Course Outline
Accelerator Physics

Meeting Times: 9:00-12:00, 14:00-17:00
Text: H. Wiedemann, *Particle Accelerator Physics,* 3rd Edition, Springer
Supplementary Texts: K. Wille, *The Physics of Particle Accelerators*, A. W. Chao and M. Tigner, *Handbook of Accelerator Physics and Engineering,* J. D. Jackson, *Classical Electrodynamics*
Grading: Homework Problems 35%; Mid-term Examination 25%; Final Examination 40%

Course Content

Introduction to Accelerators and Short Historical Overview
  - Basic Units and Definitions
  - Lorentz Force
  - Linear Accelerators
  - Circular Accelerators
- Particle Motion in EM Fields
  - Linear Beam Dynamics
  - Periodic Systems
  - Magnetic Multipoles
  - Nonlinear Perturbations
  - Coupled Motion
- Synchrotron Radiation
  - Radiation Power and Distribution
  - Insertion Devices
  - X-ray Sources
  - Free Electron Lasers
- Technical Components
  - Particle Acceleration Cavities and RF Systems
  - Spin and Spin Manipulation
- Collective Effects
  - Particle Distributions
  - Vlasov Equation
  - Self-consistent Fields
  - Landau Damping
  - Beam-Beam Effects
- Relaxation Phenomena
  - Radiation Damping
  - Toushek effect/IBS
  - Beam Cooling

1. INTRODUCTION TO RECIRCULATED LINEAR ACCELERATORS

1.1. Properties of Storage Rings, Linear Accelerators, and Recirculated Linear Accelerators

1.2. Beam Recirculation: Opportunities and Challenges

1.3. Superconducting RF (SRF)

1.4. Microtrons, Racetrack Microtrons, and Polytrons

1.5. Independent Orbit Recirculators:

1.6. Energy Recovered Linacs (ERLs)

2. INTRODUCTION TO LINEAR OPTICS

2.1. Particle Motion in the Linear Approximation (both Trans and Long.)

2.2. Ellipses in Beam Optics and the Area Theorem

2.3. Unimodular Matrices and their Twiss Parameters

2.4. Hill’s Equation and its Solution

2.5. Dispersion Tracking and Longitudinal Stability

2.6. Beam Matching and Rms Emittance

3. SINGLE PARTICLE DYNAMICS

3.1. Longitudinal Dynamics

3.1.1. Longitudinal gymnastics

3.1.2. Longitudinal tune choices

3.1.3. Correcting RF curvature (T566 or sextupoles)

3.1.4. Energy spread estimates

3.2. Transverse Dynamics

3.2.1. Basic considerations

3.2.2. Betatron Motion Damping and Antidamping

9.1. CEBAF physics upgrades

9.2. FELs

9.3. Synchrotron Light Sources (ERL,PERL,MARS)

9.4. Electron-Ion Collider (EIC)