

**Course Objectives:**

The course introduces the different scattering process, symmetries of high energy particles. It also details the standard theoretical models employed in particle physics.

**UNIT 1: Scattering Processes**

Relativistic kinematics, phase space, Mandelstam variables, Feynman rules, lifetimes and cross-sections, Golden rule; scattering of a spinless charged particle by electromagnetic field, scattering of electrons by electromagnetic field,  $e-\mu$  scattering, Moller scattering, electron-proton scattering and form factors, higher order corrections, vacuum polarization, charge renormalization, Lamb shift,  $g-2$

**UNIT 2: Symmetries and Quarks**

Discrete symmetries, isospin-SU(2), G-parity, SU(3)-classification of mesons and baryons, mass formula, magnetic moments, motivation for colour as an internal symmetry.

**UNIT 3: Parton Model and QCD**

Deep inelastic scattering (DIS) of electrons on nucleons, structure functions and scale invariance, Bjorken scaling, parton model; quantum chromodynamics: Lagrangian, symmetries.

Beta-decay,  $\mu$ -decay, parity violation, V-A theory of weak interactions, conserved vector current (CVC) hypothesis.

**UNIT 4: Standard Model and Neutrino Physics**

Glashow-Salam-Weinberg model, neutral current, physics of W, Z and Higgs, CKM mixing, C,P,T transformations, CP violation.

Neutrino Physics: neutrino oscillations.

**Reference Books:**

1. T. D. Lee, *Particle Physics and Field Theory*, Harwood, 1981.
2. T Cheng and L. Li, *Gauge Theory of Elementary Particles*, Oxford University Press, 1984.
3. I.J.R. Aitchison and A.J.G. Hey, *Gauge Theories in Particle Physics*, Vol. 1: From Relativistic Quantum Mechanics to QED, 3rd Edition, Taylor & Francis, 2002.
4. J.D. Bjorken and S.D. Drell, *Relativistic Quantum Fields*, McGraw-Hill, 1965

**Course Outcomes:**

After the completion of the course student is expected to:

- CO1: Be familiar with main theoretical concepts and experimental techniques used in elementary particle physics
- CO2: Be able to make quantitative estimates of cross-sections etc. of basic elementary particle processes
- CO3: Have a basic understanding of the Standard Model and of theoretical methods employed in particle physics