Electrodynamics 1, problem set 1

1. An infinitely long cylinder with radius b has a charge distribution $\rho(r, \phi, z) = \rho_0 \exp(-r/b)$. The charged cylinder is coaxially surrounded by a larger conducting cylindrical shell with inner radius a_1 and outer radius a_2.
   (a) Determine $\mathbf{E}$ everywhere.
   (b) Does the cylindrical shell have a charge? If so, what can be said about it?
   (c) Evaluate the force exerted on the outer cylindrical shell by the inner cylinder.

Viðar Guðmundsson, 07.01.2009

Electrodynamics 1, problem set 2

1. A sphere of radius a carries a charge density $\rho(r) = kr$, where k is a positive constant. Use two different methods to calculate the potential energy stored in the configuration.
2. Problem P.4-9 in the text book by David K. Cheng.

Viðar Guðmundsson, 12.01.2009

Electrodynamics 1, problem set 3

1. The potential at the surface of a sphere of radius a is given by

$$V_0(\theta, \phi) = k \cos(3\theta),$$

with k a positive constant. Find the potential inside and outside the sphere, and the surface charge density $\sigma(\theta)$. Assume there is no charge inside or outside the sphere.

2. Problem P.4-27 in the text book by David K. Cheng.

Viðar Guðmundsson, 20.01.2009

Electrodynamics 1, problem set 4

1. The space between two conducting concentric spheres of radii a and b is filled with inhomogeneous material with conductivity $\sigma = m/r + k$, where $a \leq r \leq b$, and m and k are constants. The inner sphere is held at potential V_0 and the outer one is grounded.
   (a) Compute the resistance of the medium.
   (b) Find the surface charge density on each sphere.
   (c) Calculate the volume charge density in the medium between the spheres.
   (d) Find the current density in the medium and the total current through it.
   (e) What is the resistance when $m \to 0$?

2. Problem P.5-22 in the text book by David K. Cheng, with the following addition: If the voltage bias at the sides of the rectangular sheet is applied by perfectly conducting electrodes what is their surface charge density?

Viðar Guðmundsson, 26.01.2009

Electrodynamics 1, problem set 5

1. Consider an infinitely thin spherical shell of radius a with a constant surface charge density ρ_s. The shell is spinning around the z-axis with a constant angular speed ω.
   (a) Determine the vector potential $\mathbf{A}$ at any point inside and outside the shell.
   (b) Calculate the magnetic flux density $\mathbf{B}$ at any point inside and outside the shell. Sketch the magnetic field lines and describe the results.
2. Problem P.6-26 in the text book by David K. Cheng.

Viðar Guðmundsson, 26.01.2009

Electrodynamics 1, problem set 6

1. Consider a sphere with a constant permeability μ in a uniform applied flux density $\mathbf{B} = B_0\hat{\mathbf{a}}_z$. Determine $\mathbf{H}$, $\mathbf{B}$, and $\mathbf{M}$ inside and outside the sphere. Sketch the solution.

   (One way to solve the problem is to assume that there are no free currents, and thus $\nabla \times \mathbf{H} = 0$. Then one can define a magnetic scalar potential $\mathbf{H}(\mathbf{r}) = -\nabla\phi_m$, and in a medium with constant μ the scalar potential is determined by a Laplace equation $\nabla^2\phi_m = 0$. The solution is achieved by applying the appropriate boundary conditions on the flux density and the magnetic field).
2. Problem P.6-28 in the text book by David K. Cheng.

Viðar Guðmundsson, 2.02.2009

Electrodynamics 1, problem set 7

1. Problem P.7-13 in the text book by David K. Cheng.
2. Problem P.7-17 in the text book by David K. Cheng.

Viðar Guðmundsson, 9.02.2009

Electrodynamics 1, problem set 8

1. Problem P.7-30 in the text book by David K. Cheng.
2. Problem P.8-19 in the text book by David K. Cheng.

Viðar Guðmundsson, 9.02.2009

Electrodynamics 1, problem set 9

1. Problem P.8-29 in the text book by David K. Cheng.
2. Problem P.8-33 in the text book by David K. Cheng.

Viðar Guðmundsson, 2.03.2009