T.Y.B.Sc. Physics paper IV sem-V (50)
Sub: Electrodynamic 2016-17

QP Code : 76962

(2½ Hours) [Total Marks : 75

. : (1) **All** questions are **compulsory.**
(2) **Figures** to the **right** indicate **full** marks.
(3) **Symbols** have usual meaning unless stated otherwise
(4) **Use** of logtable/non programmable **calculator** is **allowed.**

(a) Attempt any **one** of the following:-
(i) A point charge 'q' is held at a distance 'd' above an infinite grounded conducting plane, using method of image obtain the expression for **10**
(a) Potential 'V' above the conducting plane (b) Induced surface charge
(c) Force F on the charge 'q'.
(ii) Write down the expressions for potential due to **10**
(a) A collection of 'n' discrete charges $q_1 q_2 q_3 ... q_n$ at $r_1\ r_2 .... r_n$ respectively
(b) A linear charge density 'λ'
(c) A surface charge density 'σ'
(d) A volume charge density 'ρ'
Hence obtain potential of a uniformly charged spherical shell of radius R.

(b) Attempt any **one** of the following:-
(i) An infinite plane carries a uniform surface charge 'σ' find the electric field. **5**
(ii) Show that for electrostatic field curl $\overline{E} = 0$. **5**

(a) Attempt any **one** of the following:-
(i) Obtain the expression for potential due to polarized object and hence explain the terms surface bound charge density (σ_b) and volume bound charge density (ρ_b). **10**
(ii) Starting from Biot-Savarts law obtain the expression for $\overline{\nabla}.\overline{B}$ and $\overline{\nabla} \times \overline{B}$. **10**

(b) Attempt any **one** of the following:-
(i) Obtain the expression $\overline{\nabla}.\overline{D} = \rho_f$ for dielectrics. **5**
(ii) For a dipole $\overline{P}$ in a uniform electric field $\overline{E}$ show that the net torque acting on dipole is $\overline{N} = \overline{P} \times \overline{E}$. **5**

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3. (a) Attempt any **one** of the following:-

(i) Why it is necessary to modify Ampere's law in its original form? Obtain the expression for modified Ampere's law. 10

(ii) Obtain the expression $W = \frac{1}{2\mu_0} \int_{\text{all space}} B^2 d\tau$, for energy stored in a magnetic field. What is energy density? 10

(b) Attempt any **one** of the following:-

(i) A long coaxial cable consist of two very long thin cylindrical conductors of radii 'a' and 'b' (b>a). The inner conductor carries a current I. The current flows down the surface of the inner cylinder and back along the outer cylinder. Find the magnetic field in the region $r < a$, $a < r < b$ and $r > b$ where r is the distance from the axis of the cable. 5

(ii) Show that for uniform magnetization $\overline{K}_b = \overline{M} \times \hat{n}$. 5

4. (a) Attempt any **one** of the following:-

(i) State and prove Poynting theorem. Obtain its differential form. 10

(ii) Derive the electromagnetic wave equation in vaccum, where there are no free charges or currents. Show that the electric field, magnetic field and the direction of propogation are mutually perpendicular. 10

(b) Attempt any **one** of the following:-

(i) Explain: Newton's third law is violated in electrodynamics. How it is rescued? 5

(ii) Show that the magnitude of average momentum carried by an electromagnetic wave is 5

$$< p >= \frac{1}{2} \cdot \frac{\varepsilon_0}{c} E_0^2$$

Write the expression in vector form.

5. (a) Attempt any **one** of the following:-

(i) The electric field in some region is found to be $\overline{E} = kr^3 \hat{r}$ (k is constant) Find the charge density ρ. 4

(ii) Charge 'q' is located at the centre of a cube. What is the flux of 'E' through the top surface of the cube? 4

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(b) Attempt any **one** of the following:-

(i) Show that for a linear isotropic homogeneous dielectric the volume charge density of free charge is directly proportional to the volume charge density of bound charge. **4**

(ii) A long narrow solenoid consists of 1000 turn per meter of its length, carries 1.5A current. Find magnetic field inside the solenoid. **4**

$\left(\mu_0 = 4\pi \times 10^{-7}\ \mathrm{N/A^2}\right)$.

(c) Attempt any **one** of the following:-

(i) An infinite solenoid (n turns per unit length) carries current I, is filled with linear material of susceptibility χ_m. Find magnetic field inside solenoid. **4**

(ii) Show that $\overline{\nabla}.\overline{J}_b = 0$. **4**

(d) Attempt any **one** of the following:-

(i) A plane electromagnetic wave is incident normally from air (n_1=1) into water (n = 1.33). Find the coefficients of reflection and transmission. **3**

(ii) Show that Maxwell's equations already include the principle of conservation of charge. **3**

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