Course: Particle Physics

Lecturer: Dr. Costas Foudas
Text Books : Quarks & Leptons, Halzen and Martin; Introduction to HEP, D. Perkins; Introduction to Elementary Particles, D. Griffiths.
Office Hours: Thursdays 16:00 – 17:00, Fridays 15:00-16:00 at Room 508, Blackett

Aims: This is an introductory course in particle physics which aims to provide the students the basic background on the theoretical aspects of modern particle physics. Theoretical topics are connected with the most fundamental experimental results and techniques. A few key topics are examined in depth for the benefit of students who would pursue further studies in particle physics.

Objectives:

- To examine in depth the properties and consequences of the Dirac equation. Proofs of the relativistic covariance, parity, charge conjugation and time invariance are extensively discussed. The CPT theorem is introduced.

- To introduce the concept of the Lagrangian in field theory and to derive the equations of motion for scalar, vector and spinor fields. Global symmetries and Noether currents are introduced.

- To understand the use of the gauge principle within particle physics, with particular reference to local U(1) invariance, the QED Lagrangian, non Abelian gauge theories and the QCD Lagrangian.

- To introduce the Feynman diagrams and rules by associating them with specific terms of the Lagrangian; To show and discuss details of cross-section calculation.

- To understand the conceptual design of particle physics detectors, with reference to the functioning of the main sub-detectors.

- To introduce the theoretical and experimental discoveries which led to the development of the theory of the weak interactions.

- To introduce the vector boson mass generation via the spontaneous symmetry breaking and the Higgs mechanism.

- To introduce the Standard Model Lagrangian, discuss extensively the lepton, quark, gauge and mass sectors along with past and future experiments which aim to confront it. Discuss the limitations of the Standard Model, using neutrino oscillations, SUSY, dark matter and GUTs as examples

- To understand the concept of CP violation, and its relation to the CKM matrix and oscillations in the B and K systems.

Pre-requisites:

The major pre-requisite is the compulsory Nuclear and Particle Physics course, with the entire of the particle physics section being directly relevant. Additionally APP uses topics introduced in the Advanced Classical Physics (ACP) course, making it desirable, but not essential to have attended it. Particular topics are: Four vectors, Lagrangians and Hamiltonians (including their relevance to symmetries and conservation laws) and Maxwell's equations in vector form. Whilst having attended the Advanced Classical Physics course will deepen your understanding of the physics behind their use in particle physics, reference to the relevant section of APP's recommended texts provides the minimum necessary level of background knowledge, coupled with full use of the relevant APP problem sheets.