Course Code	Course Name	Credits
26PH512	QUANTUM MECHANICS	04

Course Objectives

- Clear understanding on Perturbation Theory
- Vivid knowledge on the concepts of variation method, WKB
- Broad idea on Scattering
- Familiarization on applications of quantum mechanics

Learning Outcomes

After completion of the course, students will be able to:

- Learn about the fundamental difference between time dependent and time independent perturbation theory
- Grasp the concept of WKB approximation and its application
- Gain knowledge about Variation method and apply to hydrogen molecule
- Explore the features of Scattering cross section using different formula

Unit 1 - Basic Postulates and Quantum Systems (12 Hrs.)

Introduction - The basic postulates of Quantum Mechanics (QM) - The state of a system - observables and operators - Measurement in QM: how measurements disturb systems - expectation values - CSCO - measurement and the uncertainty relation; Time Evolution of the system's state: time evolution operator - stationary states - Schrödinger equation and wave packets - conservation of probability - time evaluation of expectation values; Connecting Quantum Mechanics to Classical Mechanics.

Unit 2 – One – Dimensional Problems (12 Hrs.)

Properties of 1D motions: Bound, unbound states, mixed spectrum - The free particle continuous states - the potential step- square well potential, Harmonic oscillator: Energy Eigenvalues, Energy Eigen states - Oscillator wave functions.

Unit 3 - Angular Momentum (13 Hrs.)

General formalism - Geometrical representation - Spin angular momentum: Experimental evidence of spin, general theory of spin, spin ½ and Pauli Matrices - Eigen functions of orbital angular momentum: Eigen functions and Eigenvalues of Lz, Eigen functions of L2 - Addition of Angular Momenta.

Unit 4 – Three – Dimensional Problems (11 Hrs.)

3D problems in spherical coordinates: central potential, the free particle, The Hydrogen atom: Separation of the Center of Mass Motion - Solution of the Radial Equation for the Hydrogen Atom - Degeneracy of the Bound States of Hydrogen - Degeneracy relation for the hydrogen atom - Probabilities and Averages.

Unit 5 - Approximation Methods (12 Hrs.)

Time independent Perturbation Theory: Non-degenerate, Degenerate - Variational method - The Schrödinger picture, The Heisenberg picture, The Interaction picture – Time-dependent perturbation theory - Transition probability - Constant and Harmonic perturbation.

Reference Books:

1. Zettili, N. (2009). Quantum Mechanics: Concepts and Applications (2nd Ed.). John Wiley & Sons.
2. Shankar, R. (2014). Principles of Quantum Mechanics (2nd Ed.). Springer.
3. Feynman, R. (2012). Feynman lectures on Physics - Vol 3 (new millennium edition), Pearson.
4. Merzbacher, E. (2011). Quantum Mechanics, (3rd Ed.). Wiley.
5. Bransden, B., &Joachain, C. (2004). Quantum Mechanics (2nd Ed.). Pearson.

Websites and eLearning Sources:

1. https://onlinecourses.nptel.ac.in/noc24_ph15/preview
2. https://youtu.be/a9UrKTVEeZA?si=wlaEwmSJwskQQI_h
3. https://youtu.be/IKJAJdDEqhM?si=bFA1xkhgT_vXhpqo

COs and Bloom's Taxonomy Mapping – 26PH512		
Course Outcomes	**On successful completion of this course, students will be able to**	**BTL**
CO1	Recall and explain the fundamental postulates of quantum mechanics, operators, observables, and measurement theory.	K1, K2
CO2	Apply Schrödinger equation to analyze one-dimensional quantum systems such as free particle, potential well, and harmonic oscillator.	K3
CO3	Analyze angular momentum in quantum mechanics, including spin, Pauli matrices, and addition of angular momenta.	K4
CO4	Analyze three-dimensional quantum systems such as hydrogen atom and central potential problems.	K5
CO5	Evaluate approximation methods such as perturbation theory and variational techniques to solve complex quantum systems.	K6

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

Relationship Matrix – 26PH512													
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	1.58
CO2	3	3	2	2	1	1	2	3	2	2	2	1	2.00
CO3	3	3	3	2	1	1	2	3	3	2	2	2	2.25
CO4	3	3	3	3	2	2	2	3	3	3	2	2	2.50
CO5	3	3	3	3	3	2	3	3	3	3	3	2	2.83
												Total	2.23

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