Homework assignment 5.1:

1. Solve equation 5.5. For those of you that are a little rusty on solving differential equation, please check:

   http://web.missouri.edu/~kovaleskis/ApplEMandEP/Lectures/Lecture-4.pdf

   So the differential equations can be solved after a substitution. Another more systematic method is to use the hint provided in the book. This will give the following differential equation:

   $$\dddot{y} = \omega^2\left(\frac{E}{B} - \dot{y}\right)$$

   Note that this is a non-homogeneous differential equation. Such a differential equation can be solved by one of the following methods:

   Procedure for solving non-homogeneous second order differential equations:

   $$\ddot{y} + p(t)\dot{y} + q(t)y = g(t)$$

   First determine the general solution, i.e. $y_h(t)$. This is the solution of the differential equation assuming g(t)=0 i.e.:

   $$\ddot{y} + p(t)\dot{y} + q(t)y = 0$$

   Then determine a particular solution, i.e. $y_p(t)$. Often this solution looks similar to g(t). If one cannot guess $y_p(t)$ easily one could try one of the techniques described in:

   http://www.rit.edu/~w-asc/documents/services/resources/handouts/32Solving_NonHomogeneous_Second_Order_Diff_Eq.pdf

2. Study the derivation of the continuity equation on page 222. Explain the 2nd expression on page 222 and the also the 3rd equation on page 222. Note that the math of the continuity equation can be understood from the same concepts as the math of Gauss' law. However now it are not field lines entering the Gaussian surface but charged particles. Furthermore one needs to also assume conservation of charge.
3. A current flows down a wire of radius a. If the current is distributed in such a way that the volume current density is inversely proportional to the distance from the axis, what is J?
4. A uniformly charge solid sphere, of radius R and total charge Q is centered at the origin and spinning at a constant angular velocity w about the z axis. Find the current density **J** at any point (r,θ,ϕ) within the sphere.