Homework for Physics 456/656

Introduction to Accelerator Physics and Technology (Hoffstaetter)

Due Date: Thursday, 09/18/03 - 11:40 in 110 Rockefeller Hall

Exercise 1:
The PEP-II asymmetric B-Factory at SLAC stores electrons with an energy of 9.0 GeV and positrons with 3.1 GeV.
(a) How much energy is in the center of momentum system when an electron and a positron collide?
(b) What energy would positrons need to have in order to create the same energy in the center of momentum during a fixed target experiment?

Exercise 2:
When the coordinates $w = x + iy$ and $\bar{w} = x - iy$ are used, the Laplace operator has been derived to be $\vec{\nabla}^2 = 4\partial_w\partial_{\bar{w}} + \partial_z^2$.
(a) Check that this is correct.
(b) The static magnetic field in a charge free space is given by $\vec{B} = -\vec{\nabla}\psi$. Writing the magnetic field in x and y direction in complex notation as $B = B_x + iB_y$, derive a formula that expresses B and B_z in terms of $\Psi(w, \bar{w}, z)$ and only ∂_w, $\partial_{\bar{w}}$, and ∂_z.
(c) Given the vector potential in complex notation as $A = A_x + iA_y$ and A_z, derive a formula that expresses B and B_z given by $\vec{B} = \nabla \times \vec{A}$, again only using ∂_w, $\partial_{\bar{w}}$, and ∂_z and A, A_z.

Exercise 3:
Consider a box shape solenoid field. On the central axis, the solenoid field is given by

$$\vec{B}(z) = \begin{cases} B_0\vec{e}_z \text{ for } z \in [0, L] \\ 0 \text{ else} \end{cases} \tag{1}$$

(a) A particle flies into the solenoid parallel to the central axis with a horizontal distance x_0. Describe its trajectory after the solenoid.
(b) If it touches the central axis somewhere after the solenoid, where would that be? How does the focal length depend on the field B_0 and the length L?