Integrated Ph.D. Course Batch 2023

Syllabus for Special Paper –III

Title of the paper: **High Energy Physics**

Maximum marks: 100 Minimum marks: 50

Unit I: **Elementary Particles and Conservation Laws**

Overview of Elementary particles: Overview of particle discoveries, particle classification schemes, the Gellman-Nishijima scheme, the eight fold way, the quark model.

Invariance principles and conservation laws: the parity operation, parity of particles and antiparticles, tests of parity conservation, charge conjugation invariance, charge conservation and gauge invariance, baryon and lepton conservation, CPT invariance, CP violation.

Unit II: **Quarks, Gluons, and the Quark-Gluon Plasma**

Quarks and Gluons, Bag model of hadrons, Quark Gluon Plasma, Quark Gluon Plasma at High Temperature, Quark Gluon Plasma with High Baryon Density, J/Psi suppression and production in Quark Gluon Plasma, Dilepton production in QGP, Photon production on Quark Gluon Plasma, Experimental information on J/Psi production and suppression, Experimental information on photon production.

Unit III: **Scattering and Bjorken Scaling**

Scattering: scattering, elastic electron-nucleon scattering, Matrix element, proton form factors. Photons: Polarization vectors, Propagators: electron propagator, photon propagator, real and virtual photons. Deep inelastic electron-nucleon scattering, kinematics and cross-section formula. Proton model, Bjorken scaling, Scaling violation, Concepts of Mandelstam variables, Compton scattering amplitude cross-sections in Mandelstam variables. Altarelli-Parisi evolution equations.

Unit IV: **Renormalization and Observable Effects**

Renormalization: Degree of divergence of a diagram, Regularization of self- energy diagrams: Vacuum polarization diagram, Fermion self-energy diagram. Counterterms, Ward-Takahashi identity. Observable effects of renormalization: Modification of coulomb interaction, running coupling constant, cancellation of infra-red divergences.

References

Halzen F. & Martin, A. D. *Quarks and Leptons: An Introductory Course in Modern Particle Physics*. Wiley, 1984.

Griffiths D. J. *Introduction to Elementary Particles*. Wiley-VCH, 2008.

Perkins, D. H. *Introduction to High Energy Physics*. Addison-Wesley, 2000.

Lahiri and Pal. A first book of quantum field theory.

Lewis H. Ryder. Quantum field theory, Cambridge University Press.