

# Bhairab Ganguly College

2<sup>nd</sup> SEM, Class Test-2020

Paper-CORE T3, Physics Honours

Paper Name: Electricity & Magnetism

Class Teacher: Dr. D. Bhadra

Time: 1 hour

Full Marks: 30

1. Answer any **five** from the following

2X5=10

- i) What is meant by polarization of dielectric?
- ii) Define the term 'electric displacement'.
- iii) Can an electrostatic field have the form  $\vec{E} = a(y\hat{a}_x - x\hat{a}_y)$ , where  $a$  is constant.
- iv) Determine the radius of a spherical drop of water that remains stationary in a vertically downward electric field of 300 V/m. The drop carries an electronic charge.
- v) Show that the function  $\phi = 3x^2 + 8y - 3z^2$  can represent the electrostatic potential in a charge free region.
- vi) How the charge density changes with position for  $\vec{E} = [2x\hat{i} - yz^2\hat{j} - (1 + y^2z)\hat{k}]A$ . where  $A$  is constant.
- vii) Explain how images can be used in boundary value problem?
- viii) Find the boundary condition prevailing at the interface of two dielectrics, assuming no free charge to be present.

Answer any **two** from the following.

2X10=20

Q2. (a) Find the surface density of charge at any point of the sphere & show that the total charge on the sphere is zero.

(Hints:  $V(r) = -A(r - a^3/r^2)\cos\theta$ ,  $r > a$ )

4

(b) Find the force exerted on an electric dipole of moment  $\vec{p}$  placed in a non uniform electric field  $\vec{E}$  is  $\vec{F} = (\vec{p} \cdot \nabla)\vec{E}$ .

3

(c) Show that the electric field due to a spherical charge distribution of density

$\rho = 2/(\epsilon_0 r)\hat{r}$  V/m.

3

Q3. (a) In a region, the electrostatic potential is expressed by

$\phi(x, y, z) = 10(x^2 + y^2 + z^2)^{-1/2}$  Find the electric field at (2,3,4).

3

(b) The potential in a medium is given by  $\varphi(r) = \frac{q}{4\pi\epsilon_0} \frac{e^{-r/\lambda}}{r}$ .

Obtain the corresponding electric field and charge density. 4

(c) Calculate the force per unit area of a conductor carrying a surface density  $2.5 \text{ nC/cm}^2$  of electric charge. What is the direction of this force? 2

(d) What is the differential form of Gauss's law? 1

Q4. (a) A point charge  $q$  is placed at a distance  $d$  from the centre of a grounded conducting sphere of radius  $a$  ( $a < d$ ). Calculate the density of induced surface charge on the sphere. 4

(b) Hence show that the ratio of the charge induced on the part of the sphere visible from  $q$  to that of the remaining part of the sphere is  $\sqrt{\frac{d+a}{d-a}}$  4

(c) A dielectric sphere of radius  $a$  has polarization  $\vec{P} = k\vec{r}$ , Calculate the volume & surface charge density of the polarization charge in the sphere.

Also find the electric field outside the sphere due to the polarization. What is the electric field at a point just inside the sphere? 2