BACHELORS WITH PHYSICS AS MAJOR
8th SEMESTER

PHY822J1 PHYSICS _ QUANTUM MECHANICS

CREDITS: THEORY – 3, TUTORIAL: 1

THEORY (3 CREDITS: 45 HOURS)

COURSE LEARNING OUTCOMES:

These learning outcomes cover a wide range of topics related to quantum mechanics, Hilbert space and the Schrodinger Equation in three dimensions, providing a comprehensive understanding of the subject matter.

1. *Understand and analyze the concepts of stationery and scattering states.*
2. *Demonstrate proficiency in solving the time-independent Schrödinger equation for various potentials, including: Infinite square well potential, Finite square well, Delta function potential.*
3. *Quantum harmonic oscillator using analytic methods*
4. *Comprehend the Hilbert space formalism in quantum mechanics.*
5. *Understand linear operators, Hermitian operators, and their respective eigenfunctions.*
6. *Explore projection operators and their significance.*
7. *Analyze unitary operators, eigenvalues, and eigenvectors of operators.*
8. *Examine the Heisenberg equation of motion.*
9. *Solve the harmonic oscillator problem using matrix methods.*
10. *Apply the Schrödinger Equation in spherical coordinates.*
11. *Analyze the energy spectrum and quantum numbers associated with the hydrogen atom.*
12. *Understand angular momentum in quantum mechanics.*
13. *Explore commutation relations for angular momentum.*
14. *Determine the eigenfunctions of orbital angular momentum.*

UNIT-I (15 HOURS)

Stationery and scattering states of time-independent Schrodinger equation:
Infinite square well potential, finite square well, free particle, delta function potential.
Quantum harmonic oscillator, energy spectrum with complete solution (Analytic method).

UNIT-II (15 HOURS)

Hilbert space formalism for quantum mechanics, Observables, Dirac notation, linear operators, Hermitian operator and their Eigen function, projection operators, unitary operators, eigenvalues and Eigen vectors of an operator. The basic postulates of quantum mechanics, superposition principle, expectation value, Heisenberg equation of motion, harmonic oscillator and its solution by matrix method.

UNIT-III (15 HOURS)

Quantum mechanics in three dimensions, Schrodinger Equation in Spherical Coordinates, The Hydrogen Atom: energy spectrum and quantum numbers. Angular Momentum in quantum mechanics, commutation relations, Eigen functions of orbital angular momentum.

TUTORIALS (1 CREDIT: 15 HOURS)

1. Understanding the implications of a localized potential in quantum mechanics.
2. Numerical methods for solving the Schrödinger equation.
3. Tutorial on finding eigenvalues and eigenvectors for operators. Application to physical systems and interpretation.
4. Solving problems using the Heisenberg equation.
5. Tutorial on adding orbital angular momentum for composite systems. Application to multi-electron atoms.

TEXT BOOKS:

1. Principles of Quantum Mechanics by R. Shankar.
2. Quantum Mechanics: Fundamentals by Kurt Gottfried, Tung Mow Yun, Springer.
3. Quantum Mechanics: A Textbook for Undergraduates by Mahesh C. Jain, PHI.
4. Introduction to Quantum Mechanics, by David J. Griffiths and Darrell F. Schroeter, Cambridge University Press.