ELECTRICITY AND MAGNETISM–I (C)

Semester-I

Time Allowed : 3 Hours] [Maximum Marks : 30

Note : The candidates are required to attempt *two* questions each from Section A and B carrying 5 marks each and *five* from Section C consisting of 7 short answer type questions carrying 2 marks each.

Section - A

1. State and prove Stokes' theorem. 5
2. Obtain expression for divergence of a vector function in Cartesian co-ordinates. What is its physical significance ? 5
3. Derive an expression for potential at a apoint due to a continuous charge distribution. On the basis of results derived, explain the concepts of monopole moment, dipole moment and quadrupole moment. 5
4. (a) State and derive Laplace's and Poisson's equations in electrostatics. 3
   (b) Show that the function $V = x^2 - 2y + z^2$ satisfies Laplace's equation. 2

Section - B

5. (a) Discuss the validity of Ohm's law from atomic viewpoint and derive the macroscopic from of ohm's law $\bar{J} = \sigma \bar{E}$ from consideration of motion of free electron in conductor. 3½

   (b) A charge 14.4C is flowing through a copper wire in one second. Find the current density if radius of copper wire is 1 mm. 1½
6. Derive and explain the force that one moving charge exerts on another moving with a uniform velocity. 5
7. Define current and current density. Show that the conservation of charged leads to equation :

$$\frac{\partial \rho}{\partial t} + \bar{\nabla}.J = 0$$

Where J is current density and ρ is volume charge density. 5

8. (a) Derive the relation $\vec{E} = -\nabla.\vec{V}$. 3

(b) The potential function at a point is given by :
$V(x, y, z) = (3y^2 - 2z)$ volt. Find electric field intensity at point (1, 4, 2). 2

Section - C

9. Attempt any *five* parts :

(i) What are Scalar and Vector Fields ?

(ii) Show that electric field given by :

$E = x\hat{i} + y\hat{j} + z\hat{k}$ is conservative.

(iii) Define line charge density. Give its units.

(iv) Calculate work done in moving a charge 2C on the equipotential surface of 5V.

(v) What is meant by Invariance of Charge ?

(vi) Prove that IC is equal to 3×10^{10} e.m.u. of charge.

(vii) Show that resistivity is a temperature dependence quantity. 5×2=10