THE UNIVERSITY OF CALIFORNIA AT BERKELEY and
THE US PARTICLE ACCELERATOR SCHOOL

1989 School
COURSE DESCRIPTIONS

PHYSICS 401
THEORY AND DESIGN OF PARTICLE BEAMS - M.P. Reiser, University of Maryland

The physical characteristics and theoretical descriptions of charged particle beams in particle accelerators, microwave tubes, free electron lasers and other devices are presented. Topics include: Review of classical mechanics for charged particle motion in electromagnetic fields; beam optics without space charge, beam optics with space charge (paraxial theory); self-consistent models of beams with space charge; transport of intense, high-brightness beams in uniform and periodic focusing channels; nonlinear effects and emittance growth; charge neutralization in background gas. (3 credit hours)

PHYSICS 402
INTRODUCTION TO ACCELERATOR PHYSICS - H. Wiedemann, Stanford University

History and principles of charged particle accelerators. Physics of linear accelerators, particle sources, synchrotrons and storage rings. Beam dynamics in electromagnetic fields. Optics, emittance and acceleration. Lifetime, instabilities and other limitations. Injection and beam accumulation. Synchrotron radiation. Scaling laws for colliding beams and for beams for synchrotron radiation sources. Applications of accelerators for basic and applied research, technology and medicine. (3 credit hours)

PHYSICS 403
INTRODUCTION TO FREE ELECTRON LASERS - W.B. Colson, Berkeley Research Associates

History of free electron lasers (FELs). Characteristics of FEL configurations. Introductory topics include the undulator field, the electron trajectories and the properties of the radiation. Electron phase-space dynamics. Classical bunching and coherent radiation. The self-consistant pendulum equation and the slowly varying wave equation. Single mode analysis includes gain mechanisms, coherence development, and energy extraction. Alternative undulator designs like the FEL klystron and the tapered undulator. Advanced topics include coherence theory and optical self-guiding. Classical and Quantum descriptions of the fundamental FEL mechanism are compared. Numerical methods. Selected experimental results are described and interpreted. (3 credit hours)

PHYSICS 404
PRINCIPLES OF ACCELERATION - R.B. Palmer, Brookhaven National Laboratory

The mechanisms of acceleration are derived from first principles. Real devices are discussed. Practical limitations are illustrated with examples. General Theorem for the acceleration of charged particles in electromagnetic fields. Radiation Pressure and Quantum Mechanical Considerations. Ponderomotive Force. Plasma Wave Acceleration. The Inverse Free Electron Laser. The Inverse Cerenkov Effect. The Grating Accelerator. A Two Dimensional Linac. The Panofsky-Wenzel Theorem. Alvarez and Travelling Wave Structures. (2 credit hours)

PHYSICS 405
INTRODUCTION TO BEAM INSTABILITIES - A.W. Chao, Universities Research Association

Review of relativistic single particle motion in synchrotrons. Electromagnetic fields due to the beam-cavity interaction and the resistive wall. Wakefields and impedance. Coasting beam instabilities. Introduction to dispersion relations and Landau damping. Physical models of bunched beam instabilities. Coherent modes and beam signals. The course includes an introduction to various mechanisms of beam instability and a brief survey of experimental observations. (2 credit hours)