Course Syllabi

PHYS 451. Empirical Foundations of the Standard M--Ode-I I (3).

1 . Introduction
Relevant scales of length, time, mass, and densities
Review of quantum mechanics and special relativity
Relativistic kinematics; phase-space parameterizations
Nuclear mass defects and binding energies; Q-values in nuclear decays and reactions
Theory of decaying states; Wigner-Weisskopf formalism
Collision theory, the S-matrix, unitarian, in & out states, phase shifts, Feynmandiagrams
Klein-Gordon and Dirac equations; gamma-matrix technology

2. Principles of Particle Accelerators
Contemporary colluders and fixed target machines
Beam acceleration and optics

3. Particle Detection
Passage of radiation through matter
Proportional counters, time projection clambers, calorimeters
Detector component objectives and principle
Contemporary accelerator and non-accelerator detectors

4. Gauge bosons, Leptons, and Quarks as Elemental Constituents
Boson and Fermions properties; spin-statistics theorem
Flavor designations
Families
Gauge invariance and its consequences

5. Measures of Particle Interactions
Fluxes, luminosities, collision cross sections
Lifetimes, decay rates, branching ratios

6. Empirical Characterization of the Fundamental Interactions
Electromagnetic interactions of charged particles
Strong interactions of hadrons, the quark composite model of hadrons, Quark-gluon model, harmonization, duality diagrams
Weak interactions, nature of the boson-fermion couplings; neutral currents

7. Symmetries and Conservation Laws of the Fundamental Interactions
Space-time symmetries; intrinsic parities
Particle-antiparticle symmetry; charge conjugation, CPT
Internal Symmetries
Fermionic symmetries
Broken symmetries

8. Discrete Symmetry Properties of the Conjugate Neutral Mesons and CP Violation
Decay eigenstates of ; the decay and mass matrices, unitarian conditions
Regeneration and strangeness oscillations, box and penguin diagrams
Consequences of CPT and CP invariance and noninvariance
CP violation parameters
Superweak theory

9. Weak Decays, Quark Mixings, and the CKM matrix
Diagonalization of the mass matrix
Wolfenstein parameterization

10. The Nature of the Neutrino
Defining properties and the distinction between Dirac and Majorana neutrinos
Evidence for the number of light neutrinos
The question of neutrino masses; why so small?
Solar neutrino problem
Atmospheric neutrino problem
Neutrinos and the various dark matter problems
Neutrino oscillations and the MSW effect