Quantum Mechanics I

Prerequisites: Introductory course in QM with exposure to 1D Schrodinger equation. Total of 30 lectures (90 minute lectures), additional lectures/tutorials if needed.

- Revision: **(2 lectures)**
  - Schrodinger equation, 1 D problems, square wells/barriers, tunneling
- Formal structure of QM **(6 lectures)**
  - Vector spaces, operators, observables,eigenfunctions of Hermitian operators, discrete and continuous spectra
  - Statistical interpretation, Uncertainty principle, Dirac notation
  - Introduction to density matrix
- Harmonic Oscillator **(6 lectures)**
  - Schrodinger equation approach, Energy quantization, Hermite polynomial, eigenfunctions, Quick intro to numerical method to finding energy eigenvalues (shooting method) (3 lectures)
  - Operator approach using raising and lowering operators, ground state wave function and recursive approach to get higher levels, Coherent states in harmonic oscillator (3 lectures)
- QM in 3D **(6 lectures)**
  - Schrodinger equation in spherical coordinates, separation of variables, angular equation, radial equation, quantum numbers
  - Hydrogen atom
  - Angular Momentum, ladder operators, eigenvalues, eigenfunctions
  - Spin, spin (Pauli matrices), introduction to addition of angular momentum
- Symmetries in QM **(2 lectures)**
  - Discrete symmetries, Parity or space inversion
  - Lattice translation as a discrete symmetry, Blochs theorem
- Time Independent Perturbation Theory **(6 lectures)**
  - Non-degenerate perturbation theory, first and second order
  - Degenerate Perturbation Theory
  - Fine structure of Hydrogen Atom, Zeeman Effect
  - Example: Weakly Anharmonic Oscillator (if time permits)
- Special topics **(2 lectures)**
  - Variational Method, Ground State Energy of Helium
  - The WKB approximation

Suggested reference texts

- David J Griffiths : Introduction to Quantum Mechanics
- JJ Sakurai : Modern Quantum Mechanics