Centre for High Energy Physics
Faculty of Science
University of the Punjab, Lahore

Course Outline

Program	BSCP	**Course Code**	CPHY 332	**Credit Hours**	3
Course Title	**Quantum Mechanics I**				

Course Introduction

Quantum Mechanics is the part of modern physics that is essential for understanding microscopic processes involving atoms, molecules, subatomic particles, etc. This course teaches why the classical physics is insufficient for this purpose, but how its wave and particle concepts combine in a way to result in quantum mechanics. After introducing some further mathematical tools, the postulates of quantum are introduced and used for solving some one-dimensional problems. The course ends with introducing raising and lower operators for the simple harmonic oscillator and angular momentum.

Learning Outcomes

On the completion of the course, the students will:

1. Understand the fundament principles of Quantum Mechanics,
2. Be able to solve basic problems of quantum mechanics in 1D
3. Learn raising and lowering operator, and
4. Learn theory of angular momentum in quantum mechanics.

Course Content

Week 1	Visible effects of a moving ball, a bullet, light waves (and an electron).
	Wave equation, wave function, probability density and probability.
Week 2	Measurement of probability. Explaining brightness pattern by classical and quantum (i.e., probability) theory of light.
	Double slit electron beam experiment; a quantum particle in motion and in detection.
Week 3	Wavefunction collapse. Normalization and localization of a wavefunction
	A wave-packet. Fourier transform. Gaussian integral.
Week 4	The de Broglie relation and quantization in the Bohr model.
	The Heisenberg uncertainty principle.
Week 5	The group velocity and phase velocities of a wave packet.
	A wave-vector relating all wavefunctions. The Dirac notation.
Week 6	Orthonormal basis; the Dirac delta function.
	Operator and their representations.
Week 7	The momentum operator in position representation.

	The Hermitian operator, eigenvalues, and related theorems.
Week 8	Commuting operators and common eigenvectors.
	The parity operator. An even operator.
Week 9	Postulates of quantum mechanics.
	Schrodinger equations; stationary states.
Week 10	Expectation value; probability current.
	One dimensional systems: A free particle. A travelling wave.
Week 11	The potential step.
	The potential barrier. Tunneling.
Week 12	Alpha decay and tunneling.
	An infinite square well.
Week 13	Bound states and nodes.
	Ther harmonic oscillator.
Week 14	Raising and Lowering operators. SHO energies and wavefunctions.
	General angular momentum.
Week 15	The commuting set ($\hat{J}^2$and $\hat{J}_z$) and comm eigenvectors. The raising and lowering.
	Orbital angular momentum.
Week 16	Spherical harmonics. Spin angular momentum; the Stern-Gerlach experiment.
	The matrix representation of spin half. Pauli spin matrices.

Textbooks and Reading Material

1. Quantum Mechanics: Concepts and applications (2^{nd}edition), Zettili, *John Wiley & Sons* (2009).
2. Introduction to Quantum Mechanics, Griffiths, David J., *Pearson Education, New Delhi* (2014).
3. Introductory Quantum Mechanics (4^{th}edition), Liboff, Richard L., *Pearson Education, New Delhi* (2003).
4. A Text Book of Quantum Mechanics, Mathew, P. M. &Venketeson, K., *Tata McGraw Hill, New Delhi* (1991).
5. Quantum Mechanics, Gasiorowicz& Stephen, *John Wiley & Sons, New York* (1996).
6. Understanding Quantum Physics Vol. I & II, M. A Morison, *Prentice Hall Inc.* (1990).

Teaching Learning Strategies

The instructor is required to make use of Mathematica/Maple/Python to teach the concepts through visualization/antimutation and symbolic/numerical calculations. The students are required to solve a large portion of related exercises/questions/problems of the main textbooks.

Assignments: Types and Number with Calendar

At least two assignments and two quizzes. A course project may also be assigned.

Assessment

Sr. No.	Elements	Weightage	Details
1.	Midterm Assessment	35%	Written Assessment at the mid-point of the semester.
2.	Formative Assessment	25%	Continuous assessment includes: Classroom participation, assignments, presentations, viva voce, attitude and behavior, hands-on-activities, short tests, projects, practical, reflections, readings, quizzes etc.
3.	Final Assessment	40%	Written Examination at the end of the semester. It is mostly in the form of a test, but owing to the nature of the course the teacher may assess their students based on term paper, research proposal development, field work and report writing etc.