Course: Quantum One (the first of this two semester graduate sequence).

Instructor: Prof. Paul E. Parris
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E-mail questions and requests for appointments are encouraged.

Lectures: Live: 9:30-10:45 Tuesday & Thursday, Room 127, MS&T Physics.
Online: Video lectures will also be provided by the instructor at http://web.mst.edu/~parris/QuantumOne/

Main Text: Class notes/main text will be provided by the instructor, available as Acrobat (.pdf) files on the course website, and provided to enrolled students by e-mail.

Recommended Text: Quantum Mechanics, Messiah - an inexpensive Dover edition of an excellent quantum mechanics text available from the bookstore.

Additional Texts: The quantum mechanics texts by the following authors may also prove useful as supplementary sources: Cohen-Tannoudji, Diu & Laloe; Dirac, Messiah, Merzbacher, Schiff.

Homework: Weekly homework assignments will be given, collected, and graded. Your performance on these constitutes half of your course grade. Each graded problem will be worth 10 points.

A total of 400 points that may be earned from the homework. More than 400 points of (i.e. more than 40) homework problems will be assigned. This allows you to miss a few problems without penalty.

In working the homework problems, general discussion among colleagues is allowed and encouraged, particularly when it involves basic concepts the homework problems are designed to explore. It is expected, however, that solutions you hand in will primarily represent your effort and thinking on a problem, and not that of a group. In any work you perform as a graduate student you are expected to document any reference materials of which you make direct use.

Deadlines: Homework Assignments are due each Tuesday. Solutions will be posted on the web Wednesday morning. Any papers not received by the time the solutions are posted will not be graded for course credit. Infrequent requests for extension will be generally granted if they are delivered via e-mail by mid-day on the Monday before a given assignment is due.

Tests: There will be 2 tests given during the semester, each worth 133 points. A comprehensive final exam (Test III) will be given, worth 134 points.

Test I will be given the week of February 21.
Test II will be given the week of March 28.
Test III will be given on campus on May 8 from 10:00am – 12:00pm.

The final exam (Test III) for online students will be given during exam week at a time scheduled during the last two weeks of class.
Grade: Course grade will be based upon overall performance measured by the total number of points earned on the homework (400), and tests (400), expressed as a percentage of the total number of points (800) available to be earned. The relation between performance and grade will then be, at minimum, the standard one: A > 90% > B > 80% > C > 70%. These lines may be revised upward (i.e., to the student’s benefit) depending upon the judgment of the instructor, but will not be revised downward.

An Ambitious List of Topics to be Covered:

I. Introduction
   - What is Quantum Mechanics?
   - Postulates of Mechanics
   - Postulates of Schrödinger Wave Mechanics
   - Conservative Systems
   - Orthonormal Functions
   - Free Particles & Fourier Transforms

II. The Formalism of Quantum Mechanics
   - Specification of State, Linear Vector Spaces
   - Bases, Discrete and Continuous
   - The Inner Product, Representations
   - Observables
   - Operators, Multiplicative, Differential, Outer Products
   - Projection Operators, Completeness
   - Matrix Elements, Hermitian Conjugation
   - Hermitian, Anti-Hermitian, Unitary Operators
   - Matrices, Commutation Relations
   - Eigenvalues and Eigenvectors
   - Common Eigenstates of Commuting Observables
   - Measurement, Probabilities, Densities, Mean Values
   - Uncertainty, Uncertainty Principle, CSCO’s
   - Evolution of the State Vector (Schro”dinger Equation)
   - Eherenfest’s Theorem, Evolution of Mean Values
   - Conservative Systems, The Evolution Operator

III. The Harmonic Oscillator
   - Algebraic Approach to the Harmonic Oscillator
   - Spectrum and Eigenstates of the Number Operator
   - The Energy Representation
   - Time Evolution of the Quantum Harmonic Oscillator
   - Coherent States

IV. Many Particle Systems
   - Direct Product of Linear Vector Spaces
   - State Space of Many Particle Systems
   - Evolution of Many Particle Systems
   - Identical Particles - Symmetric & Antisymmetric Subspaces
   - Fermions & Bosons
   - Number Operators and Occupation Number States
   - Observables, Fock Space
   - Field Operators & Second Quantization