Rutgers Physics 385 Electromagnetism I (Fall'11/Somalwar)

Class Exam - October 20, 2011

This is a closed book/notes exam. A one-sided 8.5x11 sheet with only formulae is allowed. Please attach the sheet to your solutions. Calculators are not needed. Exam duration - 140PM to 300PM. Do any TWO out of the three given problems and indicate which ones should be graded. Total credit 30 points, 15 points per problem.

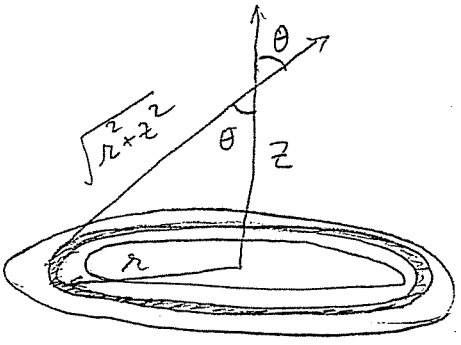
1. Use Coulomb's law to find the electric field at distance z along the axis of an annulus with inner radius a and outer radius b, and carrying a uniform charge density σ. Make sense of the answer by considering the following limiting cases : (i)a very small and b very large, and (ii) z very large. For (ii) you will need: $(1+x)^\alpha \approx 1+\alpha x$.

2. Find the potential a distance r from an infinitely long straight wire that carries a uniform line charge λ, choosing the (arbitrary) reference point at a radius of r_0. Compute the gradient of your potential. (Note that in cylindrical coordinates, the radial component of the gradient is simply the derivative with respect to r.)

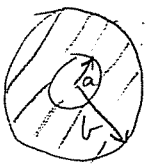
3. Consider two concentric spherical shells. The inner shell has radius a, and carries charge $+q$, whereas the outer one has radius b, and carries charge $-q$. Each shell is thin and uniformly charged.Compute the eletric field everywhere, and use your result to compute the energy in the system. As usual, consider all the limiting cases.

$$W = \frac{\varepsilon_0}{2}\int_{\text{All space}} E^2 d\tau$$

(1)



$$\cos\theta = \frac{z}{\sqrt{r^2+z^2}}$$



By Symmetry, $\vec{E}$ will be along z axis

$$\int dt/t^{3/2} = -2/\sqrt{t}$$