Physics 556/714 Problem Set #8

due *beginning of class* Thursday Apr 18

This is another hard set. Don't put it off till the last minute.

1) Griffiths problem 7.34: "Starting with equation (7.105)..."
   Beware of a typo in the book's answer for the first equation.

2) Griffiths problem 7.36: "Using the result of Problem (7.34),..."

3) Starting with the Dirac equation...
   a) Show that the helicity operator commutes with the Hamiltonian, thereby proving that one can construct states that are eigenstates of both energy and helicity.
   b) Construct a bispinor for an electron that is an eigenstate of E with positive helicity for arbitrary momentum direction.

4) Determine the angular distribution of the outgoing pions in the scattering of e^+e^- to $\pi^+\pi^-$ in the center of momentum frame. Part b) of the following problem states some relevant information.

714 students please also do the following:

5) Consider electron-positron annihilation in the center of mass to produce a single virtual photon (which may then couple to any of a number of possible final states). For convenience, take the electron momentum to be in the +z direction and the positron momentum to be in the -z direction.
   a) Use the Feynman rules, along with the standard bispinors, to prove that the spin zero component of the e^+e^- pair has zero amplitude to couple to the photon. (This is to be expected since the photon is a spin 1 particle.)
   b) It is also well known that when ultrarelativistic electrons and positrons collide in the center of mass frame, the resulting virtual photons are polarized along either the electron or positron direction (m_z=1 or -1). Prove that the coupling to the m_z=0 state has zero amplitude.