

## Questions for the oral exam

- 1) Klein-Gordon equation – a reasoning leading to the equation, its form and a conserved current, solutions of the equation
- 2) Dirac equation – a reasoning leading to the equation, its form and properties of alpha and beta matrices, conserved current, solutions of the equation
- 3) Harmonic oscillator – classical description in the Lagrange and Hamilton formalisms
- 4) Harmonic oscillator – canonical quantization, commutation relations and Fock space
- 5) Scalar field – classical description in the Lagrange and Hamilton formalisms
- 6) Scalar field – canonical quantization, commutation relations and Fock space
- 7) Dirac equation – covariant form and spinor transformation properties
- 8) Spinor field – classical description in the Lagrange and Hamilton formalisms
- 9) Spinor field – canonical quantization, commutation relations and Fock space
- 10) Spin and statistics, microcausality
- 11) Electromagnetic field – classical description in the Lagrange formalism, gauge invariance
- 12) Electromagnetic field – canonical quantization in the radiation gauge
- 13) Self-interacting scalar field – the Lagrangian and Hamiltonian densities, equation of motion
- 14) Electrodynamics – the Lagrangian and Hamiltonian densities, equation of motion, gauge invariance
- 15) Evolution operator – definition, chronologically ordered exponent
- 16) Matrix  $S$  – definition and properties, optical theorem
- 17) Cross section – definition, Lorentz invariant form, averaging over spins
- 18) Cross section of binary interaction of scalar bosons – sketch of derivation
- 19) Mott cross section – sketch of derivation
- 20) Propagator of scalar field – field theory definition, Green's function of Klein-Gordon equation
- 21) Propagator of spinor field
- 22) Propagator of electromagnetic field in the radiation gauge and Lorentz covariant form
- 23) Feynman rules
- 24) Application of Feynman rules to Bhabha scattering
- 25) Application of Feynman rules to Compton scattering
- 26) Crossed processes – Compton scattering versus electron-positron annihilation
- 27) Crossed processes – Bhabha scattering versus Moller scattering