HARVARD UNIVERSITY and THE US PARTICLE ACCELERATOR SCHOOL

June 21 - July 2, 1993

**Course Descriptions**

PHYSICS 274 Introduction to Accelerator Physics
4 Harvard Units*
Edmund J.N. Wilson, CERN and Lenny Rivkin, Paul Scherrer Institute

The course provides a broad spectrum of topics in the design and performance of particle accelerators, with emphasis on the basic physics involved. We will study the radiofrequency acceleration of particle beams and techniques for reaching the highest possible intensity. Subjects covered include basic principles of focusing and acceleration, the design of magnetic systems, lattice design principles, beam properties, multipole imperfections, nonlinear dynamics, rf systems, beam instabilities and synchrotron radiation. Examples are drawn from existing and past machines as well as from recent accelerator designs. These will include proton and electron synchrotrons, circular and linear colliders as well as new types of accelerators.

PHYSICS 275 Introduction to Radiofrequency Linacs
4 Harvard Units*
Thomas P. Wangler and James H. Billen, Los Alamos National Laboratory

This introduction to rf linear accelerators will treat rf accelerating structures and linac beam dynamics. The emphasis will be on the underlying physics. We will study the basic properties of single and coupled cavities, including cavity-mode characteristics, stored energy, quality factor, shunt impedance, and dispersion curves. The principles of operation of the most common linac-accelerating structures will be presented, including drift-tube linacs, coupled-cavity linacs, and the radiofrequency quadrupole. We will discuss focusing and defocusing effects in a linac, and longitudinal and transverse beam dynamics both for noninteracting particles and high-intensity beams. We will treat such topics as phase space, rms emittance, the rms-envelope equation, space-charge dominated beams, wakefields, and emittance-growth mechanisms, all of which are important for modern high-intensity linacs.

PHYSICS 276 Introduction to Modern Dynamics
4 Harvard Units*
Leo Michelotti, Fermilab

We are living through a renaissance in the study of dynamical systems which is being driven by combining old ideas with modern tools. This course is an introduction to the language, concepts, and methods of classical mechanics as it is practiced today, using computer and analytical methods. Topics will include phase space, resonances, bifurcations, and chaos, with emphasis on models relevant to particle accelerators.

PHYSICS 277 Physics of Coherent Radiation From Free Electrons
4 Harvard Units*
Jonathan S. Wurtele, MIT and David H. Whittum, KEK

This course will provide an introduction to the physics of coherent radiation generation from free electrons. The scope will be sufficiently broad so as to encompass a wide variety of coherent radiation devices, both well-established, such as free electron lasers, cyclotron resonance masers, and gyrotrons, and new, plasma-based schemes, such as ion channel lasers. The topics will include linear theory, non-linear modeling, amplifiers and oscillators, wave-guide and free-space systems, optical guiding, coherence, pulse evolution, and numerical methods. The students will also be given "hands-on" experience in running multi-dimensional simulation codes.

PHYSICS 278 Accelerator Instrumentation and Beam Measurement Laboratory
4 Harvard Units*
Jacob B. Flanz, MIT
Gerald P. Jackson, Fermilab
Robert H. Siemann, Stanford University

This course of lectures and laboratory studies is an introduction to experimental methods in accelerator physics. Accelerator instrumentation and beam measurements are studied in both laboratory and control room environments. Instrumentation and techniques for transverse and longitudinal measurements from beam current and position monitors to phase space diagnostics are introduced. Impedance measurements of accelerator components are also included. This experience is applied to measurements of a variety of beam characteristics using the Bates Accelerator Center. Commercial audio, rf, and microwave test equipment such as spectrum and network analyzers are used throughout the course. The student should have some familiarity with introductory accelerator physics and electrical circuits.

PHYSICS 279 Computations in Accelerator Physics
4 Harvard Units*
Robert D. Ryne, Los Alamos National Laboratory and Kwok Ko, SLAC

This course will cover numerical computations related to the design and analysis of particle accelerators, beam transport systems and the components of these systems. Lectures will cover the following topics: accelerator beamlines and magnetic optics systems, including nonlinear effects and space charge effects; accelerator structures including beam-cavity interactions and wakefield effects; and accelerator components. During the computer laboratory sessions, students will receive hands-on training using beam transport codes, multiparticle simulation codes, 2 and 3 dimensional electromagnetics codes, and wakefield codes.

*4 Harvard units is equivalent to 3 semester hours of credit