

EE2104 Introduction to Electromagnetics
Assignment 2

Deadline (for uploading): 11:59 pm, 30 Sep 2021
Please put down your name and university ID.

1. Consider a line at $x = -L/3$ to $2L/3$. It contains electric charges of density $\rho_L = \rho_{L0} (x/L)^2$ 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. The magnetic field from a current along the z -axis is proportional to

$$\mathbf{H}(x, y, z) = \frac{y\hat{\mathbf{x}} - x\hat{\mathbf{y}}}{2\pi(x^2 + y^2)}$$

- (a) Express $\mathbf{H}$ in terms of the cylindrical coordinate system. Then, briefly sketch the field.
 - (b) Evaluate curl $\mathbf{H}$.
 - (c) Evaluate div $\mathbf{H}$.
4. Consider a voltage $V(x, y) = V_0 \exp(-k^2 y^2)$, 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 $y = 0$. Label the axes accurately.
 - (c) Plot V versus y at $x = 0$. Label the axes accurately.
 - (d) Plot the contour lines on the xy -plane for $V = 0.2V_0, 0.4V_0, 0.6V_0, 0.8V_0$, and V_0 .
 - (e) Find $\mathbf{E} = -\text{grad}(V)$.
 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.