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

Program	BSCP	**Course Code**	CPHY 434	**Credit Hours**	3
Course Title	**Quantum Mechanics II**				

Course Introduction

This course extends the usage of the formalism of quantum mechanics to 3D problems, many-body applications, approximation methods and scattering theory.

Learning Outcomes

On the completion of the course, the students will:

1. Solving the central potential problems.
2. Study of system of identical particles.
3. Work in approximation methods in quantum mechanics.

Course Content

Week 1	The central potential; solution of stationary states in central potential.
	Reducing two body problem into one body. The radial Schrodinger equation.
Week 2	Hydrogen atom. Stationary states of hydrogen atom.
	Quantum numbers. Energies and state functions of the hydrogen atom.
Week 3	Shells and subshells in a hydrogen atom.
	Addition of angular momenta.
Week 4	Spin triplet and spin singlet combinations of two spin halves.
	Identical particles. Indistinguishability of identical particles.
Week 5	Systems of identical particles; symmetric and anti- symmetric states functions.
	The Pauli's exclusion principle.
Week 6	Approximation methods.
	Time independent perturbation theory, non-degenerate first order energy.
Week 7	First order perturbation to an eigenfunction and second order energy.
	The degenerate perturbation theory.
Week 8	Applications of time independent perturbation theory.
	The variational method.
Week 9	Approximate values for the energies of first few excited states.
	The WKB approximation-I.
Week 10	The WKB approximation-II.

	Time dependent perturbation theory-I.
Week 11	Time dependent perturbation theory-II.
	The transition probability, general formalism.
Week 12	Transition probability for constant perturbation.
	Scattering theory in quantum mechanics.
Week 13	Differential and total cross section.
	The lab and CM Cross sections.
Week 14	Scattering amplitude of spinless particles.
	The relation of scattering amplitude to differential cross section.
Week 15	The Born approximation.
	Validity of the first Born approximation.
Week 16	Partial wave analysis for elastic scattering.
	Partial wave analysis for inelastic scattering.

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.