

# Syllabus: PHYS 152A, Winter 2008

## “Exploring quantum physics with Mathematica”

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**Prerequisites:** Linear Algebra, Modern Physics.

**Textbooks:** David Griffiths “Introduction to quantum mechanics”;  
Richard Liboff “Introductory quantum mechanics”;  
Preskill’s lecture notes on quantum computation  
<http://www.theory.caltech.edu/~preskill/ph219/>

### Tentative list of topics

- Introduction to Mathematica. Plotting functions. Lists and matrices. Linear algebra with Mathematica. Solving ODEs. Internal structure of an object. Manipulating parts of an object.
- Random numbers and stochastic processes. Averages and correlations. Simulation of Brownian dynamics.
- Schrödinger equation in matrix form. Time-dependent vs. stationary. Observables, operators, and matrices. Eigenvalues & eigenfunctions of a Hermitian matrix; orthogonality theorem. Matrix exponent. Unitary transformations and representations. Simulate dynamics of a few-state quantum system.
- Harmonic oscillator. Coordinate representation, number occupation representation. Force. Dynamics of a forced harmonic oscillator.
- Single-spin dynamics. Two-level systems. Pauli matrices, commutation relations. Observables. Spin precession, Rabi oscillations.
- Density matrix. Vector representation of the density-matrix evolution for a two-level system. Averaging over classical noise. Fidelity. Refocusing in nuclear magnetic resonance.

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