PH-8102: Quantum Mechanics-I

L	T	P	C
4	1	0	5

Course Outcomes:

After successful completion of this course, the students should be able to

CO1: Understanding of Dirac vector space & basic quantum operators.

CO2: Use operator techniques to solve relevant problems.

CO3: Analyze the time dependence of quantum systems using the Heisenberg picture.

CO4: Use of the properties of angular momentum and spin to describe quantum systems such as the hydrogen atom and an electron in a magnetic field.

CO5: Use perturbation theory to find approximate solutions to more complex quantum-mechanical systems.

CO6: Find out the ground states of different systems using Variational method

CO/PO Mapping

S-strong, M-medium and W-weak indicate the strength of correlation

COs	Programme outcomes (POs)											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	S	S	S	M	M	W	W			S	M	S
CO2	S	S	S	M	M	M	W			S		M
CO3	S	S	M	M	S	S	W			M	S	S
CO4	S	M	S	M	W	M	W			S	W	W
CO5	S	S	S	W	M	M	W			S	M	W
CO6	S	S	S	M	M	M	W			S	M	W

L	T	P	C
4	1	0	5

PH-8102: Quantum Mechanics-I

UNIT-I

Basic Formulation and Quantum Kinematics:
Stern- Gerlach experiment as a tool to introduce quantum ideas, analogy of two level quantum system with polarization states of light. Complex linear vector spaces: ket space, bra space, Schwarz inequality, Orthonormal basis and inner product, operators and properties of operators. Expectation values of operators, Hermitian operators, Unitary operators, Eigenkets of an observable, eigen kets as base kets, matrix representations. Measurements of observable, compatible vs. incompatible observable, Simultaneous eigenvectors, commutator and uncertainty relations. Change of basis and unitary transformations. Diagonalisation of operators. Position, momentum and translation, momentum as a generator of translations, canonical commutation relations. Wave functions as position representation of ket vectors. Momentum operator in position representation, momentum space wave function. **(17 Hrs)**

Quantum Dynamics:
Time evolution operator and Schrödinger equation, special role of the Hamiltonian operator, energy eigen kets, time dependence of expectation values, spin precession. Schrödinger vs. Heisenberg picture, unitary operators, state kets and observable in Schrödinger and Heisenberg pictures, Heisenberg equations of motion, Ehrenfest's theorem. Harmonic oscillator in matrix mechanics. **(13 Hrs)**

UNIT-II

Angular Momentum:
Angular part of the Schrödinger equation for a spherically symmetric potential, orbital angular momentum operator. Eigen values and eigenvectors of L^2 and Lz. Spin angular momentum, General angular momentum, Eigen values and eigenvectors of J^2 and Jz. Representation of general angular momentum operator, commutation relations of orbital angular momentum operator, Addition of angular momenta, C.G. coefficients. Numerical problems of C.G. coefficients. **(15 Hrs)**

Stationary State Approximate Methods:
Time independent perturbation theory for Non-Degenerate levels and its applications (perturbed harmonic oscillator, rigid rotator, one dimensional box etc.), Variation method with applications to the ground states of harmonic oscillator, hydrogen, one dimensional box etc. **(15 Hrs)**

Total: 60 Hrs

BOOKS:

1. Modern Quantum Mechanics: J.J. Sakurai (Addison Wesley, Reading).
2. Introduction to Quantum Mechanics: Davd J. Griffiths (Pearson Publications)
3. A Text book of Quantum Mechanics, P.M. Mathews and K. Venkatesan (Tata McGraw Hill, New Delhi).
4. Quantum Physics: S. Gasiorowicz (Wiley, New York).
5. Quantum Mechanics: V.K. Thankappan (New Age, New Delhi).
6. Quantum Mechanics: J.L. Powell and B. Crasemann (Narosa, New Delhi).

C/BOS