Department of Physics, Bennett University

EPHY105L (I Semester 2021-2022)

Tutorial Set-4

1. **In a certain region of space the elctrostatic potential is given by $V = \frac{5}{r^2}\cos\theta$ (in spherical polar coordinates). What will be the electric field at a point with coordinates $r = 2$, $\theta = \frac{\pi}{2}$, $\phi = 0$? All distances are in meters.**

2. **A conducting plate of thickness d and with parallel surfaces is placed in a uniform electric field $\vec{E} = E_0\hat{k}$ such that the surfaces are parallel to the $x-y$ plane. What is the surface charge density on the surface of the conductor?**

3. **Can the following vector function represent an electrostatic field? Give reasons for your answer:**

$$\vec{F_1} = x^2\hat{i} + 3xz^2\hat{j} - 2xz\hat{k}$$

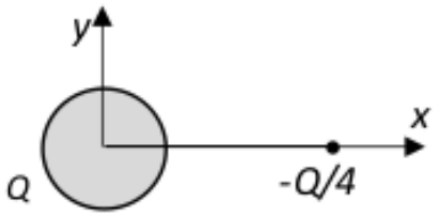
4. **A point charge with $q = 1\ \mu C$ is placed at a point with coordinates $x = 3$, $y = 2$, $z = 0$. Obtain the electrostatic field $\vec{E}$ at a point with coordinates $x = 3$, $y = 5$, $z = 0$. All distances are in meters.**

5. **Consider a spherical charge distribution with volume charge density given by**

$$\rho(r) = \rho_0\left(1 - \frac{4r}{3R}\right) \qquad 0 < r < R$$
$$= 0 \qquad\qquad\qquad\qquad r > R$$

where r is the distance from the center of the sphere and ρ_0 is a constant.
(a) Use Gauss' law to obtain the electric field everywhere due to the charge distribution.
(b) What are the values of $\vec{\nabla}.\vec{E}$ and $\vec{\nabla}\times\vec{E}$ at $r = \frac{4R}{5}$?

6. **Consider a uniform spherical charge distribution with total charge $+Q$ and a point charge having a charge $-\frac{Q}{4}$ placed at a distance d from the center of the sphere as shown in the figure.**



Obtain the position/positions where the net electric field will be zero.

7. **A negative charge of $1\ \mu C$ is placed at the center of a cavity formed inside a spherical conducting shell having an inner radius $0.2\ m$ and an outer radius $1\ m$. What is the charge density on the outer surface of the sphere?**