North Carolina State University
PY785 Final Exam
Wednesday, 15 December 2010
Instructor: T. Schaefer

Name:

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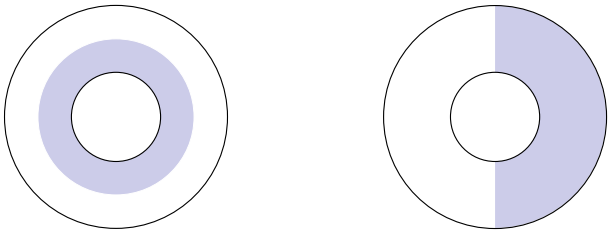
Total	_____

Instructions

1. This is a closed book exam. You may use the index card handed out in class.
2. There are five problems. Each problem is worth 10 points.
3. Write your answers in the spaces provided for each problem. Show calculations there or on the facing page.

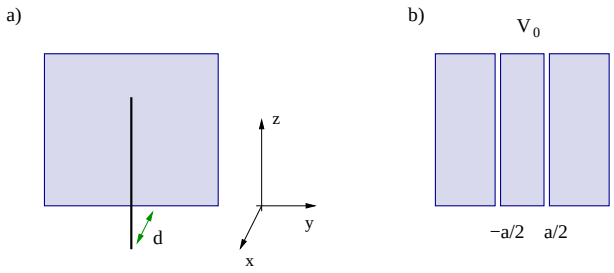


1. Consider a capacitor made of two concentric cylindrical conducting shells with radii a, b $(b > a)$. Determine the capacitance in the following two cases

   (a) The region $a < \rho < d$ $(d < b)$ is filled with a dielectric (dielectric constant ϵ).

   (b) The region $0 < \phi < \pi$ is filled with a dielectric.

   Here, ρ, ϕ refer to cylindrical coordinates with respect to the axis of the cylinder.



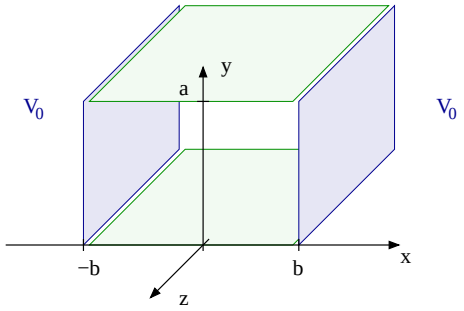
2. Consider a conducting plate in the yz plane.

   (a) Consider a long thin wire carrying a line charge $\lambda = Q/L$. The wire stretches in the z direction at a distance d from the conducting plate, see Figure a). Compute the electrostatic potential in front of the plate ($x > 0$).

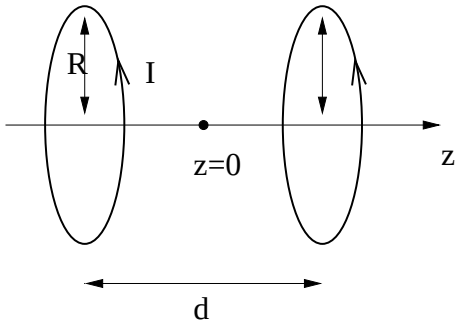
   (b) Compute the surface charge density on the plate.

   (c) The wire is removed and the region $-a/2 < y < a/2$ of the plate is maintained at the potential V_0. The rest of the plate is grounded, see Figure b). Compute the potential as a function of x for $x > 0$ and $y = 0$.

3. Consider a conducting sphere of radius a immersed in an asymptotically ($r \to \infty$) uniform electric field $\vec{E} = e_0 \hat{z}$. Compute the electrostatic potential and the electric field everywhere in space.



4. Two infinitely long grounded metal plates, at $y = 0$ and $y = a$, are connected at $x = \pm b$ by metal strips held at a constant potential V_0. (A thin insulator at the corners prevent the plates from shorting out.) Find the potential inside the rectangular pipe.



5. Two coaxial circular conductors of radius R (R is much bigger than the diameter of the conductor) carry a current I. Determine the optimal distance d between the two conductors such that the magnetic field along the symmetry axis is as homogeneous as possible. (Adjust d so as to make as many derivatives of $B_z(z = 0)$ vanish as you can. This arrangement is known as Helmholtz coils.)