Course Code	Course Name	Credits
26PH011	NUCLEAR AND PARTICLE PHYSICS	04

Course Objectives

- To recognize the fundamentals of structure of atoms and nucleus and their properties
- To acquire knowledge about the atomic models and electronic and nuclear structures
- To interpret the concepts of radioactivity and different radioactive decays
- To discuss the idea of the elementary particles, particle accelerators, and detectors

Learning Outcomes

Upon successful completion, students will have the knowledge and skills to:

- Understand the development of atomic models and quantum numbers explaining the structure of atoms.
- Explain the electronic structure of atoms including spin effects, coupling schemes, and spectroscopic phenomena such as Zeeman and Stark effects.
- Analyse the structure, properties, and stability of atomic nuclei using different nuclear models.
- Describe the processes of radioactivity, nuclear reactions, fission, and fusion and their significance in energy generation and astrophysics.
- Understand the working principles of particle detectors, particle accelerators, and the classification of elementary particles.

Unit 1 - Atomic Structure (12 Hrs.)

The Nuclear Atom - Rutherford Scattering - Scattering Formula derivation - The Bohr Atom - Atomic Spectra - Ritz combination principle - Correspondence Principle - Atomic Excitation - The Sommerfeld Atom Model – Vector Atom Model - Quantum numbers.

Unit 2 – Electronic Structure of Atoms (12 Hrs.)

Coupling Schemes - Pauli Exclusion Principle - The periodic table - Magnetic dipole moment of electronSpin-Stern-Gerlach Experiment - Spin-Orbit Coupling - Zeeman Experiment - Quantum mechanical explanation - Anomalous Zeeman Effect - Paschen-Back effect - Stark effect -Production of X-rays - Bragg's Law - Bragg X-ray Spectrometer.

Unit 3 - Nuclear Structure (12 Hrs.)

Nucleus - Classification of nucleus - General Properties - Binding Energy - Nuclear Stability -Theories of nuclear Composition - Nuclear forces - Meson theory of nuclear forces - Liquid drop model - Shell Model - Explanation of Magic numbers - Fermi gas model of the nucleus.

Unit 4 – Nuclear Transformations (12 Hrs.)

Radioactivity - Alpha Particle Spectra - Theory of Alpha decay - Theory of beta decay - Law of radioactive disintegration - Half life - Mean life - Units of radioactivity - Law of successive disintegration - Age of earth - Nuclear reactions - Scattering cross section - Nuclear fission - Nuclear reactors - Nuclear fusion - Source of stellar energy.

Unit 5 - Particle Detectors, Particle Accelerators and Elementary Particles (12 Hrs.)

Particle Detectors: Ionization chamber - solid state detectors - Geiger Muller Counter - Wilson Cloud chamber. Particle Accelerators: Cyclotron - Betatron - Synchrotron - Proton synchrotron. Elementary Particles: Particles and antiparticles - Fundamental interactions - Elementary Particle Quantum numbers - Quark model.

Reference Books:

1. Murugeshan and KiruthigaSivaprasath. (2005). Modern Physics, (12th Edition), S. Chand.
2. Besier, Mahajan. S and Choudhury. S. R, (2017), Concepts of Modern Physics, (7th Edition), Mcgraw Hill Education.
3. Kolanoski. H and Wermes. N, (2020), Particle Detectors, Oxford University Press.
4. Irving Kaplan, (1977), (2nd Edition), Nuclear Physics, Addison-Wesley.
5. Eisberg. R and Resnick. R, (2006), (2nd Edition) Quantum physics of atoms, molecules, solids, nuclei, and particles, Wiley.

Websites and eLearning Sources:

1. https://onlinecourses.nptel.ac.in/noc21_ph26/preview
2. https://youtu.be/sNQsdrqsD_s?si=0a4ixqVFePgqGQi-
3. https://youtu.be/bdfir8uT06Q?si=jl_nTzKCqiV4sPqL

COs and Bloom's Taxonomy Mapping – 26PH011		
Course Outcomes	**On successful completion of this course, students will be able to**	**BTL**
CO1	Recall and explain atomic models, quantum numbers, and nuclear properties.	K1, K2
CO2	Apply quantum and nuclear principles to analyze atomic spectra and nuclear phenomena.	K3
CO3	Analyze nuclear structure, decay processes, and stability using theoretical models.	K4
CO4	Evaluate nuclear reactions, energy generation, and particle detection techniques.	K5
CO5	Develop models and interpret results related to particle physics and nuclear systems.	K6

BTL (Bloom's Taxonomy Level) - K1 – Remembering, K2 – Understanding, K3- Applying, K4 – Analyse, K5- Evaluate and K6 - Create

Relationship Matrix – 26PH011													
Course Outcomes	**Programme Outcomes (POs)**						**Programme Specific Outcomes (PSOs)**						**Mean Score of Cos**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	
CO1	3	2	1	1	1	1	3	2	1	1	1	1	1.50
CO2	3	3	2	1	1	1	2	3	3	2	2	1	2.08
CO3	3	3	2	2	1	1	2	2	3	2	2	1	2.00
CO4	2	2	3	2	2	1	2	2	3	3	3	2	2.25
CO5	2	2	3	2	2	2	2	2	3	3	3	3	2.42
												Total	2.05

Mean Score: 3- High, 2- Medium/Moderate, 1-Low