

PHYSICS

QUESTIONS

Electromagnetic Induction & Alternating Current

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VERY SHORT ANSWER QUESTIONS

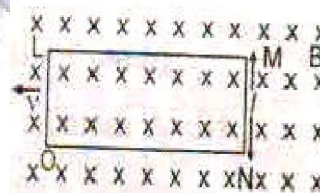
1. Define magnetic flux . Write its S.I. unit.
2. Define 1 henry.
3. What is the physical quantity which is ratio of magnetic flux and current ?
4. Which conservation law is followed by Lenz's Law?
5. Can a transformer be used to step up dc-voltage ?
6. Does a step up transformer contradict the principle of conservation of energy?
7. What is the phase difference between current and voltage in (i) pure inductor (ii) pure capacitor and (iii) pure resistor in ac circuit ?
8. What is the physical significance of inductance?
9. What is the power component of current?
10. What is wattles component of current?
11. Under what condition the power loss in ac circuit is zero?
12. What is condition of resonance in series LCR ac circuit?
13. Under what condition the power loss in ac series circuit is maximum?
14. What is the phase difference of voltage and current in series LCR circuit at resonance?
15. How does inductive reactance vary with frequency?
16. How does capacitive reactance vary with frequency .
17. What is impedance of LCR series ac circuit at a resonance?
18. Write the expression for self inductance of a long solenoid.
19. In ac circuit $V \neq V_L + V_C + V_R$; why ?
20. Can we eliminate eddy currents?
21. A 5 Hz ac current is passed through a bulb , does the bulb glow continuously?
22. The earth's magnetism does not induce a current in an artificial satellite orbiting the earth around the equator, why?
23. What do you mean by apparent value of ac current ?
24. Given two reasons for power loss in transformer.
25. Express quality factor in terms of L, C and R in series LCR circuit . What is its value at resonance ?
26. Why is a 220 V ac more dangerous than 220 V dc ?
27. The frequency ac is doubled , how R, X_L and X_C get affected ?
28. Why do capacitors block dc ?
29. What is the effect of core material on self inductance?
30. State Lenz's law.
31. Define mutual inductance and gives its. S.I. unit.
32. What is the difference between voltage and current in a LCR series circuit at resonance?

SHORT ANSWER QUESTIONS

1. A rectangular coil of area A , number of turns N is rotate at $f \text{ rev}^{-1}$ in uniform magnetic field B , the field being perpendicular to coil. Prove that the maximum emf induced in the coil is $2\pi f NBA$.
2. State Faraday's laws of electromagnetic induction.
3. Define self inductance and mutual inductance.
4. State Lenz's law. How is it useful to find the direction of current in a circuit?
5. Define self inductance and 1 henry.
6. Define mutual inductance. How does it depend on coupling between two coils?
7. What are eddy currents? How can they be reduced?
8. Show that energy density of magnetic field is $\frac{B^2}{2\mu_0}$.
9. Discuss oscillation in LC circuit.
10. A conducting rod of length l is moved in a magnetic field of strength B with V such that the arrangement is mutually perpendicular. Prove that emf induced in the rod is $\mathcal{E} = BVL$.
11. Show that the energy stored in an inductor L when a current I_0 is established through it is $U = \frac{1}{2} LI_0^2$.
12. Find an expression for phase difference between current and voltage in (i) Purely inductive circuit and (ii) purely capacitive circuit.
13. Why is series electrical power generally transmitted over long distances at high ac voltage?
14. In a series LCR circuit the voltage across the inductor, capacitor and resistor are 20 V, 20 V, and 40 V respectively. What is the phase difference between the applied voltage and current in the circuit?
[Ans : Zero]

LONG ANSWER QUESTIONS

1. Explain construction and working of an ac generator.
2. What is a choke coil? Why is it preferred to control ac current over resistor?
3. What is an LCR series resonant circuit? Find expression for resonant frequency and quality factor. Show that power dissipated at resonance in an LCR circuit is the maximum.
4. A rectangular conductor LMNU is placed in a uniform magnetic field \vec{B} directed perpendicular to the plane of paper. Obtain an expression for induced emf in the arm MN when it is moved towards left with speed V . Hence write an expression for induced emf between the ends of an axle of length L of a railway carriage travelling on horizontal ground with speed V in terms of earth's magnetic field B_e and angle of dip θ .



