I. REVIEW OF NON-RELATIVISTIC QUANTUM MECHANICS
   A. Review of the harmonic oscillator
   B. The square well in three dimensions
   C. Bound states
      1. Continuum states
      2. Resonances
   D. Quantum theory of angular momentum
   E. Approximation methods
      1. Time-independent perturbation theory
      2. Variational methods
      3. WKB and semiclassical methods

II. ATOMS AND IONS
   A. One-electron species
   B. Dirac’s equation
      1. Solutions for a radial potential
      2. Solutions for the hydrogen atom
   C. Non-relativistic approximation
      1. One-electron species
      2. Many-electron species
   D. Many-electron systems
      1. Pauli principle and Slater determinants
      2. Matrix elements with Slater determinants
   E. Atomic shell structure and independent particle models
      1. Classification of atomic levels
      2. Hund’s rules
      3. Hartree-Fock theory
      4. Thomas-Fermi Model and Density Functional Theory

III. ELECTROMAGNETIC TRANSITIONS AND PHOTONS
   A. Photons
B. Emission and absorption of photons

IV. ATOMIC SPECTRA
   A. The quantum defect
   B. Coupled channels and resonances

V. ATOMIC SCATTERING

VI. TIME-DEPENDENT PROCESSES
   A. Electromagnetic fields
   B. Ion-atom collisions

Note on text: There may be used versions of editions 1 and 2 available. These are also acceptable, however the first edition lacks answers to the problems.

Course organization:
There will be a weekly homework assignment, with homework collected on Monday of
each week. The homework will be graded and returned the same week. Homework will count 30% towards the final grade. A midterm exam at a date suitable for the class will be given. It will also count 30% towards the final grade. A final exam will count 40% towards the course grade.