Physics 4046 - Introduction to Quantum Mechanics (Fonseca)

- Number of Credits: 3
- Prerequisites:
- Luis F Fonseca
- Office: FB 127
- University of Puerto Rico – Rio Piedras Campus
  Department of Physics

Text

- Introduction to Quantum Mechanics, David J Griffiths (Prentice Hall) 2nd edition (2005)

Bibliography

- Quantum Physics, Stephen Gasiorowicz
- Introductory Quantum Mechanics, Richard Liboff
- Quantum Physics of Atoms, Molecules, Solids, Nuclei, and Particles; Robert Eisberg and Robert Resnick

Minimum Required Facilities

- Traditional lecture room

Instructional Strategy

- Lectures

Student Evaluation

- Standard A to F grading system. Grading will depend on performance in periodic problem sets and three partial exams.
- Homeworks 25%
- Partial exams 25% each

Description

- This is an introductory course in Quantum Physics for Physics majors. This course initiates with the early experiments that motivated the development of QM and introduces the basic postulates and the mathematical approach. Fundamental problems in one and three dimensions with exact solutions are explained.

Topics included are: The wave nature of matter. The Schrodinger Equation. The wave function and the Copenhagen interpretation. Operators and expectation values. The eigenvalue equation. Solving the time independent Schrodinger equation for one-dimensional potentials. Three-dimensional central potentials. Angular momentum and the Hydrogen atom wave function. Matrix representation and the electron's spin.

Objectives

After the completion of this course the student will able to:

- develop a comprehensive understanding of the basic issues in quantum physics.
- find the Hamiltonian operator of simple quantum systems and solve the Schrodinger equation.
- determine the expectation values of typical physical parameters and the uncertainty in a measurement.
- solve scattering and quantum confinement problems.
- become familiar with the Dirac notation.
- find the wave function of the electron in an hydrogen atom.
- solve spin ½ problems and use the matrix representation of angular momentum.

Contents

- Introduction
  - The quantization of electromagnetic energy: black body radiation and the photoelectric effect.
  - The De Broglie theory.
- Wave packets
  - Mathematical description of a wave packet.
  - The Schrodinger equation.
- The wave function
  - The wave function.
  - The probabilistic interpretation.
- Operators and wave functions
  - Time independent Schrodinger equation.
  - Operators and expectation values.
  - Eigenfunctions and eigenvalues.
  - The expansion postulate.
  - Dirac notation.

    - Hilbert Space.
- One-dimensional potentials and scattering
    - Boundary conditions.
    - The quantum box.
    - The potential step.
    - Transmitted and reflected fluxes.
    - Probability current density.
    - The potential well.
    - The potential barrier.
    - Tunneling.
    - WKB approximation.
    - Degeneracy.
    - Delta function potentials.
    - The harmonic oscillator.
- The Uncertainty Principle
    - Commutation relations.
    - Uncertainty relations.
- Equation of motion
    - Time dependence of the expectation values.
    - The equation of motion and the classical limit.
- Three-dimensional potentials
    - The three dimensional box.
    - The Fermi level.
    - The central potentials.
    - The angular equation.
    - Angular momentum.
    - The matrix representation.
    - The radial equation of the hydrogen atom.
    - Orbitals.
- Spin
    - The spin operators and spinors.