Physics 780.02: Introduction to High Energy Physics[1]

The goal of this class is to survey High Energy Physics. It is my intention to introduce you to both the experimental techniques used in this field as well as review the outstanding theoretical problems and puzzles that confront us today.

> Office: PRB3140
> Tel: 292-4124
> e-mail: gan@mps.ohio-state.edu
> Web: http://www.physics.ohio-state.edu/~gan/teaching/winter10/780.html
> Textbook: **Particle Physics (3rd edition) Martin and Shaw**

The following books are suggested references and are at the Science and Engineering Library:
> Introduction to Quarks and Partons, Close, QC793.5Q252C46
> The Cosmic Onion, Close, QC793.5Q252C45
> The Fundamental Particles and Their Interactions, Rolnick[2]
> Introduction to Elementary Particles, Griffiths, QC793.2G75[2]
> Introduction to Experimental Particle Physics, Fernow, QC793.2F47
> Introduction to High Energy Physics, Perkins, QC793.2P47[2]
> Leptons and Quarks, Okun, QC793.5L422038
> Quarks and Leptons, Halzen and Martin, QC793.5Q25Q3

The following web sites are also extremely useful:
> Particle Data Group (lots of free stuff):   http://pdg.lbl.gov/
> Fermilab site: http://www.fnal.gov/
> CERN site (where the web was born):   http://public.web.cern.ch/public/

The requirements for this course consist of 3-4 homework assignments and a final paper OR a final exam. We will decide on the form of the final later in the quarter.
If time permits each student will give a 15-20 minute classroom presentation on their final paper topic. The topics for this paper should be relevant to the class and of interest to you. Below I list several examples of such topics:
> Search and discovery of the top quark
> The LHC and its physics potential
> The Higgs Boson and the origin of mss
> CP violation in B-meson decay
> Search for supersymmetic particles

---

[1] The lecture notes for this class are adapted from the course given by Prof. Kass in Spring 2003.
[2] Used as a textbook by previous 780.02 classes.

Richard Kass

Physics 780.02 Tentative Course Outline Spring 2003

I) Introduction and Review
    a) Issues in HEP
    b) Units
    c) Relativistic Kinematics
    d) Feynman Diagrams

II) Conservation Laws
    a) Invariance Principles and Conserved Quantities
    b) Continuous Transformations
        1) Gauge Transformations
        2) Isospin
    c) Discrete Transformations
        1) Parity
        2) Charge Conjugation
        3) flavor oscillations and CP violation

III) Quark Model
    a) Historical Introduction
    b) 1960's Quark Model
    c) Quark Model of 1970's-80's
    d) Building Mesons and Baryons
    e) Masses of Mesons and Baryons
    f) Magnetic Moments and the Quark Model
    g) Vector Mesons and Quarks
    h) Deep Inelastic Scattering

VI) Weak Interactions
    a) History and Overview
    b) Cabibbo Theory
    c) GIM Mechanism, Neutral Currents, Charm
    d) Mathematical Form of Weak Interaction
    e) Cabibbo-Kobayashi-Maskawa Model

V) The Standard Model
    a) History and Overview
    b) Spontaneous Symmetry Breaking
    c) Higgs Mechanism
    d) Experimental Consequences/Tests of Standard Model
        1) Unification of Weak and EM
        2) Masses of W and Z
        3) Electro-Weak Interference
    e) Limits of the Standard Model

VI) Quantum Chromodynamics (QCD)
    a) Overview
    b) Tests and Predictions

VII) CP Violation and B mesons
    a) Overview
    b) Experimental Status

VIII) Neutrino Oscillations
    a) Experimental Evidence for Neutrino Oscillations
    b) The Solar Neutrino Problem (solved!)

IX) Experimental Techniques (time permitting)
    a)   Ingredients of HEP Experiments
    b)   Examples of HEP detectors

X) Where Do We Go From Here ?
    a) What's Left to Do ?
    b) Experiments to Watch in the Next Year Or So