Course Syllabus
Southeast Missouri State University

Department of Physics **Course No: PH473/PH505**
Title of Course: Quantum Mechanics **Revised: Spring 1999**

I. Catalog Description

The fundamental postulates of quantum mechanics and their application to selected systems. Topics include one-dimensional systems, perturbation theory, three-dimensional systems, angular momenta, one-electron atom, Hartree-Fock formalism, variational principles and quantum theory of scattering. Spring of odd years only. Prerequisites: PH231, MA245 (3)

II. Prerequisites

PH231 General Physics II
MA245 Vector Calculus

III. Objectives of the Course

A. Develop and understanding of the postulates of quantum mechanics and its applications to selected systems.

B. Develop and understanding of the results of quantum theory when applied to selected one-dimensional systems.

C. Develop and understanding of related topics such as perturbation theory, variational principles and the formalism of scattering theory.

IV. Expectation of Students

A. All students
   1. Attend class regularly, participate in class discussions, work the assigned problems.
   2. Demonstrate the ability to solve selected problems related to the applications of quantum theory.
   3. Demonstrate the ability to interpret the solutions resulting from the applications of quantum theory as well as meet standards of performance in various exams.

B. Graduate Students - Demonstrate research ability by submitting an original term project related to Quantum Mechanics. The project will involve (1) computer programming (2) use of selected periodicals in the field of Quantum Mechanics (3) technical writing. The completed project report will be due one week before the final exam.

V. Course Outline (Hours)

PART I: THEORY

A. THE WAVE FUNCTION (6)
   1. The Schrodinger Equation
   2. The Statistical Interpretation
   3. Probability in Quantum Theory
   4. Normalization
   5. The Uncertainty Principle

B. THE TIME-INDEPENDENT SCHRODINGER EQUATION (6)
   1. Stationary States
   2. The Infinite Square Well
   3. The Harmonic Oscillator
   4. The Free Particle
   5. The Delta Function Potential
   6. The Finite Square Well
   7. The Scattering Matrix

C. Test 1 (1)

D. FORMALISM OF QUANTUM MECHANICS (4)
   1. Linear Algebra
   2. Function Spaces
   3. The Generalized Statistical Interpretation
   4. The Uncertainty Principle

E. QUANTUM MECHANICS IN THREE DIMENSIONS (6)
   1. Schrodinger Equation in Three Dimensions
   2. The Hydrogen Atom
   3. Angular Momentum Operator
   4. Spin and Angular Momentum Eigenfunctions
   5. Clebsch-Gordon Coefficients

F. IDENTICAL PARTICLES (4)
   1. Two-Particle Systems
   2. Atoms
   3. Solids
   4. Quantum Statistical Mechanics
   5. Fermi Dirac Statistics
   6. Bose-Einstein Statistics
   7. Slater Determinants
   8. Hartree-Fock Formalism
   9. Self-consistent Field Theory

G. Test 2 (1)

PART II: APPLICATIONS OF QUANTUM MECHANICS

H. TIME-INDEPENDENT PERTURBATION THEORY (4)
   1. Nondegenerate Perturbation Theory
   2. Degenerate Perturbation Theory
   3. The Fine Structure of Hydrogen Atom
   4. The Zeeman Effect
   5. Hyperfine Splitting

I. THE VARIATIONAL PRINCIPLE (3)
   1. General Theory of Variational Principle
   2. The Ground State of Helium
   3. The Hydrogen Molecule Ion

J. THE WKB APPROXIMATION (3)
   1. Region of Application
   2. Phenomenon of Tunneling
   3. Limitations of WKB Approximation

K. Test 3 (1)

L. TIME-DEPENDENT PERTURBATION THEORY (2)
   1. Two-Level Systems
   2. Emission and Absorption of Radiation
   3. Spontaneous Emission of Radiation

M. QUANTUM THEORY OF SCATTERING (4)
   1. Introduction
   2. Partial Wave Analysis
   3. The Born Approximation
   4. The R-Matrix Theory
   5. Numerical Algorithms in Quantum Scattering

Total Hours: 45

VI. Textbook

Introduction to Quantum Mechanics by David J. Griffiths, Prentice Hall, 1995.

VII. Basis for Student Evaluation

A. Undergraduate Students
   1. Exams - 180 points
   2. Homework - 60 points
   3. Final exam - 60 points
   Total: 300 points

B. Graduate Students
   1. Three 1-hour exams - 90 points
   2. Final exam - 80 points

3. Homework - 80 points
4. Term project - 50 points

Total: 300 points