PRINCE OF SONGKLA UNIVERSITY
FACULTY OF ENGINEERING

Midterm Examination: Semester II — Academic Year: 2009
Date: Dec 24, 2009 — Time: 9.00-12.00
Subject: 210-251 Electromagnetic Field Theory — Room: หัวหุ่นยนต์
210-351 Electromagnetic Field Theory — Room: หัวหุ่นยนต์

Instructions:

a. Allow a student to bring his/her own note (**one A4-size paper**) into a room during the exam

b. Allow the student to use his/her own calculator and dictionary

Do all problems

1. The circular disk of electric charge shown in Figure 1 is characterized by an azimuthally symmetric surface charge density that increases linearly with r from zero at the center to 9 C/m^2 at r = 3 cm. Find the total charge present on the disk surface.

(4 points)

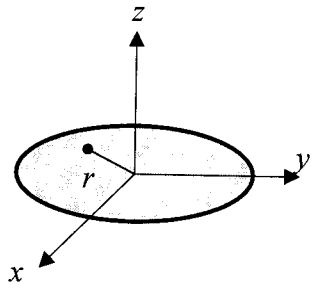

Figure 1 Surface charge

2. Two point charges with $q_1 = 2*10^{-5}$ C and $q_2 = -4*10^{-5}$ C are located in free space at (1, 3, -1) and (-3, 1, -2), respectively, in a Cartesian coordinate system. *Note that all distances are in meters.* Find

(a) the electric field **E** at (3, 1, -2)

(5 points)

(b) the force on a $8*10^{-5}$ C charge located at that point.

(1 point)

3. A cube is defined by $1 < x, y, z < 1.2$. If $\mathbf{D} = 2xy\mathbf{a}_x + x^2\mathbf{a}_y + 6z^3\mathbf{a}_z$ C/m^2:

(a) Apply Gauss's law to find the total flux leaving the closed surface of the cube

(4 points)

(b) Evaluate $\frac{\partial D_x}{\partial x} + \frac{\partial D_y}{\partial y} + \frac{\partial D_z}{\partial z}$ at the center of the cube

(3 points)

(c) Estimate the total charge enclosed within the cube by using the equation:

$$\text{Charged enclosed in volume } \Delta v \approx \left(\frac{\partial D_x}{\partial x} + \frac{\partial D_y}{\partial y} + \frac{\partial D_z}{\partial z} \right) \times \Delta v$$

(2 points)

4. Referring to Figure 2, $r_1 = 0.55$ m, $r_2 = 0.65$ m, $r_3 = 0.55$ m, $r_4 = 0.60$ m, $L = 0.35$ m, $\rho_L = 10^{-10}$ C/m, $Q_A = 2*10^{-11}$ C, $Q_B = 8*10^{-11}$ C and $Q_C = 3*10^{-11}$ C. The line charge is at a constant distance r_1. Medium is air. Find the potential at P.

(5 points)

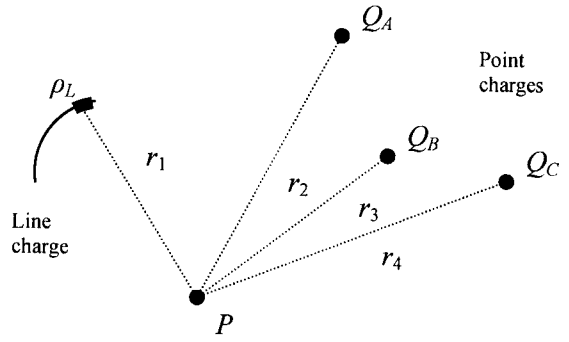

Figure 2 Point and line charges

5. A thin flat disk, of radius R_0, has a uniformly distributed charge Q, Figure 3.

   (a) Determine the electric potential at a point P on the axis of the disk, a distance x from its center.

   (4 points)

   (b) Use the electric potential to determine the electric field at point P.

   (2 points)

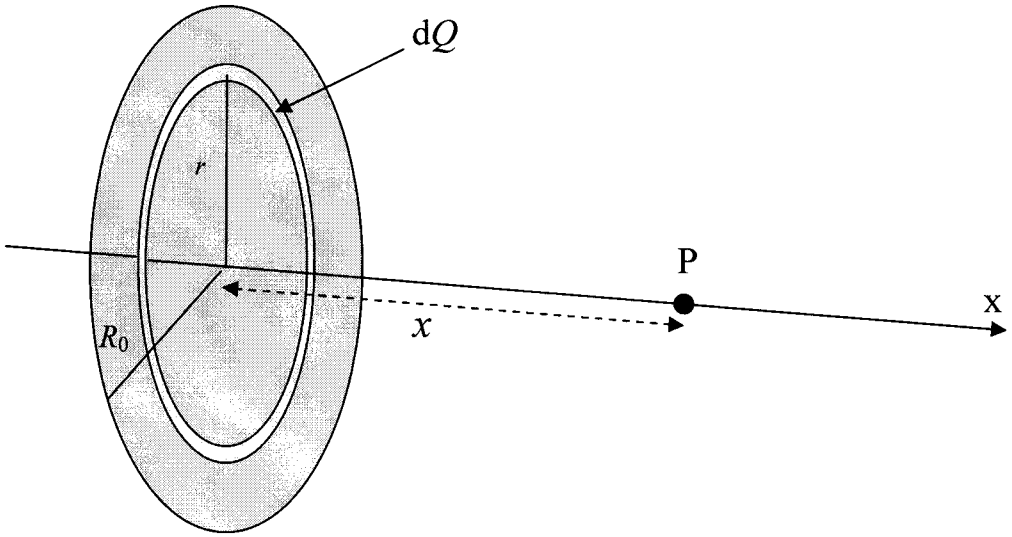

Figure 3 A uniformly charged thin disk