at resonance. Then,
(a) the voltage across R is zero
(b) the voltage across R equals applied voltage
(c) the voltage across C is zero
(d) the voltage across C equals applied voltage

33. 220 V, 50 Hz, AC is applied to a resistor. The instantaneous value of voltage is
(a) $220\sqrt{2}\sin 100\pi t$
(b) $220\sin 100\pi t$
(c) $220\sqrt{2}\sin 50\pi t$
(d) $220\sin 50\pi t$

34. If the rms current in a 50 Hz AC circuit is 5 A, the value of the current 1/300 s after its value becomes zero is ***(NCERT Exemplar)***
(a) $5\sqrt{2}$ A (b) $5\sqrt{3/2}$ A
(c) 5/6 A (d) $5/\sqrt{2}$ A

35. An alternating current of rms value 10 A is passed through a 12Ω resistor. The maximum potential difference across the resistor is
(a) 20 V (b) 90 V
(c) 169.7 V (d) None of these

36. In a circuit containing R and L, as the frequency of the impressed AC increases, the impedance of the circuit
(a) decreases
(b) increases
(c) remains unchanged
(d) first increases and then decreases

37. In an L-C-R series AC circuit, if ω_0 is the resonant angular frequency, then the quality factor (Q-factor) is given by
(a) $\omega_0 L/C$ (b) $(1/R)\sqrt{\frac{L}{C}}$
(c) $\omega_0 C/R$ (d) $L/\omega_0 R$

38. In an L-C-R circuit if impedance is $\sqrt{2}$ times of resistance, then find phase difference.
(a) Zero (b) 30°
(c) 60° (d) 45°

39. AC generator is used to
(a) convert low voltage into high voltage
(b) high voltage into low voltage
(c) mechanical energy into electrical energy
(d) All of the above

40. The selectivity of a series L-C-R AC circuit is large, when ***(CBSE Delhi 2020)***
(a) L is large and R is large
(b) L is small and R is small
(c) L is large and R is small
(d) $L = R$

41. The transformation ratio in the step-up transformer is
(a) one
(b) greater than one
(c) less than one
(d) the ratio greater or less than one depends on the other factors

42. The ratio of secondary to the primary turns in a transformer is 3 : 2. If the power output be P, then the input power neglecting all losses must be equal to
(a) $5P$ (b) $2P$ (c) P (d) $\left(\frac{2}{5}\right)P$

Assertion reasoning MCQs

For question numbers 43 to 54, two statements are given one labeled as Assertion (A) and the other labeled Reason (R). Select the correct answer to these questions from the codes (a), (b), (c) and (d) are as given below

a) Both Assertion (A) and Reason (R) are true and reason is the correct explanation of assertion.
b) Both Assertion (A) and Reason (R) are true but reason is not the correct explanation of assertion.
c) Assertion (A) is true but Reason (R) is false.
d) Assertion (A) is false and Reason (R) is also false.

43. **Assertion**: Magnetic flux and the electric flux have the same units.
Reason: Flux passing through a surface does not gives an idea about the field lines crossing that surface.

44. **Assertion** Magnetic flux and the electric flux have the same units.
Reason Flux passing through a surface does not gives an idea about the field lines crossing that surface.

45. **Assertion** If a straight wire is moved in a magnetic field, no emf will be induced across its two ends as the circuit is not closed.

46. **Assertion** Eddy currents are undersirable.
Reason Eddy currents heat up the core and dissipate electrical energy in the form of heat.

47. **Assertion** When coil in galvanometer with metallic core oscillates, then electromagnetic damping occurs.
Reason Eddy currents generated in the core opposes the motion and brings the coil to rest quickly.

48. **Assertion** The self-induced emf is also called the back emf.
Reason The self-induced emf opposes any change in the current in a circuit.

49. **Assertion** The alternating current lags behind the emf by a phase angle of $\pi/2$, when AC flows through an inductor.
Reason The inductive reactance increases as the frequency of AC source decreases.

50. **Assertion** AC generator works on the principle of self induction.
Reason Magnetic flux linked with armature coil during rotation is zero always.

51. **Assertion** Inductive reactance of an inductor in DC circuit is zero.
Reason Angular frequency of DC circuit is zero.

52. **Assertion** Average power in an AC circuit is given by $P = I_{rms}^2 R$.
Reason In one full cycle, net power is dissipated not only in a resistor.

53. **Assertion** When the capacitor is connected to an AC source, it limits or regulates the current, but does not completely prevent the flow of charge.
Reason The capacitor is alternately charged and discharged as the current reverses each half-cycle.

