

Syllabus

1. Brief review of some key experiments and concepts leading to quantum mechanics
 - 1.1 Spectral distribution of blackbody radiation and Planck's quantization of energy exchange between matter and radiation
 - 1.2 Photoelectric effect and Einstein's photon theory of light
 - 1.3 de Broglie's hypothesis of matter waves and Davisson-Germer's observation of electron diffraction by crystal lattice
2. The wave function
 - 2.1 Plausibility argument leading to Schrödinger's wave equation
 - 2.2 The statistical interpretation
 - 2.3 Normalization
 - 2.4 Momentum

3. The time-independent Schrödinger equation

3.1 Stationary states

3.2 The infinite square well

3.3 The harmonic oscillator

3.4 The finite square well

3.5 The harmonic oscillator

3.6 The free particle and wave packets

3.7 δ -function potentials

4. Some formalism

4.1 Hilbert space

4.2 Observables

4.3 Adjoint and Hermitian operators

4.4 Eigenfunctions of a Hermitian operator

4.5 Generalized statistical interpretation

4.6 The uncertainty principle

4.7 The energy-time uncertainty principle

4.8 Dirac notation

5. Quantum mechanics in 3-dimensions
 - 5.1 The hydrogen atom
 - 5.2 Angular momentum
 - 5.3 Spin angular momentum
 - 5.4 Addition of angular momenta
6. Many-particle systems
 - 6.1 Wave functions for system of identical particles
 - 6.2 Interacting particles and the mean field concept
 - 6.3 The variational method and the Hartree-Fock equations
7. Time-independent perturbation theory
 - 7.1 Rayleigh-Schrödinger perturbation theory for non-degenerate and degenerate levels
 - 7.2 Molecular properties and perturbation expansions

- 8. Time-dependent perturbation theory**
 - 8.1 Coupled equations for n-level systems**
 - 8.2 Two-level systems and Rabi solutions**
 - 8.3 Perturbation approximation for n-level systems**
 - 8.4 Harmonic perturbations**
 - 8.5 Fermi's Golden Rule**

- 9. Scattering**
 - 9.1 Boundary conditions and scattering amplitudes**
 - 9.2 The Green's function and the Lippmann-Schwinger equation**
 - 9.3 The Born approximation**
 - 9.4 Partial wave analysis and phase shifts**