Introduction to Beam Physics and Accelerator Technology

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Fermilab

A lecture series for undergraduate and graduate students within the High Energy Physics Laboratory class of Dr. Massimiliano Fiorini at the University of Ferrara, Italy, May 18–22, 2015.

Motivation

Why study accelerator physics?

- It is a challenging and engaging field. It brings together researchers with a variety of skills, including mathematics, physics, engineering, and computing.
- It is rewarding, as it connects with fundamental science, nuclear and particle physics, and applications such as medical diagnostics and treatment.
- It offers several internships, fellowships, and job opportunities.

Learning objectives

In this course, students review the main subfields of accelerator physics; define and discuss key concepts; develop models; solve numerical problems; analyze data; and discuss applications.

Methodology

The course consists of lectures, problems at the blackboard, discussions, data analysis, numerical computing, and homework. Questions and classroom participation are encouraged.

Schedule

We will meet at the Physics Department every afternoon from 14:00 till 17:00 for 5 days, May 18–22.

Evaluation

There are three main components to students performance evaluation: participation in class, a report, and questions at the oral exam.

The report will consist of multiple-choice questions, definitions, problems, and a short essay. Sample reports will be discussed in class. The report can be prepared individually or as a group, but each student should turn in his or her own handwritten copy.

Prerequisites

The course is open to undergraduate and graduate students. Prerequisites are classical mechanics, electromagnetism, and special relativity at the undergraduate level. No previous knowledge of nuclear and particle physics is necessary. It is highly recommended to attend the lectures on accelerators given by Prof. Steffens, May 11–16.

Course contents

Lecture contents are chosen among the following topics:

1. Purpose of accelerators and overview of the field.
2. The Fermilab accelerator complex.
3. Beam physics and accelerator technology at Fermilab.
4. Luminosity.
5. Review of linear dynamics.
6. Nonlinear dynamics and chaos: historical perspective; nonlinear systems; nonlinearities in accelerator physics; advantages of nonlinear integrable optics and planned experiments
7. Intense beams. Space-charge forces and impedance.
8. Electron lenses and their applications.
9. Analysis of data from the Fermilab electron-lens test stand.
10. Conclusions.

Resources

The class web site ⟨home.fnal.gov/∼stancari/apufe15⟩ is the main information repository.

Students are encouraged to take notes during class. Some topics will be introduced as lectures or seminars, and slides will be made available.

Contact information

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