B.Sc. (General) 1st Semester

(1129)

PHYSICS

Paper–C

(Electricity and Magnetism–I)

Time Allowed : Three Hours]   **[Maximum Marks : 22**

Note :—Attempt **FIVE** questions in all, selecting **TWO** questions from each Units (I & II). Unit–III is compulsory. Use of non-programmable calculator is allowed.

UNIT—I

1.   (a)   State and prove Green's theorem in a plane.

     (b)   Verify Stroke's theorem for the function $\vec{E} = x(\hat{i}x + \hat{j}y)$ integrated around the square in the plane $z = 0$, whose sides are along the lines $x = 0$, $y = 0$, $x = a$, $y = a$.

                                                $3, 1\frac{1}{2}$

2.   (a)   Find electric field due to an electric dipole at a point on its (i) axial line (ii) equatorial line.

(b) A charge $+ q$ is placed at the origin while a charge $+ 4q$ is placed at a distance of 2 m, from the origin along the X-axis. Calculate the position of the point where the resultant electric field is zero.   3,1½

3. (a) State and prove Gauss's law in electrostatics and hence show that a charged sphere acts externally as though its charge were concentrated at the centre.

(b) The electric field inside a cube of side 10 cm is given by $\vec{E} = 4 \times 10^3 x \hat{i}$ N/C. Find the charge inside the cube.   3,1½

UNIT—II

4. (a) Show that electric potential due to uniformly charged spherical shell at any point inside it is equal to the value of the potential at its surface.

(b) What is the electric potential energy of the charge configuration shown below :
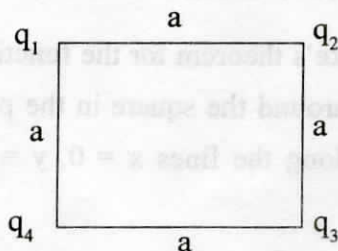
Given that $q_1 = + 1.0 \times 10^{-8}$ C

              $q_2 = - 2.0 \times 10^{-8}$ C

$$q_3 = + 3.0 \times 10^{-8} \text{ C}$$

$$q_4 = + 2.0 \times 10^{-8} \text{ C}$$

$$a = 1 \text{ metre} \qquad\qquad 3,1\frac{1}{2}$$

5. (a) Derive the differential form of Gauss's law in dielectrics.

   (b) An isolated air gap parallel plate capacitor with capacitance C_0 has charge q. A dielectric having dielectric constant K is inserted between the plates. Find the change in energy stored in the capacitor. $3,1\frac{1}{2}$

6. (a) Derive Laplace's equation. Show that the function $\phi = x^2 - y^2 + z$ satisfies the Laplace's equation.

   (b) Prove that $K = 1 + \chi_e$, where letters have their usual meaning. $3,1\frac{1}{2}$

UNIT—III

7. Attempt any **EIGHT** parts :—

   (i) What do you understand by solenoidal vector ?

   (ii) State the condition under which line integral of vector field is independent of the path of integration.

   (iii) An electron and proton are placed in uniform electric field $\vec{E}$. If e is the magnitude of charge on each, what will be net electric force on the system ?

   (iv) What is the angle between electric dipole moment and electric field due to a dipole on equatorial line ?

(v) What do you understand by Gaussian surface ?

(vi) What is meant by électrical image ?

(vii) What are equipotential surfaces ?

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

(ix) What are S.I. unit of atomic polarizability ?

(x) A sample of helium gas is subjected to an electric field of 6000 V cm^{-1}. Find Polarization produced in the sample. Given atomic polarizability is 0.18×10^{-40} farad m^2 and number of helium atoms per unit volume is 2.6×10^{25} atoms m^{-3}. $8 \times \frac{1}{2} = 4$