PHY-914 Particle Physics-I

Credit Hours: 3-0

Prerequisite: None

Objectives and Goals: The purpose of this course is to give an overview of the fundamental particles of the Universe. It also introduces the interactions of particles and the relation between these particles and the forces. This course will help student to tackle research problems in depth.

Core Contents: Review of fundamental forces, Relativistic notation, Lorentz transformation, Lorentz group and its generators, Scattering matrix and application, Symmetry in Physics, Parity, Charge conjugation, Selection rules and globally conserved quantum numbers, Quark Model, Yang Mills theory, V-A structure of weak interactions, Muon decay

Detailed Course Contents: Fundamental forces and their relative strengths, Units in high energy physics, Relativistic notation, Lorentz transformation, Kinematics of scattering processes, Scattering matrix and its application, Symmetries in Physics, Lorentz group and its generators, Discrete symmetries such as parity and charge conjugation, Intrinsic parity of pion, Parity constraints on S-matrix for hadronic reactions, Selection rules and globally conserved quantum numbers, Introducing isospin, Calculation of pion-nucleon scattering using isospin conservation, Charge conjugation, G-parity, Unitary groups and SU(3), Particle representations in flavor SU(3), weight diagrams for pseudoscalar meson octet, weight diagram for baryon octet, SU(6) wave function for mesons, Magnetic moment of baryons, Yang Mills theory, QCD Lagrangian and its gauge invariance, Conserved current for QCD Lagrangian, Overview of Asymptotic freedom of QCD, V-A Interaction, Classification of weak processes, Semileptonic decays, Calculation of unpolarized and polarized muon decay

Course Outcomes: At the end of the course, the students will have learnt the methodology for calculations of cross-section and decay rates of different processes and will be able to understand

- the Quark model

- QCD Lagrangian and its gauge invariance
- weak interactions

Textbook: Fayyazuddin and Riazuddin, Modern Introduction to Particle Physics, 3rd ed. World Scientific 2011. (Referred as FR)

Reference Books:

1. Mark Thomson, Modern Particle Physics, Cambridge University Press 2013.
2. I J R Aitchison and A J G Hey, Gauge Theories in Particle Physics: A Practical Introduction, Volume I: From Relativistic Quantum Mechanics to QED, IOP 2013.
3. David J. Griffith's, Introduction to elementary Particle Physics, John Wiley & Sons 1987.

Weekly Breakdown		
Week	***Section***	***Topics***
1	FR 1.1-1.2,1.9	Review of fundamental forces and their relative strengths, Units in particle physics, Relativistic notation.
2	FR 2.1-2.3	Lorentz transformation, Kinematics of scattering processes, Interaction picture.
3	FR 2.4-2.6	Scattering matrix, phase space, Application of two body scattering and decays.
4	FR 3.1-3.1.1	Symmetries in Physics, Review of group definition, Rotation and SO(3) group, Lie algebra of rotation group.
5	FR 3.1.2,3.3	Lorentz and Poincare group, Lie algebra of Lorentz and Poincare group, Parity.
6	FR 3.4-3.5	Intrinsic parity of pion, Parity constraints on S-matrix for hadronic reactions.
7	FR 4.1-4.2	Selection rules and globally conserved quantum numbers, introducing isospin, Calculation of pion-nucleon scattering using isospin conservation.
8	FR 4.4-4.5 ,5.1	Charge conjugation, G-parity, Unitary groups and SU(3).
9	FR 5.2	Particle representations in flavor SU(3), weight diagrams for pseudoscalar meson octet, weight diagram for baryon octet.
10	FR 5.4-5.4.1	Irreducible representation of SU(3), Young Tableaux.
11	FR 6.1-6.2	SU(6) wave function for mesons, Magnetic moment of baryons.
12	FR 6.3-6.4, 7.2	Radiative decays of mesons, Radiative decays of baryons, Gauge principle for relativistic quantum mechanics.
13	FR 7.3 -7.4.2	Yang Mills theory, QCD Lagrangian and its gauge invariance, Conserved current for QCD Lagrangian, Overview of Asymptotic freedom of QCD.
14	FR 10.1-10.2.2	V-A Interaction, Classification of weak processes, Semileptonic decays

15	FR 10.2.4	Calculation of unpolarized and polarized muon decay.