Course Code	Course Name	Credits
26PH005	ATOMIC PHYSICS	04

Course Objectives

- Learn to detect charged particles, measure electron properties, and analyze atomic models and spectra through problem-solving.
- To study molecular energy transitions, fine structures, and the Raman effect, applying spectroscopy techniques in real-world scenarios.
- To investigate nuclear components, stability, radioactive decay laws, and apply these concepts to practical problems in various fields.
- To understand nuclear models, fission, and fusion processes, focusing on energy release and reactor design through theoretical and practical analysis.

Learning Outcomes

Upon successful completion of this course it is intended that a student will be able to:

- Detect charged particles, measure electron properties, apply Bohr/Sommerfeld models with quantum numbers, spin-orbit coupling, and Pauli exclusion for atomic structure and spectra.
- Analyze Zeeman/Paschen-Back effects, molecular rotational-vibrational spectra, Franck-Condon principle, and Raman scattering for spectroscopic diagnostics.
- Evaluate nuclear stability via binding energy, decay laws, half-life, radioactive series, and dating for radiation and stability studies.
- Model nuclei with liquid drop/shell theories, compute fission/fusion energy, chain reactions, critical mass, and reactors for energy applications.
- Classify elementary particles, understand fundamental forces, conservation laws, CPT theorem, quarks, and Standard Model principles.

Unit 1 - Charged Particles And Atomic Models (12 Hrs.)

Detecting charged particles in electric and magnetic fields. Measuring electron charge and mass (Dunnigton's and Millikan's methods). Bohr's atom model and hydrogen spectrum. Sommerfeld's corrections and fine structure of the hydrogen spectrum. Quantum numbers, spin-orbit interaction, and L-S and J-J coupling. Pauli's exclusion principle and electron configuration. Includes problem-solving related to atomic models and spectroscopy.

Unit 2 – Atomic And Molecular Spectra (12 Hrs.)

Study of sodium doublet fine structure, normal and anomalous Zeeman effects, and Paschen Back effect. Molecular energy levels, rotational and vibration-rotation spectra, and FranckCondon principle. Raman effect and its quantum explanation. Includes applications in spectroscopy and molecular analysis.

Unit 3 - Nuclear Properties And Radioactivity (13 Hrs.)

Constituents of nuclei, nuclear mass, and binding energy. Study of nuclear stability, mass defects, and the binding energy curve. Nuclear size, spin, energy levels, and parity. Radioactive decay laws, Half-life, Decay rate, radiation types, radioactive series, successive transformation and radioactive dating. Problems involving decay laws and practical applications.

Unit 4 – Nuclear Models, Fission, And Fusion (13 Hrs.)

Properties of the neutron (mass, charge, detection). Liquid drop model of nucleus, Semi empirical mass formula & Shell model. Study of nuclear fission and energy released, nuclear chain reactions, critical mass, and nuclear reactors. Fusion processes, thermonuclear reactions, stellar energy, and hydrogen bomb. Includes problems on energy release and reactor design.

Unit 5 - Elementary Particle Physics (10 Hrs.)

Classification of elementary particles (mesons, hyperons, particles, and antiparticles). Four fundamental forces, conservation laws, CPT theorem, resonance particles, and quark model. Unification of interactions and the Standard Model. Applications in particle physics.

Reference Books:

1. A.B. Gupta, Modern Atomic and Nuclear Physics, 2nd revised edition, Books and Allied, 2009.
2. Modern Physics by R. Murugeshan, KiruthigaSivaprasath, S. Chand & Co., New Delhi (2008).
3. Modern Physics by D.L.Sehgal, K.L.Chopra and N.K.Sehgal. Sultan Chand & Sons Publication, 7th Edition, New Delhi (1991).
4. Atomic Physics by J.B. Rajam, S. Chand & Co., 20th Edition, New Delhi (2004). Atomic and Nuclear Physics by N. Subrahmanyam and BrijLal, S. Chand & Co. 5th Edition,NewDelhi (2000).
5. Modern Physics by J.H. Hamilton and Yang, McGraw-Hill Publication, (1996).
6. Atomic physics by A B Gupta and DipakGhosh – Books and Allied Publishers.

Websites and eLearning Sources:

1. https://onlinecourses.nptel.ac.in/noc25_ph04/preview
2. https://youtu.be/eRIN9CPDrpo?si=B9KZPk0-vnqKZf5e
3. https://youtu.be/fOMvJj39eTU?si=PBwpNZ-fO217C6so

COs and Bloom's Taxonomy Mapping – 26PH005		
Course Outcomes	**On successful completion of this course, students will be able to**	**BTL**
CO1	Recall and describe atomic models, quantum concepts, and nuclear structure.	K1, K2
CO2	Apply quantum principles to analyze atomic spectra and particle interactions.	K3
CO3	Analyze nuclear properties, decay processes, and stability using theoretical models.	K4
CO4	Evaluate nuclear reactions, energy production mechanisms, and radiation effects.	K5
CO5	Develop models and solve problems related to nuclear systems and particle physics applications.	K6

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

Relationship Matrix – 26PH005													
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	1	2	1	1.92
CO3	3	2	2	1	1	1	2	2	2	2	2	1	1.75
CO4	3	2	3	2	2	1	2	2	3	3	3	2	2.33
CO5	2	2	3	1	2	2	2	2	3	2	3	3	2.17
												Total	1.53

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