Program of Accelerator Physics and Relativistic Electrodynamics
Course in Master Degree in Electronic Engineering
A. A. 2018 - 2019
Prof. Andrea Mostacci
Prof. Alessandro Variola

FIRST PART: Relativistic Electrodynamics.

1- Principles of classical mechanics and electromagnetism

Introduction, the principles of classical mechanics, the concept of absolute space and time, the Maxwell equations and the electromagnetic waves, the experiment of Michelson-Morley, the concept of ether.

2- Relativistic kinematics

The Lorentz transformations, introduction to space-time, concept of simultaneity and proper time, relativistic invariant, Minkowski space, relativistic Doppler effect.

3- Relativistic dynamics

Momentum, work and kinetic energy, equivalence of mass and energy, transformations of momentum and energy, pulse-energy quadrivector, transformations of forces.

4- Relativity and electromagnetism

Transformations of charge and current density, the covariance concept and the transformations of fields, potential quadrivector, e.m. field of a relativistic point charge with constant velocity, retarded potentials.

5- Relativistic electrodynamics

Brief review of analytical mechanics, the principle of virtual work, Lagrange equations, the Hamilton function, relativistic Hamiltonian of a charged particle.

SECOND PART: Accelerator Physics.

1- Introduction to particle accelerators

A brief history on particle accelerators, electrostatic accelerators, accelerators based on time varying fields, Cyclotrons, Betatrons and Linacs.

2- Beam dynamics

Phase stability in synchrotrons, field index and weak focusing, strong focusing colliders and storage rings.

3- Accelerator devices and new acceleration techniques

Dipoles, quadrupoles and sextupoles, RF cavities.

4- Transverse beam dynamics in circular accelerators

Hamiltonian in Fernet-Serret coordinate system, Hill's equation, transverse beam dynamics, matrix formalism, betatron function and tune, Courant-Snyder invariant and Twiss parameters.

5- Longitudinal beam dynamics in circular accelerators

Electromagnetic fields in RF devices, standing wave and travelling wave structures, momentum compaction, slippage factor and transition energy, synchrotron oscillations with small and large amplitude.

A. Mostacci, A. Variola, 23.09.2018

E-mail: andrea.mostacci@uniroma1.it
Didactic web pages: http://www.sbai.uniroma1.it/users/mostacci-andrea