Sem.	Subject code	Course title	No. of hours	Credits	Paper type
V	17U5PME1	Relativity and quantum mechanics	5	6	Major Elective

Objectives:

(i). To expose the undergraduate students to the basic concepts of quantum mechanics and their application to simple problems. (ii). To make the students to understand the laws of special and general theory of relativity.

Learning outcome:

(i). The students will be able to appreciate the world of quantum physics and understand the nuances of the relativistic phenomenon. (ii). The students will be able to find solution to simple quantum mechanical systems.

Unit I: Relativity

Special relativity–Frames of reference–Postulates of special relativity–Time dilation–Ultimate speed of light–Doppler effect–Expanding Universe–Length contraction–Twin paradox–Relativistic momentum–Relativistic mass–Mass and energy–Energy and momentum–General relativity–Gravity and light–Galilean transformation–Lorentz transformation–Velocity addition–Simultaneity.

Unit II: Particle properties of waves

Electromagnetic waves–Black body radiation–Ultraviolet catastrophe–Planck radiation formula – Photoelectric effect –Quantum theory of light–Compton effect–Pair production–Photon absorption–Photons and gravity–Gravitational red shift– Examples (Black holes, Quasars and galaxies).

Unit III: Wave properties of particles

de Broglie waves–Physical meaning of wave function–Phase velocity–Group velocity–Electron microscopes–Davission Germer experiment–Particle in a box–Uncertainty Principle–Energy and time–Interferometry with electron and atoms–Quantum interference with electron beams.

Unit IV: Time dependent Schrodinger equation

Wave Function–Wave equation–Schrodinger's time dependent and steady-state equations–Linearity and Superposition–Expectation value–Operators–eigen values and eigen functions–Operators and eigen values-Particle in a box (normalized wave function)–Momentum representation–Finite potential well–Tunnel effect–Scanning Tunneling Microscope –Harmonic Oscillator.

Unit V: Quantum theory of hydrogen atom

Schrodinger's equation for the hydrogen atom–Separation of variables–Quantum numbers–Designation of angular momentum states–Uncertainty principle and space quantization– Electron probability density–Probability of finding the electron–Selection rules–Fine structure– Spin-orbit coupling–Pauli exclusion principle–Symmetric and antisymmetric wave functions– Examples (Fermions and bosons).

Text Book(s):

1. Concepts of Modern Physics , Arthur Beiser, Shobhit Mahajan, S. Rai Choudhury, 7th Edn., Tata McGraw Hill Publishing Company, (2015).

Unit I : Chapter 1, Section 1.1–1.5, 1.7–1.9, 1.10, 1.11.1, Appendix I to chapter 1

Unit II : Chapter 2, Section 2.1 –2.3, 2.7–2.9.

Unit III : Chapter 3, Section 3.1– 3.6, 3.8 –3.10.
Unit IV : Chapter 5, Section 5.1– 5.3, 5.4 –5.11.
Unit V : Chapter 6, Section 6.1– 6.7.1, 6.9, 6.12, 6.13, 7.2, 7.3.

Books for Reference :

1. Modern Physics by R.Murugeshan &Er.Kiruthiga Sivaprasath , 17th Edn., S.Chand & Co Ltd (2004).
2. A Text book of Quantum Mechanics by P.M. Mathews & K. Venkatesan, 2nd Edn., McGraw Hill Publishing Company. (2010).
3. Quantum Mechanics by Leonard I Schiff , 4th Edn.,McGraw Hill Publishing Company. (2016).
4. Quantum mechanics, by G. Aruldhas, 2nd Edn., PHI Learning Pvt. Ltd., (2011)

Websites:

1. https://www.edx.org/course/quantum-mechanics--everyone-georgetownx-phynx-008-o1x
2. https://ocw.mit.edu/courses/physics/8-20-introduction-to-special-relativity-january-iap-2005//