Quantum Mechanics I

Programme: M.Sc. (Physics) Year: 1st Year Semester : 1st semester
Course : Core Credits : 4 Hours (LTP): 40+12+0

Course Context and Overview (100 words):
Quantum mechanics has become an indispensable ingredient in understanding physics of atomic and subatomic particles. Thus, it helps in getting a grasp on subjects such as atomic physics, nuclear physics and quantum optics. The course tries to give a flavor of the vast topic of quantum mechanics and hopefully motivate students in advancing themselves in further understanding of this subject.

Prerequisites Courses:
None

Course outcomes (COs):

On completion of this course, the students will have the ability to:	
CO1:	Apply principles of quantum mechanics to calculate observables on known wave functions.
CO2:	Solve time-dependent and time-independent Schrodinger equation for simple potentials.
CO3:	Learn quantization of angular momentum and spin and its application to Hydrogen Atom problem.
CO4:	Apply techniques like time-independent perturbation theory and WKB methods to solve problems related Atomic and Molecular problems.
CO5:	Apply the of knowledge of Quantum Mechanics to further study other topics in theoretical physics.

Course Topics:

Topics	**Lecture Hours**
UNIT 1: Basic principles of quantum mechanics	6

1. Probabilities and probability amplitudes	
2. Linear vector spaces. Bra and ket vectors.	
3. Completeness, orthonormality, basis sets, change of basis	
4. Eigenstates and eigenvalues	
5. Position and momentum representations	
6. Wavefunctions, probability densities, probability current	
7. Schrodinger equation	
8. Expectation values	
9. Generalized uncertainty relation.	
UNIT 2: One dimensional potential problems	2
1. Particle in a box	
2. Potential barriers.	
3. Tunnelling	
UNIT 3: Linear harmonic oscillator:	7
1. Wavefunction approach	
2. Operator approach	
UNIT 4: Motion in three dimensions	15
1. Schrodinger Equation in Spherical Polar coordinates	
2. Hydrogen Atom	
3. Angular Momentum	
4. Spin	
UNIT 5: Time-independent perturbation theory	5
1. Non-degenerate and degenerate cases. Examples: a) Zeeman Effect b) Stark Effect	
UNIT 6: Semiclassical approximation	5
1. The WKB method	

Textbook references (IEEE format):

Text Book:

1. D. Griffiths, *Introduction to Quantum Mechanics*. Pearson Education, 2005.

2. A. Ghatak and S. Lokanathan, *Quantum Mechanics: Theory and Applications, ser. Fundamental Theories of Physics*. Springer Netherlands, 2004, no. v. 1.
3. R. Shankar, *Principles of Quantum Mechanics*. Springer, 1994.
4. J. J. Sakurai, *Modern Quantum Mechanics*. Pearson Education, 2006.

Reference books:

1. R. Feynman, R. Leighton, and M. Sands, *The Feynman Lectures on Physics*, ser. The Feynman Lectures on Physics. Pearson/Addison-Wesley, 1963, no. v. 3.
2. E. Merzbacher, *Quantum Mechanics*. Wiley, 1998.
3. V. Thankappan, *Quantum Mechanics*. J. Wiley, 1993.
4. P. Mathews and K. Venkatesan, *A Textbook of Quantum Mechanics*. McGraw-Hill Book Company, 1978.