Homework 18

Problem 1. 15 points. Turning the beam around – ultimate storage rings

Let's consider that we build a storage ring (magnets only), where ultra-relativistic charged particles traveling in circle of constant radius ***R*** while radiating synchrotron radiation. It means that the magnetic field is adjusted to the loss of its energy.

(a) Find the energy of the particle as function of the traveled distance ***s*** or angle ***s/R***;
(b) Find the distance when the particle's energy is reduced by a factor 2.
(c) Loosing half of the energy is considered to be "dead-end" for recirculating the beams – than linear accelerators have to do the job. For R being 6,371 kilometers – that of the Earth, find critical energy of electrons, muons and protons when particles are loosing ½ of the energy in a single turn.

Problem 2. 10 points. Circulating particle in magnetic field

Consider ultra-relativistic charged particle with initial energy circulating in an uniform constant magnetic field $\mathbf{B}_y$.

(a) Find energy of the particle as function of time.
(b) What will be its trajectory?

Note: Neglect non-relativistic effects