City University of Hong Kong
Electrical Engineering
Semester A 2020-2021

EE2104 Introduction to Electromagnetics
Assignment 2

Deadline (for uploading): 7:00 pm, 10 Oct 2020
Please put down your name and university ID.

1. Consider a voltage $V(x,y) = V_0 \exp[-(x^2+y^2)/\lambda^2]$, where V_0 is a constant in volts and λ is a constant in meters.
   (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 $\mathbf{E} = -grad(V)$.

2. Consider a line at $x = 0$ to L. 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.

3. (a) Point charges of 50 nC each are located at $A(1, 0, 0)$, $B(-1, 0, 0)$, $C(0, 1, 0)$, and $D(0, -1, 0)$ in free space. Find the total force on the charge at A.
   (b) Let a point charge $Q_1 = 25$ nC be located at $P_1(4, -2, 7)$ and a charge $Q_2 = 60$ nC be at $P_2(-3, 4, -2)$ in free space. Find $\boldsymbol{E}$ at $P_3(1, 2, 3)$.

4. 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
$$\rho_L(\phi) = \rho_{L0}\cos^2 2\phi$$
where ϕ is measured from the x-axis and ρ_{L0} (C/m) is a constant.

5. Consider a rod of radius a centered along the z-axis with charge of density
$$\rho_v(\rho, \phi, z) = \rho_0(1 - e^{-\rho^2/a^2})$$
where ρ_0 (C/m^3) is a constant. Using Gauss's law, find $\boldsymbol{E}$ as a function of ρ.