PHY-5606, Quantum Mechanics-I

Fall 2002

Dr. Aniket Bhattacharya

Textbook: R. Shankar, *Principles of Quantum Mechanics*, 2nd ed.

Recommended supplementary textbook: G. Baym, *Lectures on Quantum Mechanics*

Office: MAP 429
Office Hours: M-W 10:30-12:00
or by appointment

Phone: 823-5206
email: *aniket@physics.ucf.edu*
Web : www.physics.ucf.edu/ aniket

This is the first half of the graduate quantum mechanics course. I will spend one or two lectures (i) to find out your background and (ii) review briefly the early developments of quantum theory. Then I will try to cover the topics as furnished in the *course outline* below. In this course we will be talking about non-relativistic quantum mechanics only. Selected topics from relativistic quantum mechanics will be covered in Quantum Mechanics-II (PHY-6624) which will be offered in Spring 2002.

Homework: Homeworks will be an indispensable part of going on with and doing well in the course. Almost every week I will assign homework which will be graded. Nothing could be better than if you get together in small groups and initiate pertinent discussions. You are also welcome to drop by my office for discussions and communicate through *e-mail*. But I urge that you do the homeworks yourselves.

Tests: There will be two **midterms** (in class and closed books/notes) and a **comprehensive** Final.

Grade: Your final grade will be determined by your overall performance weighted in the following manner:

Homework - 40%, Midterm I - 15%, Midterm II - 15%, Final - 30%

I will adopt +/- grading policy. Grades **A** and **B** within themselves will have three categories, namely **A-**, **A**, **A+**, and **B-**, **B**, **B+** respectively.

References : I strongly urge that you look at other useful books listed below:

Modern Quantum Mechanics, J. J. Sakurai
Quantum Mechanics, Landau & Lifshitz
Principles of Quantum Mechanics, P. A. M. Dirac
Quantum Mechanics, E. Merzbacher
Lectures on Physics, Vol-III, R. P. Feynman
Quantum Mechanics, Zettili

I will not strictly follow the text book, nor the sequence in which the topics are presented. Therefore I recommend that you try to attend all of my lectures in order to perform better in this course. But the topics that I will cover are all contained in the text book.

Course Outline:

- Photon Polarization, Stern-Gerlach Experiment,
- Concept of probability amplitude, linear Superposition, complex vectors, Hilbert space, Dirac's bra and ket vectors, postulates of Quantum Mechanics, operators and their representation, Hermitian and Unitary operators.
- Algebra of bra and ket vectors, matrix representation of the operators, eigenvalue problems, representation of rotation matrices.

- Heisenberg's uncertainty principle; derivation and order of magnitude estimates.
- Non-commutivity of operators in Quantum Mechanics, Commutator algebra.
- Spin; representation through Pauli spin matrices, algebra of spin matrices.
- Schrödinger equation, time evolution and Unitary operators, time evolution of eigenkets, construction of time dependent state vectors, propagator.
- One dimensional problems, bound states: examples: (i) infinite and finite square well potential well (ii) harmonic oscillator in energy representation, creation and annihilation operators (iii) harmonic oscillator in co-ordinate representation, Hermite polynomials.
- symmetries & parity.
- One dimensional scattering from finite potential step, tunneling.
- Heisenberg versus Schrödinger representation; spin dynamics.
- Bohr's correspondence principle, Ehrenfest's theorem and concept of probability current.
- Two and three dimensional bound states: Angular momentum and effective potential; representation of angular momentum in co-ordinate bases, general methods of solving radial part of the Schrödinger's equation, Laguerre polynomials, two and three dimensional harmonic oscillators.
- The Hydrogen atom; energy eigenvalues and eigenfunctions.
- Dynamical symmetries and accidental degeneracies, Runge-Lenz vector, solution of the hydrogen atom problem exploiting dynamical symmetry ideas.
- Non-degenerate and degenerate stationary perturbation theory; examples, Stark and Zeeman effects, wave functions and energy eigenvalues in a periodic potential.

Most of the topics are covered in Chapters 1-7,9, 11, 13, 14, 17 in Shankar's book. Depending upon our pace and general interests, I may include some special topics. Your suggestion is very much welcome ! As we go along with the course your constant feed back will definitely be very helpful. Please feel free to drop by my office.