Approval: 10th Senate Meeting

IIT Mandi
Proposal for a New Course

Course Name : **Nuclear and Particle Physics**

Course Number : PH 612

Credits : (3-0-0-3)

Prerequisites : Quantum Mechanics, Electromagnetic Theory

Intended for : I-Ph.D., M.Sc., B.Tech 3rd and 4th Year.

Distribution : **Elective**

Semester : Odd/Even

Preamble : The objective of the proposed course is to introduce students to the fundamental principles and concepts of nuclear and particle physics. Students will be able to know the fundamentals of the interaction of high energy particles. This course is expected to provide a working knowledge to real-life problems.

Course Outline : The course begins with basic nuclear phenomenology including stability. Eventually it will explore nuclear models and reactions; experimental methods: accelerators, detectors, detector systems; particle phenomenology: leptons, hadrons, quarks; elements of the quark model: spectroscopy, magnetic moments, masses.

Modules :

1. *Properties of Nuclei*: Nuclear size, nuclear radius and charge distribution, mass and binding energy, semiempirical mass formula, angular momentum, parity and isospin, magnetic dipole moment, electric quadrupole moment and nuclear shape. (5 Lectures)
2. *Two-body problems*: Deuteron ground state, excited states, spin dependence of nuclear forces, two nucleon scattering, charge symmetry and charge independence of nuclear forces, exchange nature of nuclear forces, Yukawa's theory. (4 Lectures)
3. *Nuclear decay*: Alpha, Beta and Gamma decay, Gamow theory, Fermi theory, direct evidence for the neutrino. (4 Lectures)
4. *Nuclear models*: Liquid drop model, shell model, magic numbers, ground state spin, and collective model. (4 Lectures)
5. *Nuclear Reactions*: Different types of reactions, Breit-Wigner dispersion relation, Compound nucleus formation and break-up, nuclear fission, neutron physics, fusion reaction, nuclear reactor. (5 Lectures)
6. *Elementary particles*: Fundamental interactions. Particle Zoo: Leptons, Hadrons. Organizing principle: Baryon and Lepton Numbers, Strangeness, Isospin, The eightfold way. Quarks: Color charge and strong interactions, confinement, Gell-Mann – Okubo mass relation, magnetic moments of Hadrons. Field Bosons: charge carrier. The Standard Model: party non-conservation of weak interaction, Wu's experiment, elementary idea about electroweak

unification, Higgs boson and origin of mass, quark model, concept of colour charge, discrete symmetries, properties of quarks and leptons, gauge symmetry in electrodynamics, particle interactions and Feynman diagrams. (18 Lectures)

Books:

Text

1. K. S. Krane, Introductory Nuclear Physics, John Wiley (2008).
2. D. J. Grifths, Introduction to Elementary Particles, John Wiley & Sons Inc. (2008)

References

1. W. E. Burcham and M. Jobes, Nuclear and particle Physics, John Wiley & Sons Inc.R. R.(1979).
2. W. L. Cottingham and D. A Greenwood, An Introduction to Nuclear Physics, Cambridge UniversityPress (2001).
3. A. Das and T. Ferbel, Introduction to nuclear and particle physics, John Wiley (2003) .
4. M. A. Preston and R. K. Bhaduri, Structure of the nucleus, Addison-Wesley (2008).
5. S. N. Ghoshal, Atomic and Nuclear Physics (Vol. 2) (S. Chand, 2010).
6. Roy and B. P. Nigam, Nuclear Physics: Theory and Experiment, New Age.
7. D. Perkins, Introduction to High Energy Physics, Cambridge University Press; 4th edition (2000).
8.G. L. Kane, Modern Elementary Particle Physics, Westview Press.
9. B. R. Martin, Nuclear and Particle Physics: An Introduction, Wiley (2013).