Quantum Mechanics: Course Summary

The course will comprise 14 lectures:

1. Classical mechanics: the basics of Lagrangian and Hamiltonian formalisms, continuous symmetries and conserved quantities, general continuous transformations, Hamilton-Jacobi eq.,
2. Quantum states: the principle of superposition and the ket/bra vectors, geometry of the space of states,
3. Dynamical variables: linear operators and their adjoints, eigenvalues and eigenstates, the general physical interpretation, compatible measurements, spectral theorem for self-adjoint operators with a finite number of eigenvalues,
4. Representations: Dirac's delta function, basic kets and bras, resolution of unity, wave functions and matrix operators, transformation functions and their physical interpretation,
5. Quantization: quantum Poisson Bracket, Schrödinger's and momentum representations, the uncertainty principle, displacement operators and unitary transformations,
6. Equations of motion: Schrödinger's and Heisenberg's forms of equations of motion, stationary states, free particles, motion of wave packets, density operators and their motion,
7. Harmonic oscillator: eigenvalue problem, lowering and raising operators, Schrödinger's and momentum representations,
8. Angular momentum: rotation operator, eigenvalue problem, the spherical representation of the eigenstates, systems with two angular momenta, spin of the electron,
9. Motion in a central field of motion: application to hydrogen atom,
10. Perturbation theory: stationary and time-dependent methods,
11. Atoms and radiation: transition probabilities and selection rules,
12. Collision problems: computation of the scattering coefficient,
13. Assembly of bosons: symmetrical and anti-symmetrical states, connection btw bosons and oscillators, transition probabilities, application to photons,
14. Atoms and photons: quantization of the Maxwell field in the Coulomb gauge; the emission, absorption and scattering coefficients.

The course will be based on Paul Dirac's "The Principles of Quantum Mechanics" (4th edition). There will be an optional written testout exam in the first weeks of the course. The final exam will be a combination of problem-solving exam (students will work on the handed problems at home) and oral exam (85% + homeworks: 15%).