THE CITADEL
THE MILITARY COLLEGE OF SOUTH CAROLINA

Department of Electrical and Computer Engineering

ELEC 318 Electromagnetic Fields **HW #5, due February 26, 2015**

Reading Assignment: Chapter 4 (all)
Chapter 5 (Sections 5.1-5.3)

Written Assignment:

1. An infinitely-long coaxial cylindrical structure has an inner conductor of radius a = 2 mm and an outer conductor of radius b = 4.5 mm. The space between the conductor is filled with a volume charge density of $\frac{10\varepsilon_0}{r}\ \frac{\text{C}}{\text{m}^3}$ and a permittivity equal to that of free space. The inner conductor is grounded and the outer conductor is maintained at 40 V. Determine the potential everywhere in the space $2 \le r \le 4.5\,\text{mm}$.

2. The potential field $V = 2x^2yz - y^3z$ (V) exists in a dielectric medium with a relative permittivity of 2.
   (a) Determine if the potential field satisfies Laplace's equation.
   (b) Calculate the total charge within the unit cube $0 \le x \le 1\,\text{m}, 0 \le y \le 1\,\text{m}, 0 \le z \le 1\,\text{m}$.

3. Calculate the energy stored in the region $R \le 2\,\text{m}, 0 \le \theta \le \pi, 0 \le \phi \le \pi$ for an electric field intensity equal to $2R\sin\theta\cos\phi\,\hat{\mathbf{R}} + R\cos\theta\cos\phi\,\hat{\boldsymbol{\theta}} - R\sin\phi\,\hat{\boldsymbol{\phi}}$ V/m, in free space.

4. A spherical capacitor has inner radius a and outer radius b and is filled with an inhomogeneous dielectric with permittivity equal to $\varepsilon_0 k/r^2$. Determine the capacitance of the capacitor in terms of ε_0, k, a, and b.

5. In free space, infinite planes y = 4 m and y = 8 m carry charges of 20 nC/m^2 and 30 nC/m^2, respectively. If plane y = 2 m is grounded, calculate the electric field intensity at P(–4 m, 6 m, 2 m).