5. What are eddy currents ? How can they be minimized ? Write two advantage of these currents.

NUMERICAL QUESTIONS

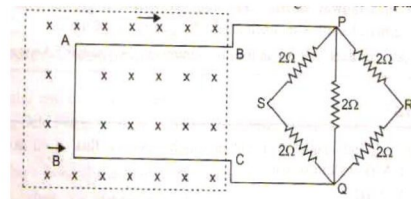
1. What is the self inductance of a coil in which magnetic flux of 40 mWb is produced when a current 2 A flows through it ?
[Ans : 2×10^{-2} H]
2. The magnetic flux passing through a coil changes from 12×10^{-3} Wb to 6×10^{-3} Wb in 0.01 s; calculate the emf induced in the coil.
[Ans : 0.6 V]
3. The rate of change of current 2 A/s induces an emf 40 mV in a solenoid , what is the self inductance of this solenoid ?
[Ans : 20 mH]
4. A 40Ω resistor , mH inductor and $2 \mu\text{F}$ capacitor are connected in series to 110 V , 50 Hz ac source . Calculate the current in the circuit.
[Ans : 0.07 A]
5. The area enclosed by a circular coil of 2000 turns is 100 cm^2 . Its plane is kept perpendicular to a magnetic field of 0.3 weber / meter² and is rotated through 180° . Calculate the change in magnetic flux.
[Ans : 6×10^{-4} Wb] [Hint : $\Delta\phi = 2BA$]
6. The magnetic flux threading in a coil change from 12×10^{-3} Wb to 6×10^{-3} Wb to 6×10^{-3} in 0.01 second . Calculate the induced emf.
[Ans : 0.6 V]
7. The self-inductance of a coil is 10H. If the induced emf in the coil be 120 volt , find the rate of change of current in the coil.
[Ans : $\frac{\Delta I}{\Delta t} = 12 \text{ A/s}$] [Hint : $\varepsilon = L \frac{\Delta I}{\Delta t}$]
8. The self-inductance of a coil is 0.4 mH. The current flowing in it changes by 250 mA in 0.1 second. Calculate the emf induced in the coil.
[Ans : 1 mV]
9. A large circular coil of radius R and a small circular coil of radius r are put in the vicinity of each other. If the coefficient of mutual induction for this pair equal 1 mH , what would be the flux linked with the larger coil when a current of 0.5 A flows through the smaller coil?
[Ans : 5×10^{-4} Wb]

10. A metallic square loop ABCD of size 15 cm and resistance 1Ω is moved at a uniform velocity V m/s in a uniform magnetic field of 2T, the field lines being normal to the plane of paper. The loop is connected to an electrical network of resistor, each of resistance 2Ω . Calculate the speed of the loop, for which 2 mA current flows in the loop.

[Ans : 1.33 cm/s]

[Equivalent resistance of loop between terminals P and Q is 1Ω . Total resistance, $R_T = 2\Omega$]

[Hint : $I = \frac{Bvl}{R_T}$.]



11. The instantaneous current from a ac source is $I = 5 \sin(314t)$ ampere. What are the average and rms value of an alternating current?

[Ans : $I_{av} = 0, I_{rms} = \frac{5}{\sqrt{2}}$ ampere]

12. What is the rms value of current in ac circuit containing resistance $R = 10\Omega$, capacitance $C = 10\mu F$ in series across a 220 V, 50 Hz ac mains.

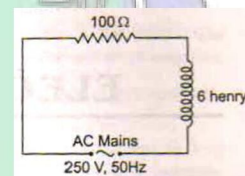
[Ans : 3.4 A]

13. A capacitor (C), a 150Ω resistor and 80 mH inductor are placed in series with a 50 Hz – ac source. Calculate the capacitance of capacitor (C) if the circuit is in resonance.

[Ans : $250\mu F$]

14. The resistance and self-inductance in an ac circuit are shown in fig. Find the value of current and power factor of the circuit.

[Ans : 0.133 A, 0.053]



15. Determine the impedance of a circuit if reactance of C and L are 340Ω and 300Ω respectively and R is 30Ω .

[Ans : 50Ω]

16. A resistance of 2 ohm, a coil of inductance 0.01H are connected with a capacitor and put across a 200 V and 50 Hz supply. Calculate

- The capacitance of capacitor so that the circuit resonates.
- The voltage across capacitor at resonance.

[Ans : $1.01 \times 10^{-3} F$ (ii) 314 V]

17. An inductor L, a capacitor $20\mu F$, a resistor 10Ω are connected in series with an ac source of frequency 50 Hz. If the current is in phase with the voltage, calculate the inductance of the inductor.

[Ans : 0.51 H]

18. An alternating voltage $V=200 \sin 300 t$ is applied across a series combination of resistance $R=10\Omega$, and an inductor of 800 mH. Calculate
- Impedance of circuit.
 - Peak value of current in the circuit.
 - Power factor of the circuit.

[Ans : (i) 240.2Ω (ii) 0.832 amp (iii) 0.041]

19. A resistor of 200Ω and capacitor of $40 \mu\text{F}$ are connected in series to a 220 V ac source with angular frequency $\omega=300 \text{ Hz}$. Calculate the rms voltage across the resistor and the capacitor. Why is the algebraic sum of these voltage more than the source voltage? How do you resolve this paradox?

[Ans : $V_R = 203 \text{ V}$, $V_C = 84.6 \text{ V}$, $V_R + V_C > 220 \text{ V}$]

[Hints : Due to phase diff. of $\frac{\pi}{2}$ between V_C and V_R

Hence $\sqrt{V_R^2 + V_C^2} = 200 \text{ V}$]

Note : if any mistake on this, kindly inform on the mail id :

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Your Observation! Our Correction !!

