Ref. No.: Ex/PHY/TG/105/20/2019

MASTER OF SCIENCE EXAMINATION, 2019

(1st Year, 1st Semester, Day)

PHYSICS

Electrodynaimcs - I

Paper - PHY/TG/105

Time : Two hours **Full Marks : 40**

Answer any *two* questions.

1. (a) The potential of conductor B due to a charge Q imparted on conductor A (the two conductors are electrically separated) is given by the function Ψ. In a different arrangement, when the same charge Q is imparted on conductor B, the potential of conductor A is given by the function Φ. Find the relation between the functions Φ and Ψ.

   (b) Two large parallel conducting plates are separated by a distance d. A point charge q is placed at a height h from one of the plates. Find the charges induced in the two plates, if both the plates are grounded, by considering some suitable alternative arrangement that does not contain any point charge.

   (c) Two concentric metallic spheres of radii R_1 and R_2 (with $R_1 < R_2$) are held at potentials ϕ_1 and ϕ_2 respectively. Find the potential in the region $R_1 < r < R_2$.

   Marks: $6 + 8 + 6 = 20$

2. (a) Two semi-infinite dielectric media are separated by the $x - y$ plane. The medium with $z > 0$ is having permitivity ϵ_1 and the other has permitivity ϵ_2. A point charge q is placed at $z = h\hat{z}$, where $h > 0$. Find the bound surface charge densities in the two media along the $x - y$ plane.

   (b) A solid ellipsoid of revolution with the lengths of the three semi-axes given by (a, a, c) is charged uniformly with volume charge density ρ. Find the quadrupole moment with respect to the centre of the ellipsoid.

   Marks: $10 + 10 = 20$

3. (a) Consider a long solenoid of radius R and with n turns per unit length. A current I is passing through it.

      i. Find the magnetic field vector within the solenoid.

      ii. Find the magnetic vector potential both inside and outside the solenoid.

   (b) A uniform surface charge density σ is given on a spherical shell of radius R and the shell is being rotated about one of its diameters with an angular velocity ω. Find the magnetic field inside and outside the sphere using the magnetic scalar potential Ψ and the relation $\vec{B} = -\mu_0 \vec{\nabla} \Psi$.

   Marks: $(4 + 6) + 10 = 20$