Fundamentals of Accelerator Physics and Technology with Simulations and Measurements Lab

Instructors: Stuart Henderson, Jeff Holmes, and Yan Zhang, Oak Ridge National Lab

Purpose and Audience

This course is intended as an introduction to the field of accelerator physics and technology. The course is suitable for senior undergraduate students, or students from other fields with a particular interest in accelerator physics. The course is also appropriate for engineers and technicians working in accelerator-related fields who wish to broaden their background. *Prerequisites: Either previous coursework or a general understanding of classical physics and electromagnetism.*

Objectives

This course will focus on the fundamental principles of acceleration and particle transport, and will avoid rigorous mathematical derivations. A theoretical understanding of the principals, provided through daily lectures, will be coupled to a practical implementation of the concepts through laboratory exercises.

Instructional Method

This course includes a series of lectures in the morning, followed by afternoon laboratory sessions on related subject matter. Laboratory sessions will include computer simulations and experimental measurements of accelerator hardware. Students will write and submit lab reports for the majority of the lab exercises. Additional problem sets, to be completed outside of scheduled class time, will be assigned in the morning lecture sessions. Problem sets will be graded in a timely fashion, and feedback will be provided by the instructors.

Course Content

The lectures will begin with the historical development of accelerators and their past and present applications. From there, the course will cover principles of acceleration, including the physics of linear accelerators, synchrotrons, and storage rings. The emphasis will be shared between hadron and lepton accelerators. The basic concepts of magnet design will be introduced, along with discussions of machine lattice design and particle beam optics. Longitudinal and transverse beam dynamics will be explored, including synchrotron and betatron particle motion. Lastly, a number of additional special topics will be reviewed, including, synchrotron radiation, injection techniques, and collective effects and beam instabilities.

The afternoon laboratory sessions will be closely related to the subject matter in the lectures. Computer lab modules will be used as aides for lattice design exercises and beam optics studies. Accelerator hardware and measurement instrumentation will be made available for experimental measurements of a variety of parameters.

Reading Requirements

(to be provided by the USPAS) Particle Accelerator Physics I, Springer-Verlag (2003) by

Helmut Wiedemann. Additional handouts with supplementary material will be provided by the course instructors.

Credit Requirements

Students will be evaluated based on performance: homework assignments (35 % of final grade) computer/lab sessions (35 % of final grade), final exam (30% of final grade).