PH5211: Introduction to Nuclear and Particle Physics - Syllabus

1. Nuclear physics: basic facts about the nuclei: size, shape, binding energy, electric and magnetic moments; nuclear forces: charge independence, isospin symmetry, NN, pi-pi scattering, relations between scattering cross sections; the deuteron: models of n-p potentials; nuclear models: liquid drop and shell; elementary ideas of Effective Field Theory; elementary ideas on radioactivity; nuclear fission and fusion; elementary ideas about nuclear reactors.

2. Fundamental forces in nature; classification of particles: bosons and fermions; hadrons and leptons; spin, addition of angular momentum, helicity and chirality; quark content of hadrons; isospin, flavor, and color symmetry, particle quantum numbers, Gell-mann Nishijima formula.

3. Real and virtual processes; matrix elements; relativistic kinematics of decay and interaction process ($1\rightarrow2$ and $2\rightarrow2$) illustrated with examples from electromagnetic, weak and strong processes; Scattering amplitudes, differential and total cross-sections, decay rates and life-times; Breit-Wigner formula.

4. Elementary introduction to accelerators including, event rates and luminosity; the interaction of particles with matter, scintillators and time-of-flight detectors, the principle of gas chambers, silicon detectors, calorimetry and detectors for particle identification. Large detector systems at electron-positron, electron-proton and hadron colliders.

Text books

[1] Introductory Nuclear Physics, Kenneth S. Krane, Wiley India Pvt Ltd.
[2] The Nucleon-Nucleon Interaction, Gerald Brown and A.D. Jackson, North Holland.
[3] Introduction to Elementary Particles, 2nd Edition, David Griffiths, Wiley-VCH.
[4] Introduction to High Energy Physics, Donald H. Perkins, Cambridge.
[5] Detectors for Particle Radiation, Konrad Kleinknecht, Cambridge.
[6] Techniques for Nuclear and Particle Physics Experiments: A How-To Approach, William R. Leo, Springer.

PH5811: Advanced particle physics - Syllabus

1. Continuous symmetries and conservation laws; flavor and color symmetry revisited; Discrete symmetries: Parity, Charge conjugation; Time reversal and CPT theorem.

2. Electromagnetic processes: helicity conservation, Compton and Bhabha scattering, higher order corrections.

3. Weak processes: pion decay, parity violation, CP violation, neutral-meson oscillations, CKM matrix. The neutrino sector, neutrino oscillations, neutrino experiments.

4. Strong processes: Deep inelastic scattering and the parton model, quarks and the Drell-Yan process, elementary ideas of QCD, perturbative QCD.

5. Electroweak interactions, charged and neutral currents. Electroweak symmetry breaking and Higgs mechanism. W and Z bosons. The Glashow-Salam-Weinberg model, the standard model of particle physics.

6. Discovery of the top quark and searches for (or discovery of) the Higgs boson. Physics beyond the standard model. Relationship of particle physics with cosmology.

Text books

[1] Introduction to Elementary Particles, 2nd Edition, David Griffiths, Wiley-VCH.
[2] Introduction to High Energy Physics, Donald H. Perkins, Cambridge.
[3] Quarks & Leptons, Francis Halzen and Alan D. Martin, Wiley India Edition.