University of Copenhagen - Courses

NMAB19003U Introduction to Quantum Computing

COLLAPSE ALL

Volume 2021/2022

Content

This course will provide an introduction to the field of quantum computing and information, covering a variety of topics ranging from computation and cryptography to foundations of quantum physics. Once familiar with the fundamentals, we will explore current research topics and discuss how quantum phenomena give rise to new algorithms for machine learning, quantum computational supremacy, cryptographic schemes with unprecedented security guarantees, and device-independent protocols.
As part of the exercises, you will run simple quantum programs on an actual, albeit noisy, quantum computer available through the cloud.
Topics covered include
- Fundamentals of quantum computing (quantum states, superposition, measurement, unitaries)
- The circuit model (qubits, unitary gates)
- Basic protocols (e.g. teleportation, superdense coding, state discrimination)
- Basic quantum algorithms (e.g. Deutch-Josza, Grover, HHL) and the concept of quantum computational supremacy
- Bell inequalities, non-local games and the concept of device-independence
- Basic quantum protocols for cryptography, e.g. quantum key-distribution

Learning Outcome

Knowledge: the students will have an understanding of the basic principles of quantum information and computing, including knowledge of basic protocols, applications, and algorithms.
Skills: Carry-out computations corresponding to valid transformations of quantum states as a result of measurement or application of unitary gates.
Competencies: Ability to analyze simple quantum protocols and reason about basic information processing capabilities of quantum computers.

Recommended Academic Qualifications

1) Linear algebra: LinAlg or LinAlgDat course or equivalent
2) Basic probability: SS or DMA or StatFys course or equivalent

Teaching and learning methods

4 hours of lectures and 2 hours of exercise classes per week for 7 weeks.

Workload

Category	Hours
Lectures	28
Preparation	134
Theory exercises	14
Exam	30
Total	206

Feedback form

Written
Oral
Individual
Collective
Students will receive written individual feedback on their assignement solutions. Collective oral feedback will be given during lectures and exercise classes regarding the problems/questions posed to the class.

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Exam

Credit
7,5 ECTS

Type of assessment

Continuous assessment
Oral examination, 25 minutes
The students' performance will be evaluated via
- 2 individual, equally weighted assignments during the term
- Final oral exam (with 25 minutes preparation), where the student presents one randomly selected topic from a previously known list of topics

The assignments will account for 40% and the oral exam for 60% of the final grade.

Aid

Only certain aids allowed
All aids allowed for the assignments.
Personally handwritten notes on paper allowed during the 25-minute preparation period before the examination.

Marking scale

7-point grading scale

Censorship form

No external censorship
Several internal examiners at the oral exam. One internal examiner for the assignments.

Re-exam

Final exam with two internal examiners: a 25 minutes oral exam without preparation or aids.

Criteria for exam assesment

The student must in a satisfactory way demonstrate that he/she has mastered the learning outcomes.

Course information

Language
English

Course code
NMAB19003U

Credit
7,5 ECTS

Level
Bachelor

Duration
1 block

Placement
Block 1

Schedule
C

Course capacity
No limit

Course is also available as continuing and professional education

Study board
Study Board of Mathematics and Computer Science

Contracting department

Department of Mathematical Sciences

Contracting faculty

Faculty of Science

Course Coordinators

Albert H. Werner (Werner@math.ku.dk)
Laura Mancinska (mancinska@math.ku.dk)

Lecturers

Morten Kjærgaard

Saved on the 28-04-2021

Timetable

21E-B1-1;Hold 01;;Introduction to Quantum Computing

BACK

If you have questions about the course please contact your local Student service.

UNIVERSITY OF COPENHAGEN

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