Problem Set 7
Electrodynamics
Winter, 2005

Due: February 25, 2005

Problem 1: Find the spherical quadrapole moments (q_{2m}) and the quadrapole matrix (Q_{ij}) for a cylinder of radius a and length $2a$ centered on the origin of the coordinate system for both the axis of the cylinder orientated along the z axis and along the x axis. You might want to integrate either or both of these calculations in cylindrical coordinates. Show that the two Q_{ij}'s are related by a tensor rotation (i.e. multiply the tensor on one side by a rotation matrix and on the other by the inverse rotation matrix). How can you relate the two q_{2m}'s?

Problem 2: Jackson 4.4.

Problem 3: A cylinder of radius R and length L has its sides grounded and both ends held at a potential $V = V_0 \cos\frac{\pi r}{2R}$. Find the potential everywhere inside the cylinder. Plot your results.

Problem 4: A cylinder of radius R and length L has both grounded and it sides held at a potential $V = -V_0 \sin\frac{\pi z}{L}$. Find the potential everywhere inside the cylinder. Plot your results. Also plot the results if the cylinder's ends were at the potential given in problem 3 and the sides were given by the potential in this problem.

Qualifying Exam Problems

Do not use *Mathematica* to solve these problems!

Fall '95 – Electrodynamics I

A sphere (radius R) made of an insulating material is coated with a thin layer of a resistive material (thickness μ and bulk resistivity ρ). Inside the sphere is a battery which produces a voltage V. The battery is connected via resistanceless leads to small pads (of radius $r \ll R$) at either end of the sphere (see diagram below).

1. Find the voltage at all points on the surface of the sphere.
2. Find the voltage at all points outside the sphere. (If you expand the voltage in terms of a series of orthogonal polynomials, you must write down the integrals that need to be evaluated to determine the coefficients of that series, but you need not evaluate the integrals.)

3. Give a physical argument why the magnetic field is zero everywhere outside the sphere.