**PHY820 Homework Set 3**

1. [5 pts] Goldstein, Problem 1-10.

2. [5 pts] Two particles, characterized by charge $q_1$ and $q_2$, respectively, and by mass of $m_1$ and $m_2$, move under the influence of each other in an external uniform electric field $\vec{E}$. Examine the Lagrangian for the particles with external and mutual Coulomb potential terms and demonstrate that the particle motion may be studied by considering *separately* the motion of the center of mass and the motion in the particle relative separation.

3. [5 pts] Goldstein, Problem 1-16.

4. [10 pts] Consider a particle of mass $m$ and charge $q$ moving in a uniform constant magnetic field $\vec{B}$ pointing in the $+z$ direction.

   (a) Demonstrate that $\vec{B}$ can be written as $\vec{B} = \vec{\nabla} \times \vec{A}$ with $\vec{A} = \frac{1}{2}\vec{B} \times \vec{r}$. Prove that equivalently in cylindrical coordinates, $(\rho, \phi, z)$, $\vec{A} = \frac{1}{2} B\rho\hat{\phi}$.

   (b) Write the Lagrangian for the particle in cylindrical coordinates and find the three corresponding Lagrange equations.

   (c) Describe in detail those solutions of the Lagrange equations in which $\rho$ is a constant. Sketch a particle trajectory following those solutions.

5. [5 pts] Goldstein, Problem 1-23.