

Classical mechanics: principal of least action; lagrangean mechanics, symmetries and conservation laws; hamiltonian mechanics, Poisson brackets and canonical transformations;

Mathematical scaffolding for quantum mechanics: linear vector spaces, Dirac notation, linear operators; hermitian operators; eigenvalue problems and functions of operators; spaces of infinite dimension; self-adjoint operators; the Dirac delta function and Fourier transforms;

Wave mechanics: the time-dependent Schrödinger equation; probability densities and currents;

The postulates of quantum mechanics: the postulates and their meaning; state vectors and operators; the time-evolution of quantum systems and the Schrödinger equation; the Heisenberg picture; complete sets of compatible observables; uncertainty relations; introduction to Feynman path integrals; density matrices;

One-dimensional problems: particles free, in boxes, and near steps; delta function potentials; bound states; periodic potentials, tunnelling;

The simple harmonic oscillator: raising and lowering operators; the eigenvalue spectrum; coordinate space representation; normal modes of oscillation;

Symmetries and conservation laws: discrete and continuous symmetries; parity; translational invariance in space and time; rotational invariance in space; Lie groups, Lie algebras, and structure constants;

Orbital angular momentum and rotations: commutation relations for angular momentum; the orbital angular momentum eigenproblem; spherical harmonics; central forces, and the hydrogen atom;

Steady state approximation methods: non-degenerate perturbation theory; degenerate perturbation theory; the Rayleigh-Ritz variational method;

Scattering theory: scattering amplitudes and cross-sections; the Born approximation and its validity; bound states and resonances.

- Please ensure that you have looked through this *Handout* before the second meeting of the class so that you can let me know if there are any *major* areas about which you feel unsure.
- Please also consider (re)reading the following: *Baym* (Chap. 3, pp. 46-69; Chap. 5, pp. 134-145; Chap. 6, pp. 148-167); and *Shankar* (Chap. 4, pp. 115-150).