

Course 11: Nuclear and Subatomic Particle Physics

Course code: MSCPH-511

Credit: 3

BLOCK 1 Nuclear Properties and Nuclear Models

Unit –1: **Nuclear Properties:** Nuclear mass and binding energy, binding fraction, size, constituents, discovery of neutron, nuclear spin, magnetic moment, quadrupole moment, parity.

Unit –2: **Nuclear Binding:** Binding energy, nuclear reactions, Q equation, solution of Q equation

Unit –3: **Nuclear Forces:** Nuclear forces, deuteron, n-n and p-p interaction, spin dependence of n-p interaction, meson theory of nuclear force, exchange forces nature of nuclear force.

Unit –4: Quantum mechanical treatment, relation between potential V_0 and distance r , isotopic spin formalism and generalized Pauli Exclusion Principle.

Unit –5: **Nuclear models:** Nuclear models, Liquid drop model, Bethe–Weizsäcker formula, nuclear shell model, collective models.

BLOCK 2 Radioactivity

Unit –6: **Radioactivity:** Radioactivity, law of radioactivity, growth and decay of radioactivity, successive disintegrations, various types of equilibrium, age of minerals and rocks.

Unit –7: **alpha decay** Alpha particle and alpha decay, Q value of alpha decay, Geiger–Nuttall law, barrier penetration in alpha disintegration, and probability of alpha decay.

Unit –8: **Beta decay:** Beta decay Q values for beta decay, neutrino, parity violation in weak interaction, Fermi theory of beta decay.

Unit –9: **Gamma decay:** Gamma decay, Compton scattering of gamma rays, pair production, K capture, internal conversion, multipole transitions.

BLOCK 3 Nuclear reactions

Unit –10: **Nuclear reactions:** Types nuclear reactions, conservation laws, energetic of nuclear reaction, isospin, reaction cross section, nuclear scattering, scattering cross section

Unit –11: **Fission and Fusion:** Compound nucleus, direct reactions, resonance reactions, optical model, neutron physics, fission, fusion

Unit –12: **Particle accelerators and detectors:** Electrostatic accelerators, cyclotron, synchrotron, linear accelerators, colliding beam accelerators, Gas-filled counters, surface barrier detectors, Scintillation detectors, inorganic scintillators NaI(Tl), semiconductor detectors.

Reference Books:

1. **Atomic and Nuclear Physics Vol. II: S N Ghoshal.**
2. Structure of the Nucleus: M. A. Preston, R. K. Bhaduri
3. Nucleon-nucleon Interaction: Brown and Jackson.
4. Introductory Nuclear Physics: S.S.M. Wong.
5. Theory of Nuclear Structure: M.K. Pal.
6. Nuclear Physics: H M Agarwal