T.Y.B.Sc Sem V
17/10/2013

Con. 1269–13.

CG–2286

(2½ Hours) [Total Marks : 60

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 logtable/non programmable calculator is **allowed**.

1. (a) Attempt any **one** :—
   (i) Show that the average potential over a spherical surface of radius R due to single charge q located outside the sphere is same as the average potential due to charge q located at the center of the sphere. **8**
   (ii) A point charge 'q' is placed at a distance d above an infinite, grounded conducting plane. Find electrostatic potential at any point in space and electrostatic field near the plane. Explain how uniqueness theorem is used in solving the problem. **8**

   (b) Attempt any **one** :—
   (i) Show that electrostatic field can be obtained as the negative gradient of its scalar potential i.e $\vec{E} = -\vec{\nabla} V$ **4**
   (ii) Define electric flux and obtain Gauss' law for free space, in integral form. **4**

2. (a) Attempt any **one** :—
   (i) For a linear, homogenous, isotropic dielectric system, obtain expressions for energy stored and electrostatic energy density. **8**
   (ii) For a polarized dielectric, show that, potential could be given as that due to bound surface charge density and bound volume charge density. **8**

   (b) Attempt any **one** :—
   (i) Show that the net charge induced in the dielectric due to polarization of the dielectric is zero. **4**
   (ii) For a linear, isotropic, homogenous dielectric, show that the volume charge density of free charges (ρ_f) is directly proportional to the volume charge density of bound charges (ρ_f). **4**

3. (a) Attempt any **one** :—
   (i) Give the physical interpretation of bound currents. **8**
   (ii) Starting from Maxwells's equations in integral from (in matter) obtain boundary conditions on field vectors. **8**

   (b) Attempt any one :—
   (i) What are diamagnets, paramagnets and ferromagnets ? What is the sign of χ_m (magnetic susceptibility) for them ? **4**
   (ii) Obtain Ampere's law in magnetized material. **4**

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4. (a) Attempt any **one** :—
   (i) Obtain the expression for work energy theorem in electrodynamics, hence define Poynting Vector. **8**
   (ii) For a plane electromagnetic wave obtain the expressions for average values of energy density. Poynting vector and momentum <u>, <S> and <p>. **8**
   (b) Attempt any **one** :—
   (i) Obtain wave equation from Maxwell's equations. **4**
   (ii) Explain how Momentum conservation is rescued in Electrodynamics. **4**

5. (a) Attempt any **two** :—
   (i) Find the potential inside and outside a spherical shell of radius R, which carries uniform surface charge (take reference point to be infinity). **3**
   (ii) A point charge 1 μc is placed at a point (0, 0, 2). A grounded conducting plane of infinite extent is kept coinciding with xy plane. Using method of images, find the potential at point (2, 1, 5), the coordinates are given in SI units. Given : $\epsilon_0 = 8{\cdot}85 \times 10^{-12}\ c^2/Nm^2$ **3**
   (iii) The Polarization in a dielectric is given by $\vec{P} = 2x\,\hat{x} + 3y\,\hat{y} + 7\hat{z}$ find bound volume charge density ρ_b. **3**
   (iv) Find the electric suspectibility (χ_e) of diamond, if its dielectric constant is 5·7. **3**
   (b) Attempt any **two** :—
   (i) Show that divergence of volume bound current density is zero. **3**
   (ii) If magnetic susceptibility of Gadolinium is 0·48 find the permeability of Gadelinium ($\mu_o = 4\pi \times 10^{-7}\ N/A^2$) **3**
   (iii) A plane electromagnetic wave in free space has maximum magnetic field $B_0 = 4 \times 10^{-6}$ T. Find the corresponding maximum electric field E_0 (Given $c = 3 \times 10^8$ m/s). **3**
   (iv) For a certain electromagnetic wave $\overline{E} = E_0 e^{-i(kx-wt)}\,\hat{i}$ and $\overline{B} = \overline{B}_0\, e^{-i(kx-wt)}\,\hat{j}$, find the Poynting Vector $\overline{S}$. **3**
