Approval: 10th Senate Meeting

Course Name : Quantum Mechanics

Course Number : PH513

Credits : 3-0-0-3

Prerequisites : Basic undergraduate physics courses and faculty consent

Intended for : I-Ph.D., M.Sc., B.Tech 3rd and 4th Year.

Distribution : Core for I-Ph.D./Elective for others

Semester : Odd

Preamble: This course is an introductory level course on quantum mechanics covering its basic principles. Several applications of quantum mechanics will be discussed to train students to apply these ideas to model systems in both one-dimension and three-dimensions.

Course outline: The course begins with a discussion on origins of quantum theory and will introduce the basic postulates. Applications of quantum mechanics on various one dimensional cases will be discussed. Further Dirac notation will be introduced. Applications of quantum mechanics in three dimensions will be discussed. Approximation techniques such as perturbation theory (both time dependent and time independent) and variational methods will be also discussed in this course.

Modules:

1. Origins of quantum theory, Postulates of quantum mechanics, observables and operators, theory of measurement in quantum mechanics, state of the system and expectation values, time-evolution of the state, wave-packets, uncertainty principle, probability current, transition from quantum mechanics to classical mechanics-Ehrenfest theorem. [6 lectures]

2. Application of Schrodinger equation: scattering, tunneling, bound states , harmonic oscillator, electrons in a magnetic field in 2D, comparison of classical and quantum results [8]

3. Basic mathematical formalism of quantum mechanics, Dirac notation, linear vector operators, matrix representation of states and operators, commutator relations in quantum mechanics, commutator and uncertainity relations, complete set of commuting observables [7]

4. Theory of angular momentum in quantum mechanics, commutator relations in angular momentum, eigen values and eigen states of angular momentum, spin-angular momentum [6]

5. Application of Schrodinger equation in 3-D models, symmetry and degeneracy, central potentials, Schrodinger equation in spherical co-ordinates, solution to hydrogen atom problem [6]

6. Time independent non-degenerate and degenerate perturbation theory, fine-structure of hydrogen, Zeeman effect and hyperfine splitting [7]

Text books:

1. Introduction to quantum mechanics-D J Griffith (Pearson, Second edition, 2004)
2. Quantum Mechanics -Vol.1, Claude Cohen-Tannoudji, B Diu, F Laloe (Wiley, First edition
3. Modern Quantum Mechanics - J J Sakurai(Addison Wisley, revised edition, 1993) 1991)

References:

1. Introductory Quantum Mechanics, R Liboff (Pearson, Fourth edition, 2002)
2. Quantum physics of atoms and molecules-R Eisberg and R Resnick (Wiley, 2nd edition, 1985)
3. Quantum Mechanics B. H. Bransden and C. J. Joachain (Pearson, Second edition, 2000)
4. Principles of Quantum Mechanics - R Shankar (Plenum Press, Second edition, 2011)
5. The Feynmam Lectures in Physics, Vol. 3, R.P. Feynman, R.B. Leighton, and M. Sands (Narosa Publishing House, 1992)
6. Practical Quantum Mechanics - Siegefried Flügge (Springer 1994)