Physics 8100 - Electromagnetic Theory I

Fall 2017 **N. Dietz**

Assignment # 7 (due to Wednesday, November 13, 2017)

Problem 1: *(30 points)*

An infinitely long rectangular conductive tube has three sides grounded, while the fourth (imagined to be insulated from others by very tine gapes) is held at potential V_o. Find the potential at all interior points.!

Boundaries:

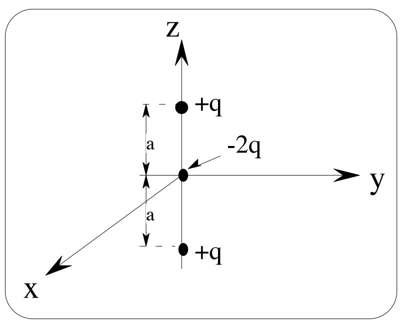
$x = 0,\ \Phi = 0;$ | $x = a,\ \Phi = 0;$ | $y = 0,\ \Phi = 0;$ | $y = b,\ \Phi = V_o$]

Problem 2: *(20 points)*

Find the potential and the electric field strength along the axis of a thin uniformly charged circular disc of radius *R* and total charge *q*. Show that the normal component of the field changes by σ/ε_0 on passing through the surface of the disc. Consider the field at large distances from the disc.

Problem 3: *(20 points)*

(a) Find the first two sets of non-vanishing moments, q_{lm}, for the following charge distribution



Hint: $$\rho(\vec{r}) = \frac{q}{2\cdot\pi\cdot r^2}\cdot\left[-\delta(r)+\delta(r-a)\cdot\delta[\cos(\theta)-1]+\delta(r-a)\cdot\delta[\cos(\theta)+1]\right]$$

(b) Write down the multipole expansion of the potential due to this charge distribution, keeping only the first two sets of q_{lm}.

Problem 4: *(30 points)* - Jackson problem 3.5

A hollow sphere of an inner radius 'a' has the potential specified on its surface to be $\Phi = V(\vartheta,\varphi)$.

Prove the equivalence of the two forms of the solution for the potential inside the sphere:

a) $$\Phi(\vec{r}) = \frac{a\cdot(a^2-r^2)}{4\cdot\pi\cdot\ ^2}\cdot\int d\Omega' \frac{V(\vartheta',\varphi')}{\left[r^2+a^2-a\cdot r-2\cdot a\cdot r\cdot\cos\gamma\right]^{3/2}}$$ with $\cos\gamma = \cos\vartheta\cdot\cos\vartheta' + \sin\vartheta\cdot\sin\vartheta'\cdot\cos(\varphi-\varphi')$

b) $$\Phi(\vec{r}) = \sum_{l=0}^{\infty}\sum_{m=-l}^{l} A_{l,m}\cdot\left(\frac{r}{a}\right)^l\cdot\Psi_{l,m}(\vartheta,\varphi);$$ with $A_{l,m} = \int d\Omega'\cdot\Psi_{l,m}(\vartheta',\varphi')\cdot V(\vartheta',\varphi')$