DD2366 Open Quantum Systems 7.5 credits

Öppna kvantsystem

This is a translation of the Swedish, legally binding, course syllabus.

If the course is discontinued, students may request to be examined during the following two academic years

Establishment

This official course syllabus is valid from the autumn semester 2024 in accordance with decision by the director of first and second cycle education: J-2024-0633.Date of decision: 2024-03-27

Grading scale

A, B, C, D, E, FX, F

Education cycle

Second cycle

Main field of study

Computer Science and Engineering

Specific prerequisites

Knowledge and skills in programming, 6 credits, equivalent to completed course DD1310-DD1319/DD1321/DD1331/DD1337/DD100N/ID1018.

Knowledge in algebra and geometry, 7.5 higher education credits, equivalent to completed course SF1624.

Knowledge in calculus in one variable, 7.5 higher education credits, equivalent to completed course SF1625.

Knowledge in multivariable analysis, 7.5 higher education credits, equivalent to completed course SF1624.

Active participation in a course offering where the final examination is not yet reported in LADOK is considered equivalent to completion of the course. Being registered for a course counts as active participation. The term 'final examination' encompasses both the regular examination and the first re-examination.

Language of instruction

The language of instruction is specified in the course offering information in the course catalogue.

Intended learning outcomes

After passing the course, the student shall be able to

- use basic theoretical and numerical methods to describe quantum systems interacting with an environment
- give an account of how performance and limitations of quantum information systems and components depend on the properties and interference from a quantum mechanical environment
- evaluate and design quantum information components

in order to

- in an independent and scientifically substantiated way, be able to understand and appreciate the influence of the environment on mainly quantum information processing systems, but also on quantum technology more generally
- be able to assess what is possible and not possible to do with a given quantum calculation platform.

Course contents

Basic quantum mechanics: Hilbert space, observables, Hermitian operators, the Schrödinger representation, the Heisenberg representation, the interaction representation, the Schrödinger equation, the measurement problem, entanglement, Einstein's 'spooky action at a distance' impact.

Quantum information handling: local operations and classical communication, quantum key distribution, various quantum calculation infrastructures.

Dynamics of open quantum systems in general. Time evolution of partial density matrices. Kraus operators.

Quantum-Markov processes. The Lindblad equation and Lindblad operators.

Decoherence and dissipation. Quality measures.

General dynamics of open quantum systems: The Feynman-Vernon functional.

Real sources of error in quantum calculation components. The Aharonov-Kitaev-Nisan model for error propagation.

The Jaynes-Cumming model and the spin-boson model.

Simulation techniques for open quantum systems with memory.

Examination

- TEN1 - Written exam, 7.5 credits, grading scale: A, B, C, D, E, FX, F

Based on recommendation from KTH's coordinator for disabilities, the examiner will decide how to adapt an examination for students with documented disability.

The examiner may apply another examination format when re-examining individual students.

Grade A is examined through an oral examination.

Transitional regulations

HEM1 is replaced by TEN1.

Ethical approach

- All members of a group are responsible for the group's work.
- In any assessment, every student shall honestly disclose any help received and sources used.
- In an oral assessment, every student shall be able to present and answer questions about the entire assignment and solution.