Quantum mechanics
Themes of the complex exam

1. The postulates of quantum mechanics, pure and mixed states, density operator, the measurement problem, Bell inequalities

2. Measurements, expectation value, variance, standard deviation, Heisenberg inequality, intelligent states.

3. Representations, evolution operator, Schrödinger and Heisenberg picture

4. Time evolution of the quantum system, constants of motion, Ehrenfest's theorem

5. The harmonic oscillator, stationary states, coherent and squeezed states

6. Angular momentumin quantum mechanics

7. Hydrogen atom as a Coulomb problem, spectrum and the corrections

8. Stern-Gerlach experiment, spin, Pauli equation

9. Symmetries and conservation laws in quantum mechanics

10. Stationary perturbation theory, with some simple applications (e.g. Stark effect of the H atom)

11. Interaction picture and time dependent perturbation theory

12. Two-level system in an external resonant field, the Rabi problem

13. Perturbation theory of the interaction of an atomic system with the electromagnetic field.

14. The many-body problem, systems of identical particles, bosons and fermions

15. The method of second quantization for many-body systems

16. Approximation methods for the determination of stationary states of many-body systems

17. Scattering problems in quantum-mechanics, scattering cross section, Lippmann-Schwinger equation

18. Approximation methods in scattering problems, the method of partial waves and the Born approximation

19. One and three-dimensional problems: potential-well, hard sphere, bound and scattering states

20. Basics of relativistic quantum mechanics, Klein-Gordon equation, Dirac equation

Literature:

- C. Cohen-Tannoudji, Quantum Mechanics, Vols. 1-2, Second Edition, Wiley, 1991.
- J.J. Sakurai, Modern Quantum Mechanics, Addison-Wesley, 1994.
- A. Bohm, Quantum Mechanics, Third Edition, Springer-Verlag, 1993.

- L.I. Schiff, Quantum Mechanics, McGraw-Hill, 1988.
- L.D. Landau, Kvantummechanika, Tankönyvkiadó, 1978.
- C. Itzykson and J.-B. Zuber, Quantum Field Theory, McGraw-Hill, 1980.