UNIVERSITY OF PUERTO RICO
RIO PIEDRAS CAMPUS
COLLEGE OF NATURAL SCIENCES
DEPARTMENT OF PHYSICS
UNDERGRADUATE PROGRAM

Title: Elements of Quantum Mechanics

Code: PHYS 4046

Number of Credits: 3

Prerequisites: PHYS 3016, PHYS 4031, PHYS 4051, PHYS 4068

Description

This introductory course in Quantum Mechanics for Physics majors, with emphasis on the Schrodinger theory of Quantum Mechanics. Topics include Born's interpretation of the wave function, stationary solutions, properties of eigenfunctions and energy quantization. Solutions to simple time-independent problems such as: the step potential, the square well, the infinite well and the harmonic oscillator. Applications to hydrogen-like atoms, including the concepts of angular momentum and spin.

Objectives

After the completion of this course the student will be able to understand the basic concepts in quantum mechanics. During the semester the student: will understand the necessity of a new approach (different than classical mechanics) to describe microscopic systems, will learn about the statistical description of the microscopic systems and the new meaning of observations and measurements (as compared with deterministic classical mechanics), will develop a comprehensive understanding of the basic techniques used in quantum mechanics, will understand the key role of quantum mechanics in the areas of physics, chemistry, biology, materials science and electronics. and will develop the ability to solve the Schroedinger equation for simple systems and to apply the standard mathematical techniques used in quantum mechanics to describe microscopic systems.

Course Content

Topic	Assigned time (hours)
1. The quantization of electromagntic energy: black body radiation and photoelectric effect. The atomic spectra. The De Broglie theory.	3
2. Mathematical description of a wave packet. The Schroedinger equation.	3
3. The wave function. The probabilistic interpretation.	3

Probability current density.	
4. Operators and expectation values.	3
5. Time independent Schroedinger equation. Boundary conditions. The quantum box. Eigenfunctions and eigenvalues.	3
6. The potential step. Transmitted and reflected fluxes.	3
7. The potential well. The potential barrier. Tunneling.	3
8. The expansion postulate. Degenerancy. Delta function potentials.	3
9. The harmonic oscillator.	3
10. The complete set and the expantion theorem. Analogy with vector space. Commutation relations. Dirac Notation. Hermitian operators. Uncertainty relations.	3
11. Time dependence of the expectation values. The equation of motion and the classical limit.	3
12. The three dimensional box. The Fermi level. The central potentals. The angular equation.	3
13. Angular momentum. The radial equation.	3
14. The Hydrogen atom. Orbitals. The matrix representation. The spin operators and spinors.	3
15. Identical particles. The Pauli principle. The Slater determinant. Fermions and bosons.	3
Total hours	45 contact hours

Instructional Strategy

Lecture. Discussion with the students of typical problems. Description of actual applications of the results of the quantum mechanics problems. Homeworks.

Minimum Require Facilities

Traditional lecture room.

Student Evaluation

The course will be evaluation with three partial exams with a weight of 20% of the evaluation and the homeworks with a weight of 40% of the evaluation.

Grading System

The overall score is determined by calculating the percentage of points obtained by the student. Grades are then assigned according to the standard curve: 100-90% = A, 89-80% = B, 79-70% = C, 69-60% = D, 59-0% = F.

Bibliography

Quantum Physics. Stephen Gasiorowicz. 2nd edition, John Wiley & Sons (1996). The Structure of Matter. Stephen Gasiorowicz. Addison Wesley (1979). Introduction to Quantum Mechanics. David J. Griffiths. Prentice Hall (1994).

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