ECED 3300
Electromagnetic Fields
Final Examination

Place: Sexton Gymnasium of Dalhousie University.
Instructor: Sergey A. Ponomarenko
Date and Time: Wednesday, December 3, 2008, 12:00 – 15:00 pm.
Closed Books: Formula sheets are provided; no calculators are allowed.

Problem 1 (20pts)

A long cylindrical capacitor has the inner and outer radii a and b, respectively. The capacitor is filled with an inhomogeneous dielectric with $\epsilon(\rho) = \epsilon_0 k\rho$, where k is a constant. Determine the capacitance per unit length of the capacitor.

Problem 2 (30pts)

Two point charges of the opposite signs, $Q_1 > 0$ and $Q_2 < 0$, are placed along the $z-$axis at the positions h_1 and h_2, respectively, above a grounded conducting xy-plane, as indicated in Fig.1.

(a) Find the **magnitude** and **direction** of the force experienced by the charge Q_2.

(b) Determine the electrostatic energy of the system.

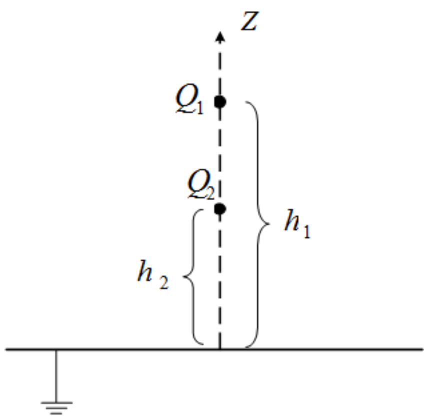

FIG. 1: Illustration to Problem 2

Problem 3 (15pts)

Two long parallel current filaments are placed a distance d apart from each other, as exhibited in Fig. 2. The filaments carry currents I_1 and I_2 in the opposite directions. Find the **magnitude** and **direction** of the interaction **force per unit length** between the currents. You may assume the currents are located in free space and you may express your answer in terms of μ_0.

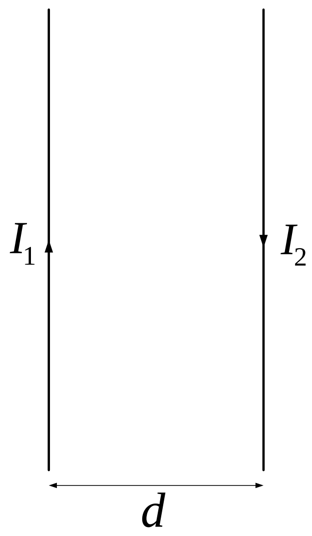

FIG. 2: Illustration to Problem 3

Problem 4 (15pts)

Two homogeneous dielectric regions $z \leq 0$ (region 1) and $z \geq 0$ (region 2) have dielectric constants $\epsilon_{r1} = 4$ and $\epsilon_{r2} = 2$, respectively. Given the electric field $\mathbf{E}$ in region 1, $\mathbf{E}_1 = 2\mathbf{a}_x + 3\mathbf{a}_y + 5\mathbf{a}_z$ V/m, find electric field $\mathbf{E}_2$ and flux density $\mathbf{D}_2$ in region 2. You may leave your results in terms of ϵ_0.

Problem 5 (20pts)

Determine the vector potential $\mathbf{A}(\rho, \phi, z)$ corresponding to the following magnetic flux density distribution in free space

$$\mathbf{B}(\rho, \phi, z) = \begin{cases} \frac{\mu_0 I \rho^3}{2\pi a^4}\, \mathbf{a}_\phi, & \rho \leq a; \\ \frac{\mu_0 I}{2\pi\rho}\, \mathbf{a}_\phi, & \rho \geq a; \end{cases}$$

where I and a are given.