PHYS 771 – Quantum Mechanics I, Fall 2011

Syllabus

Prerequisites: PHYS 471 or equivalent.

Catalog description: This is the first course of a two-semester sequence in quantum physics. Topics include the Schrodinger equation and its solutions, matrix mechanics, operator methods, the harmonic oscillator, the hydrogen atom, spin and angular momentum.

Textbook: *Quantum Mechanics*, Third Edition, by Eugen Merzbacher, John Wiley and Sons (1998).

Reference books: *Quantum Mechanics*, by Albert Messiah, North Holland (1961)
Quantum Mechanics, Third Edition, by Leonard I. Schiff, McGraw-Hill (1968)
Quantum Mechanics, *Nonrelativistic Theory*, by L. D. Landau and E. M. Lifshitz
Quantum Mechanics, by C. Cohen-Tannoudji, B. Diu, and F. Laloe

Class Time and Location: M, W 11:30 - 1:00 PM; CB 106
Course Instructor: Dr. A.G. Petukhov
Office: 223 EEP
Office Hours: M, W 3:00-4:30 PM or by appointment
Phone: 394-2364;
E-mail: Andre.Petukhov@sdsmt.edu
Course website: http://odessa.phy.sdsmt.edu/~andre/PHYS771

Note: Students with special needs or requiring special accommodations should contact the instructor, Dr. A.G. Petukhov, at 394-2364 and/or the campus ADA coordinator, Julie McCoy, at 394-1924 at the **earliest** opportunity.

The grades will be based on homework assignments, a midterm exam and a final exam. The homework assignments must be submitted electronically to Ms. Erin Handberg: erin.handberg@gmail.com

Grade structure

Homework	40 %	A	> 90 %
Midterm Exam	25 %	B	90% - 80 %
Final Exam	35 %	C	80% - 70%
		D	70% - 60%
		F	<50%

Tentative Lecture Topics

Introduction. Historic remarks. Beginnings of quantum physics. "Old" quantum mechanics. Relation to classical mechanics and electrodynamics.

Development of the wave mechanics and the Schrödinger equation. De Broglie hypothesis. Wave packets, group velocity. Wave equation for a free particle. Time-dependent Schrödinger equation. Time-independent Schrödinger equation – stationary states.

The Schrödinger equation and the wave function. Interpretation of $\Psi(\mathbf{r},t)$ and quantum measurements. Continuity equation. Momentum representation. Uncertainty principle. Operators and the expectation values. Dynamics of the expectation values.

The formalism of quantum mechanics. Hermitian operators. Eigenvalues and eigenfunctions. Superposition, completeness and closure. Unittary operators. Vector spaces and inner products. Change of basis. Hilbert space and coordinate representation.

The linear harmonic oscillator. Eigenvalues and eigenfunctions. The motion of wave packets.

Problems in one dimension. The potential step. The rectangular potential barrier. The square well.

The WKB approximation. The method.The connection formulas. Application to bound states. Transmission through a barrier.

Elements of matrix mechanics. The eigenvalue problem for normal operators. The calculation of eigenvalues and the construction of eigenvectors. Commuting observables and simultaneous measurements. The Heisenberg uncertainty relations. The harmonic oscillator revisited.

Angular momentum in quantum mechanics. Orbital angular momentum. Algebraic approach. Eigenvalues for L_z and $\mathbf{L}^2$. Spherical harmonics. Angular momentum and kinetic energy.

Spherically symmetric potentials. Separation of variables for the central-force problem. The free particle and the spherical square well potential. The radial equation and the boundary conditions. The Coulomb potential.