Topics for PHYS 3701 Introduction to Quantum Mechanics
Spring 2019

Textbook sections from Quantum Mechanics, 6e, Rae and Napolitano

- **The Schrödinger Wave Equation (in Three Spatial Dimensions)**
  - Matter waves: From Planck to Einstein to deBroglie (Chapter 4)
  - The nonrelativistic free particle plane wave and its differential equation (5.1, 6.1)
  - Including the potential energy: Schrödinger's wave equation (5.1, 6.1)
  - The continuity equation w/example from Maxwell's Equations (2.3)
  - The probabilistic interpretation of the wave function (7.1, 12.2)
  - Stationary states and the time-independent Schrödinger equation (7.6)
- **Solutions to the Schrödinger Equation in One Dimension**
  - The "particle in a box": Infinite walls or periodic boundary conditions (5.3. 5.4)
  - The particle in a box with finite walls (5.5)
  - Free particles encountering steps, wells, and barriers (5.6, 12.1)
  - The simple harmonic oscillator (5.7)
  - Periodic potentials: The Kronig-Penney problem and energy bands
- **Solutions to the Schrödinger Equation in Three Dimensions**
  - The "particle in a box": Density of states for a free particle (6.2)
  - The "cylindrical box": Bessel functions
  - The isotropic simple harmonic oscillator in Cartesian coordinates (6.2)
  - Spherical symmetry, angular momentum, and spherical harmonics (6.3)
  - The free particle in spherical coordinates: Spherical Bessel functions (6.3)
  - The isotropic simple harmonic oscillator in spherical coordinates
  - One-electron atoms: Energy eigenvalues and wave functions (6.4)
- **The Fundamental Postulates of Quantum Mechanics**
  - Momentum and position operators, commutation, and the Hamiltonian (7.2, 7.4)
  - Dirac notation; Eigenstates of position, momentum, and energy (9.4)
  - Measurement observables and expectation values (7.3)
  - The simple harmonic oscillator solved with operator algebra (7.8)

- **Angular Momentum**
  - Angular momentum operators and their commutation relations (8.1)
  - Spherical harmonics as angular momentum eigenfunctions (8.2)
  - Derivation of the formal eigenstates of angular momentum (8.4)
  - The Stern-Gerlach experiment, spin-1/2, spinors, and the Pauli matrices (8.3, 9.3)
  - Spin precession (11.1)
  - The "addition" of orbital and spin angular momenta (9.6)
- **Stationary Perturbation Theory**
  - The perturbation expansion for the non-degenerate case (10.1)
  - Simple examples (10.1)
  - Degenerate perturbation theory (10.2)
  - Simple examples, including the linear Stark effect (10.2)
  - The spin-orbit interaction (9.5)
  - The Zeeman effect (9.5)
  - The variational principle (10.3)
- **Time-dependent Hamiltonians and Perturbations**
  - Spin resonance phenomena (11.1, 11.3)
  - The sudden approximation (11.2)
  - Time-dependent perturbation theory (11.3)
  - Fermi's Golden Rule (11.4)
- **Scattering Theory**
  - Formulation of the problem; The scattering Green's function (12.1)
  - The definition of the cross section (12.2)
  - Born approximation (12.3)
  - Example: Square well and Yukawa/Coulomb potentials (12.3)
  - The method of partial waves, and application to scattering resonances (12.4)