(b) State the second uniqueness theorem and under what condition(s) it will reduce to the first one. (3)

(c) In a material for which $\sigma = 5.0$ S/m, $\varepsilon_r = 1$ and electric field intensity is $E = 250\sin 10^{10}t$ V/m. Find the conduction and displacement current densities and the frequency at which they have equal magnitudes. (6)

6. (a) An infinitely long cylinder, of radius R, carries a "frozen-in" magnetization, parallel to the axis, $\vec{M} = kr\hat{r}$ where k is a constant and r is the distance from the axis (there is no free current anywhere). Find the magnetic field inside and outside the cylinder

(i) Locate all the bound currents, and calculate the field they produce.

(ii) Use Ampere's law to find $\vec{H}$, and then get $\vec{B}$. (3+3+3+3)

(b) Two coaxial solenoids each carrying current I, but in opposite directions. The inner solenoid of radius a has N_1 turns per unit length and the outer of radius b has N_2 turns per unit length. Find $\vec{B}$ in each of the three regions : (i) inside the inner solenoid, (ii) between them and (iii) outside the outer solenoid. (2+2+2)

[This question paper contains 4 printed pages.]

Your Roll No.....

Sr. No. of Question Paper : 4123 **H**

Unique Paper Code : 2222011202

Name of the Paper : Electricity and Magnetism

Name of the Course : **B.Sc. (H) – DSC**

Semester : II

Duration : 3 Hours Maximum Marks : 90

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. Question **1** is compulsory.
3. Attempt any **four** questions from question numbers **2-6.**
4. **All** questions carry equal marks.

1. Attempt all parts of this question : (6×3=18)

(a) Two uniform infinite sheets of electric charge densities $+\sigma$ and $-\sigma$ intersect at an angle of 45°. Find the magnitude and direction of the resultant electric field.

(b) Calculate the charge density in an enclosed region due to the potential

$$V = x^2 + y^2 + z^2.$$

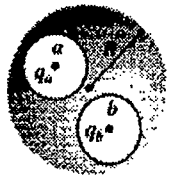
(c) Show that equation of continuity is a consequence of Maxwell's equations.

(d) Given that $\vec{E_1}=2\hat{i}-3\hat{j}+5\hat{k}$ (V/m) at the charge-free dielectric interface between two different dielectric materials of 2 and 5, respectively. Find $\vec{E_2}$ and $\vec{D_2}$.

(e) Determine whether the following elements are paramagnetic or diamagnetic (i) Chlorine Atoms (Atomic No. = 17, Atomic Mass = 35.43 u), and (ii) Copper atoms (Atomic No. = 29, Atomic mass = 63.55 u)

(f) A current sheet of width 4 m lies in the $z = 0$ plane and contains a total current of 10 A in a direction from the origin to (1, 3, 0) m. Find an expression for $\vec{K}$.

2. (a) Two spherical cavities, of radii a and b, are hollowed out from the interior of a (neutral) conducting sphere of radius R. At the center of each cavity a point charge placed q_a and q_b. Find the surface charge densities on the walls of both the cavities and the surface of the conductor. What is the force experienced by q_a and q_b? (9)



(b) A block of iron ($\mu = 5000\ \mu_0$) is placed in a uniform magnetic field with 1.5 Wb/m^2. If iron consists of 8.5×10^{28} atoms/m^3, calculate (i) the magnetization M (ii) the average dipole moment. (9)

3. (a) A point charge q is located at a from the center of a grounded conducting sphere of radius R along y axis such that (a > R). What is the potential outside the grounded conducting sphere? (9)

(b) In spherical coordinates, V = 0 for r = 0.10 m and V = 100 V for r = 2.0 m. Assuming free space between these concentric spherical shells, find E and D. (9)

4. (a) Calculate the Laplacian of electrostatic potential at any arbitrary point P due to a point charge q located at r' from the origin. (9)

(b) Is it true that in a uniform material with magnetic susceptibility χ_m and electric conductivity 0, the bound current distribution can only be a surface current (assume no time dependence). Justify. (3)

(c) Using Ampere's law obtain magnetic flux density B inside and outside the toroid. (6)

5. (a) A very long cylinder of linear dielectric material is placed in an uniform electric field E_0. Find the resulting field within the cylinder. (The radius is R, the susceptibility χ_r and the axis is perpendicular to E_0.) (9)

P.T.O.