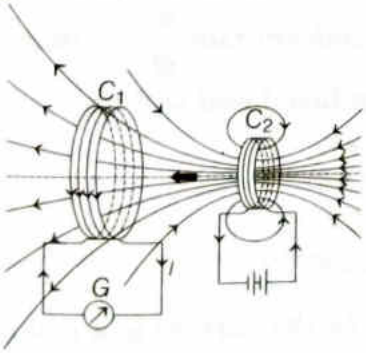
54. **Assertion** At resonance, power of L - C - R series circuit is zero.
Reason At resonance, $X_C > X_L$.

Case-based MCQs

Case Study 1

Induced Current

The steady current in the coil C_2 as shown below produces a steady magnetic field. As coil C_2 is moved towards the coil C_1, the galvanometer shows a deflection. This indicates that electric current is induced in coil C_1. When C_2 is moved away, the galvanometer shows a deflection again, but this time in the opposite direction. This deflection is based upon the Faraday's law of electromagnetic induction.



Read the passage carefully and answer the questions (56 to 60) in the following case.

56. The change in magnetic flux

(a) decreases the radius of the coil C_1 to half the initial radius

(b) induces emf in the coil C_1

(c) increases the radius of coil C_1 to double the initial radius

(d) None of the above

57. Which of the following statement(s) is/are correct?

I. The steady current in the coil C_2 produces a steady magnetic field.

II. If coil C_2 is moved towards the coil C_1, the galvanometer shows a deflection.

Choose the correct option.

(a) Only I (b) Only II

(c) Both I and II (d) Neither I nor II

58. What will be the direction of deflection of galvanometer, when C_2 is moved away?

(a) Same direction (b) Opposite direction

(c) No deflection (d) Neither (a) nor (b)

59. For duration of deflection in G, i.e. current flow in coil C_1, which of the following statement is correct?

(a) The deflection lasts as long as C_2 is in motion

(b) The deflection lasts till 1 min after motion of C_2 stops

(c) The deflection lasts till 1 h after motion of C_2 stops

(d) The deflection lasts forever

60. When the coil C_2 is held fixed and C_1 is moved , then

(a) same effects are observed, i.e. current is induced in coil C_1

(b) no current is induced in coil C_1

(c) number of magnetic field lines through C_1 do not change

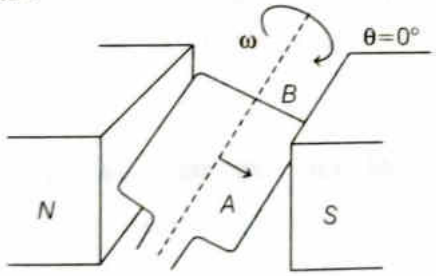
(d) current in coil C_2 increases drastically

Case Study 2

AC Generator

An AC generator produces electrical energy from mechanical work, just the opposite of what a motor does. In it, a shaft is rotated by some mechanical means, such as an engine or a turbine starts working and an emf is induced in the coil.

It is based on the phenomenon of electromagnetic induction which states that whenever magnetic flux linked with a conductor (or coil) changes, an emf is induced in the coil.



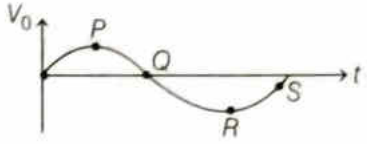
Read the passage carefully and answer following questions in the following case.

61. The change of flux is greatest at θ is equal to (take, $\phi_B = NBA\cos\omega t$)

(a) 90°, 270° (b) 90°, 45°
(c) 60°, 90° (d) 180°, 90°

62. The graph below shows the voltage output plotted against time.

Which point on the graph shows that the coil is in a vertical position?



(a) P (b) Q
(c) R (d) S

63. An AC generator consists of a coil of 1000 turns and cross-sectional area of 100 cm^2, rotating at an angular speed of 100 rpm in a uniform magnetic field of 3.6×10^{-2} T. The maximum emf produced in the coil is

(a) 1.77 V (b) 2.77 V
(c) 3.77 V (d) 4.77 V

64. When the coil is rotated with a constant angular speed ω, then the angle θ between the magnetic field vector **B** and the area vector **A** of the coil at any instant *t*, is

(a) $\theta = AB$ (b) $\theta = At$ (c) $\theta = \omega t$ (d) $\theta = Bt$

65. Which method is used to induce an emf or current in a loop in AC generator?

(a) A change in the loop's orientation
(b) A change in its effective area
(c) Both (a) and (b)
(d) Neither (a) nor (b)