Course Type	Course Code	Name of Course	L	T	P	Credit
DC	PHC207	NUCLEAR SCIENCE AND ENGINEERING	3	0	0	9

Course Objective

The objective of the course is to discuss the basic of nucleus, its constituents, different model related to it, nuclear energy and its production, particle detectors and accelerators. We will also learn about fundamental particles.

Learning Outcomes

Upon successful completion of this course, students will:

- have a broad understanding of the nuclear models, constituents of nucleus and its basic properties.
- have a high-level understanding of the nuclear forces, nuclear reactions, nuclear decay, particle accelerators and detectors.
- be able to know about fundamental particles e.g. fermions, leptons, baryons, mesons, neutrinos and antiparticles.

Unit No.	Topics to be Covered	Lecture Hours	Learning Outcome
1	**Basics of nucleus and its stability:** Nuclear binding energy, sizes, spins, angular momentum, magnetic moments, parity, quadrupole moments, energetic and stability against particle emission, Gamow's theory of Alpha decay, Fermi theory of Beta decay, Gamma decay	11	This topic covers of basics of nucleus, its fundamental properties, nuclear stability and theory of radio-active decays.
2	**Two Nucleon Problem:** Nature of nuclear forces, Meson theory of nuclear forces, Deuteron problem, Nucleon-Nucleon scattering, scattering length	7	This unit will help student to get knowledge about the nuclear forces and nuclear scattering.
3	**Nuclear model:** Liquid drop model, Shell model, Semi-empirical mass formula, Fermi-gas model.	3	In this topic, students will learn about different models of nucleus.
4	**Nuclear Reactions:** Conservation laws, Classification, Compound Nucleus theory, Continuum and Statistical theories, Cross-sections, Breit-Wigner formula, Direct Reactions.	7	This topic tells that different nuclear theory and nuclear reactions.
5	**Detectors & Accelerators:** Gas-Filled Ionization Detectors, Proportional counter, G.M. counter, Linear Accelerator, Synchrotron	4	This part will help to understand about acceleration of particles and its detection.
6	**Nuclear reactors:** Nuclear **fission**, critical size of reactor, general aspect of reactor design, classification of reactors, neutron moderation, Fissile and fissionable material, fast breeders, Nuclear **fusion**: Basic reactions and energetic, Lawson's criteria for fusion, Stellar fusion	6	In this topic, students will learn about the theory of production of nuclear energy, materials required to produce it.
7	**Elementary particles:** Leptons, Mesons and Baryons, concept of antiparticle, discrete symmetries and conservation laws, Isospin and strangeness	4	In this topic, students will learn about constituent of universe, different forces in nature, fundamental particles etc.
	Total	**42**	

Textbooks:

1. Nuclear Physics; I. Kaplan; Narosa; 2006
2. Introductory Nuclear Physics; Kenneth S. Krane; Wiley India Pvt Ltd; 2011
3. Modern Elementary Particle Physics, 2nd Edition, Gordon Kane, Cambridge University Press, 2017.

Reference Books:

1. Nuclear Physics; D. C. Tayal; Himalaya Publishing House; 2013
2. Quarks and Leptons; Halzen and Martin. Wiley India Pvt Ltd; 2008.
3. Nuclear Physics: Theory and Experiments; Roy & Nigam; New Age International; 2014
4. Theory of Nuclear Structure; S.K.Gupta; Alfa Publication; 2011