Embry-Riddle Aeronautical University
Prescott Campus

Course	**EP455**	**Quantum Physics (Spring 2008)**	**3 credit hours**
	Bldg. 55B	**M W F 1:50-2:50 PM**	

Instructor **Dr. Darrel Smith**
Office Hours See my website: **http://physicsx.pr.erau.edu/**

Office Building AC1 Room 253
Phone 777-6663

Course Description

The Schrodinger equation in 1 and 3 dimensions and its solutions for step potentials, the harmonic oscillator, and the hydrogen atom. Operators and their matrix representations: Dirac bracket formalism, angular momentum and spin, spin-orbit interaction. Identical particles and exchange symmetries. Time independent and time dependent perturbation theory and approximation methods: transition rates; Fermi's Rule, Scattering Theory. Classical and quantum statistical distributions. Prerequisite: EP 440 or instructor consent.

Goals

This course is a required course for students in Space Physics. It may be used by other programs as an elective. Its purpose is to provide a more mathematically sophisticated, senior-level treatment of the fundamental principles of quantum mechanics that will:

1) provide the student with an adequate background for understanding and applying many modern technologies and devices (spectroscopes, lasers, solid-state electronics, superconducting devices, etc.) that rely on quantum principles in their design and operations,

2) expose the student to physical application of important mathematical techniques and approximation methods
3) provide an adequate transition between the more descriptive introduction to modern physics in the PS303 course, and more advanced work (possibly at the graduate level).

Textbook **Introduction to Quantum Mechanics (Second Edition)**, by David J. Griffiths, Pearson-Prentice Hall, ISBN 0-13-111892-7.

Required Materials **A scientific calculator and table of integrals (or Mathematica or Maple).**
Attendance "Regular attendance and punctuality, in accordance with the published class schedule, are expected at all times in all courses." . . . . ***Don't miss class !!***

Course Outline

Chapter 1 The Wave Function
Chapter 2 Time-Independent Schrodinger Eqation

1st Exam (20%)

Chapter 3 Formalism
Chapter 4 Quantum Mechanics in Three Dimensions

2nd Exam (20%)

Chapter 5	Identical Particles
Chapter 6	Time-Independent Perturbation Theory
Chapter 8	The WKB Approximation*
Chapter 9	Time-Dependent Perturbation Theory*

*Time permitting

April 23, 2008 Last Day of Classes

April 30, 2008 8:00 – 10:00 AM Final Exam Held in Room 55B

Homework (30%)

Homework Summary – Each homework assignment is worth 10 points. Five points will be awarded to homework papers where a reasonable effort has been made to solve the problems. One or more problems will be graded for an additional five points for a total of 10 points. Students are encouraged to expand their practical knowledge of physics and improve their problem-solving skills by working more than just the assigned problems. One point is taken off every day homework is late. **See my website** http://physicsx.pr.erau.edu/ **for a current list of homework problems.**

Final Exam (30%) ***Comprehensive*** ***The date of the final is on my website***

Grading	**Weight**		
Homework	30%		A = 90 - 100%
Exams	20% each	(2 exams = 40%)	B = 80 - 90%
Final	30%		C = 70 - 80%
			D = 60 - 70%

The best way to prepare for the exams is to understand how to solve the homework problems. You are responsible for understanding the solutions to homework problems as well as the material presented in class.

<u>**Learning Outcomes**</u>:

1. Solve Schrodinger's equation for simple one dimensional systems involving wells and/or barriers and compute expectation values.
2. Understand the derivation of the solution of Schrodinger's equation for the simple harmonic oscillator, both by standard techniques of differential equations and by the operator formalism.
3. Know the four basic postulates of quantum mechanics, and understand the mathematical structure of the theory: linear vector spaces and operators, matrix representation of the operators, the Schmidt orthogonalization procedure, Dirac Bra-ket formalism.
4. Set up the Schrodinger equation in three dimensions in both cartesian and spherical coordinates, and solve it in certain specific cases, such as a particle in a three-dimensional box and hydrogen-like atoms.
5. Recognize the angular momentum operators, and be able to derive their eigenfunctions, and eigenvalues.
6. Know the experimental results leading to the postulate of spin angular momentum, and understand spin angular momentum operators, their eigenfunctions, and eigenvalues.
7. Add different angular momenta, and understand L-S and J-J coupling and the use of Clebsch-Gordon coefficients.

8. Understand the exchange symmetries for bosons and fermions, the Pauli exclusion principle, and how degeneracy rules and the Pauli principle relate to chemical properties and the ordering of the Periodic Table of elements.
9. Solve Schrodinger's equation approximately using Time-Independent Perturbation theory, computing first order corrections to both eigenfunctions and eigenvalues in the presence of a small perturbation.

10. Use Variation Theory or the WKB approximation to obtain approximate solutions of the Schrodinger Equation in simple cases.

11. Solve time-dependent problems using Fermi's Golden Rule.

12. Understand the elements of scattering theory, and compute scattering amplitudes in the Born approximation.

13. Use partition functions to obtain the Planck, Bose-Einstein, Fermi-Dirac, and Maxwell-Boltzman distributions, and to compute thermodynamic quantities.

14. Perform calculations using one or more of the following methods: Hartree-Fock method of the self-consistent field; the Thomas-Fermi statistical method for multi-electron atoms; use of propagators in scattering theory; sudden perturbations.