

Tutorial Set - 4

1. In a certain region of space the electrostatic 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 $q = 1 \mu\text{C}$ 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 in meters).

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

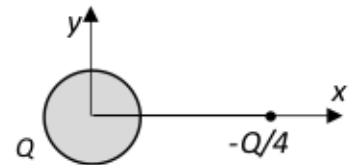
$$\rho(r) = \rho_0 \left(1 - \frac{4r}{3R}\right) \quad 0 < r < R$$
$$= 0 \quad r > R$$

where r is the distance from the center of the sphere and ρ_0 is a constant.

- a) Use Gauss's law to obtain the electric field everywhere due to the charge distribution.

- b) What are the values of $\nabla \cdot \vec{E}$ and $\nabla \times \vec{E}$ at $r = \frac{4R}{5}$?

6. Consider a uniform spherical charge distribution with total charge $+Q$ and a point charge having a charge $-Q/4$ placed at a distance d from the centre 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 $1 \mu\text{C}$ 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?