Accelerator Physics Homework #4

1. We have a synchrotron which accelerates protons from 10 to 100 GeV in 1 second, with the energy changing linearly with time. The circumference of the ring is 3km. The transition is 25.
   1. Calculate the revolution periods at the injection and extraction energies.
   2. The RF system has a harmonic number of 588; that is, one revolution period corresponds to 588 RF cycles. Calculate the RF frequency in MHz at injection and extraction (this difference may seem small, but changing the resonant frequency of a cavity is always hard).
   3. Calculate the slip factor (including sign) at injection, extraction, and also near transition (say =24)?
   4. If I have an RF voltage of 1 MV, what synchronous phase s do I need at these three energies?
   5. For each of these energies, calculate
      1. The synchrotron tune s
      2. The maximum bucket size Eb
      3. Assume the real energy spread is half the bucket size, calculate t and the longitudinal emittance L.
2. The Lorentz Force is given by:  
     
   Show that the x component of this force can be written

