EXERCISES FOR THE COURSE ON LONGITUDINAL BEAM DYNAMICS (LUND 2013)

1) Give the general definition of the:

- Energy gain by a particle per turn.
- Main RF parameters.
- Transit time factor.
- Momentum compaction factor.
- Longitudinal emittance and acceptance => Comparison with the transverse case.
- Transition energy.
- Slip factor (which is equal to 0 at transition energy).
- Link between the synchronous phase (i.e. the phase of the synchronous particle) and the variation of the magnetic field with time.
- Equation of motion for any particle in the longitudinal phase space.
- Simplified equation of motion in the case of small amplitudes => Linearization.
- Stability condition for synchrotron oscillations.

2) What are the values of the relative momentum spread and the RF phase for the synchronous particle in the absence of acceleration and deceleration (below transition energy)? Where is this particle located in the stationary bucket? What is the energy gain of this particle at each passage through the RF cavity? What are the values of relative momentum spread and RF phase for the synchronous particle in the presence of acceleration (below transition energy)?

3) Assuming that the longitudinal emittance is conserved, how does the bunch length vary if the peak RF voltage is increased?

4) What is the maximum value of the longitudinal emittance (give the name)? For which value of the synchronous phase is it maximum? What is the name of the limit between the stable and unstable regions, in the longitudinal phase space? Assuming that acceleration of protons is performed for a synchronous phase of 50 deg below transition, what do the RF system have to do above transition? Why?

5) Exam given at the JUAS in 2012:

- Exam: http://emetral.web.cern.ch/emetral/JUAS/2012/LongitudinalDynamicsExamination_JUAS2012_EM.pdf.
- Solution: http://emetral.web.cern.ch/emetral/JUAS/2012/LongitudinalDynamicsExamination_Correction_JUAS2012_EM.pdf.