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63 (FY)SEM-3/MAJ/PHYMAJ2014

2024

PHYSICS

Paper : PHYMAJ2014

(Electricity and Magnetism)

Full Marks : 50

Pass Marks : 20

Time : Two hours

The figures in the margin indicate full marks for the questions.

1. Choose the correct answer : 1×5=5

(a) In $\vec{E} = -\vec{\nabla}U$, the negative sign signifies

(i) E is opposite to U

(ii) E is negative

(iii) E increases when U decreases

(iv) E is directed in the direction of decreasing U

(b) Gauss's law in differential form is

(i) $\vec{\nabla} \times \vec{E} = \rho/\epsilon_0$

(ii) $\vec{\nabla} \cdot \vec{E} = \rho/\epsilon_0$

(iii) $\vec{\nabla} \times \vec{E} = 0$

(iv) $\vec{E} = -\frac{\partial \vec{v}}{\partial \vec{r}}$

Contd.

- (c) Curl of a magnetic field is
- 0
 - $\mu_0 \vec{J}$
 - $-\mu_0 \vec{J}$
 - $\vec{\nabla} \times \vec{A}$
- (d) The magnetic flux link with a coil of n turns and area of cross-section A held with its plane parallel to the magnetic field \vec{B} is
- $nAB/2$
 - nAB
 - $nAB/4$
 - zero
- (e) The r.m.s. value of alternating current is related to its peak value by equation-
- $I_{rms} = \sqrt{2} I_0$
 - $I_0 = \sqrt{2} I_{rms}$
 - $I_{rms} = 2 I_0 / \pi$
 - $I_0 = 2 I_{rms} / \pi$

2. Answer the following questions : **(any five)**
2×5=10

- State Gauss's law in electrostatics. Write two properties of electric field lines.
- Show that $\gamma = xyz$ satisfies Laplace's equation.

- Define magnetic susceptibility and magnetic permeability.
- Define self inductance and mutual inductance.
- Define sharpness of resonance. Under what condition does a circuit become more selective ?
- State Norton's theorem and Thevenin's theorem of electrical network.
- State and explain Biot-Savart's law.

3. Answer the following questions : **(any five)**
5×5=25

- Derive an expression for capacitance of a parallel-plate capacitor.
- State and explain maximum power transfer theorem.
- Explain reciprocity theorem of mutual induction.
- Show that $\vec{\nabla} \times \vec{B} = \mu_0 \vec{j}$, where the symbols have their usual meanings.
- Applying Ampere's circuital law, derive an expression for magnetic field inside a long solenoid carrying current.
- Derive an expression for Faraday's law of electromagnetic induction in integral form.

- (g) Define current and charge sensitivity of a ballistic galvanometer. Derive an expression for torque on a current loop in a uniform magnetic field.
- (h) Derive an expression for magnetic force between current elements.

4. Answer the following questions: **(any one)**

10×1=10

(a) (i) Define the terms dielectric constant and electric susceptibility. Deduce the relation between them. 2+3=5

(ii) Derive an expression for energy stored in an inductor. Calculate the energy stored in the magnetic field of a solenoid of inductance 20mH when a current of 3mA flows through it. 3+2=5

(b) (i) Derive an expression for force and torque acting on an electric dipole placed in a uniform electric field.

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(ii) Mention the analogy between electric dipole moment and magnetic dipole moment. Apply Biot-Savast law to derive an expression for magnetic field due to a straight wire carrying current.

2+4=6