Exam. Code : 103201
Subject Code : 1309

B.A./B.Sc. 1st Semester

PHYSICS (Electricity and Magnetism)
Paper—B

Time Allowed—Three Hours]   [Maximum Marks—35

Note :— (1) There are **five** Sections i.e. A, B, C, D and E.

(2) Section A is compulsory.

(3) Attempt **ONE** question from each section.

(4) All questions carry equal marks.

SECTION—A

1. (a) Is the volume charge density invariant ? How ?

(b) What do you understand by point charge in physics ?

(c) What will be the value of $\bar{E}$:

(i) in a region where potential v is constant

(ii) at a point where potential v is zero ?

(d) Can two equipotential surfaces intersect ? Explain.

(e) What do you understand by monopole and quadrupole ?

(f) Two parallel wires separated by 10 cm are carrying current 5 A each in the same direction. Find the magnitude and nature of force between them.

(g) What do you mean by atomic dipole ? $7 \times 1 = 7$

SECTION—B

2. (a) Explain what do you understand by gradient of a scalar function ? Give its physical interpretation.

   (b) Prove that curl of gradient U is zero.   5+2

3. (a) Define electric flux and electric flux density. Establish relation between them. Write their SI units.

   (b) Prove that the total flux over a surface due to a charge lying outside is zero.   5+2

SECTION—C

4. (a) State and prove Stoke's theorem.

   (b) Electric potential at a point is given by $V = x^2y + 2z$. What are the components of electric field at that point ?   5+2

5. (a) Prove that the line integral of the electrostatic field between two points is path independent.

   (b) An electrostatic field is curl free. Explain why ?

      5+2

SECTION—D

6. (a) Derive the continuity equation

$$\text{div } \vec{J} + \frac{\partial e}{\partial t} = 0 .$$

   What form will it take for steady current ?

(b) In copper there are 10^{22} free electrons per cm^3, all of which contribute to a current 1 A in a wire of copper of $0.01 \ cm^2$ cross-sectional area.

Calculate : (i) average drift speed of electron in copper

(ii) the electric field in the wire.

Given resistivity of copper is $1.6 \times 10^{-6} \ \Omega m$.

4+3

7. Derive the expressions for :

(i) electrical conductivity

(ii) electrical resistivity

in terms of :

(a) mass of an electron

(b) charge on electron

(c) mean free time

(d) the conduction electron density.   7

SECTION—E

8. Find an expression for the electric field of a point charge moving with a uniform velocity.   7

9. Derive the expressions for :

(i) Differential form of Ampere's law for magnetic materials.

(ii) Integral form of Ampere's law for magnetic materials.   4+3