(3 *hrs*) **Total Marks : 100**

N.B. : (1) **All** questions are **compulsory**.

(2) **Figures** to the **right** indicate **full** marks.

(3) Draw **neat** diagrams wherever **necessary**.

(4) Symbols have usual meaning unless otherwise stated.

(5) Use of **non-programmable** calculator is allowed.

Constants: 1] $\varepsilon_0 = 8.85 \times 10^{-12} C^2/Nm^2$

2] $\mu_0 = 4\pi \times 10^{-7} N/A^2$

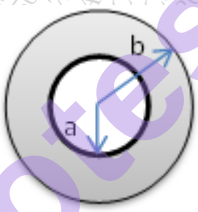
3] Electronic charge = $1.6 \times 10^{-19} C$

1. Attempt any **Two:---**

(a) State and prove First and Second Uniqueness theorems. **10**

(b) Determine the curl of electric field due to a point charge in free space. **10**
Show that the electrostatic field is obtained as $\bar{E} = -\bar{\nabla} V$.

(c) Derive the Gauss's law in integral form. **10**



A hollow spherical shell carries charge density $= \frac{k}{r^2}$, in the region $a \leq r \leq b$.
Find the electric field in the three regions: (i) r < a, (ii) a < r< b, (iii) r > b.

2 Attempt any **Two:---**

(a) Derive an expression for energy stored in a linear homogeneous dielectric system. **10**

(b) Derive the Ampere's law using Biot-Savart's law. **10**
Compare Electrostatics and Magnetostatics.

(c) Derive an expression for potential due to a polarized object in terms of bound charges. Show that $\sigma_b = \bar{P} \cdot \hat{n}$ and $\rho_b = \bar{\nabla} \cdot \bar{P}$. **10**

3. Attempt any **Two:---**

(a) State the Maxwell's equations before applying correction to it. Explain the need to correct these equations. How did Maxwell resolve this difficulty? **10**

(b) Derive an expression for vector potential due to magnetized object in terms of bound currents. **10**
An infinitely long circular cylinder carries a uniform magnetization M parallel to its axis. Find the magnetic field due to M inside and outside the cylinder. There is no free current anywhere.

(c) Obtain the boundary conditions for the fields: Electric field $\bar{E}$, Electric Displacement $\bar{D}$, Magnetic field $\bar{B}$ and auxiliary field $\bar{H}$. **10**

4. Attempt any **Two:---**

(a) State and prove Poynting's theorem. Obtain the differential version of Poynting theorem **10**

(b) Write the Maxwell's equations for a region with no free charges and free currents. Obtain the wave equation from Maxwell's equation. Show that for plane wave solutions the electric field, magnetic field and the direction of propagation are mutually perpendicular. **10**

(c) In case of plane monochromatic wave show that the contribution towards the energy density from magnetic and electric fields are equal. Obtain the expression for average values for energy density, Poynting vector, and momentum density in case of plane monochromatic wave. **10**

5. Attempt any **Four:---**

(i) Determine if any of the following vectors can be electrostatic field: **05**
(i) $\bar{E} = k[6xyz\hat{x} + 3x^2z\hat{y} + 3x^2y\hat{z}]$
(ii) $\bar{E} = k[xy\hat{x} + 2yz\hat{y} + 3xz\hat{z}]$

(ii) If the potential is a function of only position vector r, V(r), then solve the Laplace's equation $\nabla^2 V = 0$. **05**

(iii) 2.5 Ampere current flows through a solenoid having 3700 turns per meter. Calculate the magnetic field inside and outside the solenoid. (Given: $\mu_0 = 4\pi \times 10^{-7} N/A^2$) **05**

(iv) A hydrogen atom with the Bohr radius of half an angstrom is situated between two metal plates 1 mm apart, which are connected to opposite terminals of a 500V battery. What fraction of the atomic radius does the separation distance'd' amount to, roughly? **05**
(Given: Atomic polarizability $\alpha = 4\pi\varepsilon_0 \times 0.667 \times 10^{-30} m^3$,
$\varepsilon_0 = 8.85 \times 10^{-12} C^2/Nm^2$, Electronic charge = $1.6 \times 10^{-19} C$)

(v) The magnetic susceptibility of a linear sample of Tungsten is 7.8×10^{-5}. If auxiliary field (H) of 50,000 Ampere.turns/m is applied along the z-axis, find the magnetization M and the magnetic field B in the medium. **05**

(vi) A parallel plate capacitor is immersed in a sea water with permittivity $\varepsilon = 81\varepsilon_0$, permeability $\mu = \mu_0$ and resistivity $\rho = 0.23\Omega.m$. The capacitor is driven by the voltage $V_0 \cos(2\pi\nu t)$ and frequency 4×10^8Hz. What is the ratio of conduction current to displacement current? **05**

(vii) Electromagnetic wave in empty space has amplitude of electric field 300V/m find the value of amplitude of magnetic field(c=3 x 10^8m/s) **05**

(viii) An electromagnetic wave is incident normally on the surface of glass from air, find the reflection coefficient. Given (n=1.5) **05**
