

EE2104 Introduction to Electromagnetics
Assignment 2

Deadline (for uploading): 11:59 pm, 30 Sep 2022
Please put down your name and university ID.

1. Consider a line at $x = -L/4$ to $3L/4$. It contains electric charges of density $\rho_L = \rho_{L0} (x/L)^5$ for some constant ρ_{L0} in C/m. Find the total charge.
2. A sphere centered at origin has radius b . It contains electric charge of density $\rho_v(r, \theta, \phi)$ in C/m³.
 - (a) Find the total charge when the density $\rho_v = \rho_0$ for some constant ρ_0 .
 - (b) Find the total charge when the density $\rho_v = \rho_0 \exp(-r^3/b^3)$ for some constant ρ_0 .
3. Consider a voltage $V(x, y) = V_0 \exp(-k^2 xy)$, where V_0 is a constant in volts and k is a positive constant in m⁻¹.
 - (a) Is $V(x, y)$ a scalar field or a vector field?
 - (b) Plot V versus x at $y = 1/k$ and then at $2/k$. Label the axes accurately.
 - (c) Plot V versus y at $x = 1/k$ and then at $2/k$. Label the axes accurately.
 - (d) Plot the contour lines on the xy -plane for $V = 0.25V_0, 0.50V_0, 0.75V_0$, and V_0 .
 - (e) Find $\mathbf{E} = -\text{grad}(V)$.
4. Consider two points $A(0, 0)$ and $B(0, L)$ on the xy -plane for some positive distance L . Find the electric field $\mathbf{E}(2L, 4L)$ under the following conditions.
 - (a) Point charges $+Q$ and $-Q$ are put at A and B , respectively.
 - (b) Infinite line charges of densities $+\rho_L$ and $-\rho_L$ are put at A and B , respectively. The line charges are parallel to the z -axis.Keep all the expressions in the rectangular coordinate system.

5. From the Coulomb's law, derive the electric field measured at $(x, y, z) = (0, 0, h)$ from a charged circle centered at the origin. The circle is oriented along the xy -plane with radius a . The line charge density is given by

$$\rho_L(\phi) = \rho_{L0} \sin^2 2\phi$$

where ϕ is measured from the x -axis and ρ_{L0} (C/m) is a constant.