Sem.	Subject code	Course title	No. of hours	Credits	Paper type
VI	17U6PME2	Atomic and nuclear physics	6	7	Major Elective

Objectives:

(i) The student will be introduced to classical and quantum ideas of atomic structure of elements (available in periodic table) to have a better understanding of modern experimental results pertaining to Stern - Gerlach experiment, Zeeman, Paschen - Back and Stark effects. (ii) A topic on "Cosmic rays" has been introduced to make the students understand the past and future of our universe. (iii) The structure and basic properties of nucleus are introduced for the understanding of the nuclear reactions and transformations.

Learning outcome:

(i) The students will be able to understand the different spectra obtained with different experimental techniques (like Zeeman, Paschen - Back and Stark effect) and they will acquire knowledge to solve related problems in that area.

(ii) The students will acquire the knowledge of the basic structure and properties of nucleus and understand the nuclear transformations and the properties of alpha, beta and gamma rays.

(iii) The students will understand the working principles of detectors of nuclear reactions, particle accelerators and nuclear reactors.

(iv) The topic on cosmic rays, will make the students to think about the past and future of the universe. The students will identify the elementary particles in the nucleus and will understand their properties.

Unit I: Atomic Structure – I

The nuclear atom–Thomson's atom model–Rutherford atom model–Electron orbits–Bohr atom model–Energy levels and spectra-Origin of line spectra–Atomic excitation–Frank Hertz experiment–Vector atom model–Quantum numbers–Coupling schemes.

Unit II: Atomic Structure – II

Pauli's exclusion principle–Periodic table–Electronic configuration–Magnetic dipole moments due to orbital motion of electron and spin of electron–Stern and Gerlach experiment–Spin orbit coupling–Zeeman effect–Larmor's theorem–Quantum mechanical explanation of normal Zeeman effect–Anomalous Zeeman effect–Paschen-Back effect–Stark effect.

Unit III: Nuclear Structure and nuclear transformations

Nuclear composition–Atomic masses–Nuclear properties–Spin and magnetic moment–Binding energy–Binding energy per nucleon–Liquid drop model–Radioactive decay–Half life–Alpha decay–Tunnel theory of alpha decay–Beta decay–Gamma decay.

Unit IV: Detectors, accelerators, and nuclear reactors

Ionisation chamber–Geiger Muller counter–Wilson cloud chamber–The cyclotron–The synchrocyclotron–The betatron–Nuclear fission– Energy released in fission–Chain reaction–Nuclear reactors–Nuclear fusion–Source of stellar energy–Thermonuclear reactions .

Unit V: Cosmic rays and elementary particles

Discovery of cosmic rays–Latitude effect–East west effect (azimuth effect)–Altitude effect–Primary cosmic rays–Secondary cosmic rays–Cosmic ray showers–Discovery of positron–mesons–Van-Allen belts–Origin of cosmic rays–History of the universe–Hubble's law–Future of

the universe–Classification of elementary particles–Particles and antiparticles–The fundamental interactions–Quantum numbers–Conservation theory–Quark model.

Text book(s):

1. Concepts of Modern physics, Arthur Beiser, Shobhit Mahajan, Rai Choudhury, 7th Edition, McGraw Hill Education Pvt. Ltd., India, (2015).
2. Modern physics, R. Murugeshan and S. Kiruthiga, 17th revised Edition, S. Chand & Co. Pvt. Ltd., India, (2014).

Unit I: Book 1: 4.1, 4.2, 4.5, 4.6, 4.6.1, 4.9, 4.9.1.
Book 2: 6.12 – 6.14.
Unit II: Book 2: 6.15 – 6.21, 6.23 – 6.28.
Unit III: Book 1: 11.1, 11.2, 11.2.1, 11.4, 11.5, 12.1, 12.2, 12.4, 12.4.1, 12.5, 12.6.
Unit IV: Book 2: 29.3, 29.6, 29.7, 30.4 – 30.6, 35.2 to 35.9.
Unit V: Book 2: 37.1-37.15, 38.1, 38.2, 38.4 – 38.7.

Books for reference:

1. Hugh D. Young, Roger A. Freedman, Sears and Zemansky's University Physics with Modern Physics, 14th edition, Pearson Pvt. Ltd., India, (2017).
2. Max Born, Atomic physics, The English language book society, UK, (1989).
3. Shatendra K. Sharma, Atomic and Nuclear Physics, Dorling Kindersley, India, (2005).
4. D.C. Tayal, Nuclear Physics, Himalaya Publishing House, India, (2007).
5. S.B.Patel, Nuclear Physics an introduction, New Age international Pvt.Ltd., India, (2011).

Websites:

1. https://www.nuclear-power.net/
2. https://ocw.mit.edu/courses/physics/8-942-cosmology-fall-2001/
3. https://ocw.mit.edu/courses/materials-science-and-engineering/3-091sc-introduction-to-solid-state-chemistry-fall-2010/structure-of-the-atom/