MAT3420 - Quantum Computing 2024

TEACHING PLAN -version of 6 February 2024

Lecturer: Nadia Larsen

Note: The list below is a plan and will be adjusted during the semester according to our progress in the course.

Primary literature for the course: The book "An Introduction to Quantum Computing" by P. Kaye, R. Laflamme and M. Mosca, Oxford University Press, available online from the university's library service. Hereafter we refer to this book as [KLM].

Additional reading: Another good source of reading is the recent book "Introduction to Classical and Quantum Computing" by Thomas Wong, available as pdf-file from the author's personal webpage https://www.thomaswong.net/introduction-to-classical-and-quantum-computing-1e4p.pdf. This book is at a more elementary level, and includes some concrete elements of quantum programming.

Week 3
Lecture 1, 16 January. Presentation of the course. Sections 1.1-1.7 in [KLM].
Lecture 2, 19 January. Linear Algebra and the Dirac notation. Sections 2.1-2.3 in [KLM].

Week 4
Lecture 3, 23 January. Linear operators. Functions of operators, tensor products, the Schmidt decomposition. Sections 2.5-2.6 in [KLM].
Lecture 4, 26 January. Section 2.7. Qubits and the framework of quantum mechanics, sections 3.1-3.3 in [KLM].

Week 5
Lecture 5, 30 January. Exercises. Chapters 2 and 3.
Lecture 6, 2 February. Measurement, mixed states, quantum operations. Sections 3.4-3.5 in [KLM].

Week 6
Lecture 7, 6 February. Section 3.5. Exercises 1-5 and 6(a) for week 6.
Lecture 8, 9 February. The quantum circuit model and measurement. Sections 4.1-4.5. in [KLM].

Week 7
Lecture 9, 13 February. Finish chapter 4. Superdense coding, quantum teleportation, sections 5.1-5.2 in [KLM]
Lecture 10, 16 February. Exercises for week 7.

Week 8
Lecture 11, 20 February. Quantum algorithms, section 6.1 in [KLM]. Exercises for week 8.
Lecture 12, 23 February. Quantum algorithms. Sections 6.1-6.3 in [KLM]. No physical lecture. Video of lecture will be posted in advance.

Week 9
Lecture 13, 27 February. Exercises. Sections 6.1-6.2.
29 February: The mandatory assignment will be posted on the course webpage.
Lecture 14, 1 March. The Deutsch-Josza algorithm. Section 6.4 in [KLM].

Week 10
Lecture 15, 5 March. Exercises.
Lecture 16, 8 March. A first look at Simon's algorithm. Section 6.5 in [KLM].

Week 11
Lecture 17, 12 March. Simon's algorithm. Section 6.5 in [KLM].
14 March: The mandatory assignment must be submitted in Canvas.
Lecture 18, 15 March. A first look at algorithms with superpolynomial speed-up: phase estimation. Section 7.1 in [KLM].

Week 12
Lecture 19, 19 March. Exercises. Section 6.5.
Lecture 20, 22 March. Algorithms with superpolynomial speed-up: phase estimation and the quantum Fourier transform. Section 7.1 in [KLM]. No physical lecture. Video of lecture will be posted in advance.

Week 14
Lecture 21, 2 April. Exercises. Section 7.1.
Lecture 22, 5 April. Error analysis for estimating arbitrary phases. Section 7.1.1 in [KLM].

Week 15
Lecture 23, 9 April. Periodic states. Section 7.1.2.
Lecture 24, 12 April. Review of (or, brief introduction to) basic concepts of number theory and integer arithmetics. Section 7.1.3 in [KLM]. Eigenvalue estimation. Section 7.2.

Week 16
Lecture 25, 16 April. Exercises.
Lecture 26, 19 April. The order-finding problem. Section 7.3.

Week 17
Lecture 27, 23 April. Exercises, section 7.3.
Lecture 28, 26 April. Grover's quantum search algorithm. Section 8.1 in [KLM].

Week 18
Lecture 29, 30 April. Some elements of quantum complexity theory, with focus on the search problem in the black-box model. Sections 9.1-9.3 in [KLM].
Lecture 30, 3 May. Error correction, classical and quantum. Sections 10.1-10.4 in [KLM].

Week 19
Lecture 31, 7 May. Exercises. Sections 8.1-8.2.
Lecture 32, 10 May. No physical lecture. Video lecture about no-cloning, error recovery, more of section 10.4. The 3-and 9-qubit quantum codes. Section 10.5 in [KLM].

Week 20
Lecture 33, 14 May. The 9-qubit quantum code, fault-tolerant quantum computation. Sections 10.5-10.6 in [KLM].
Lecture, 17 May. No lecture.

Week 21
Lecture 34, 21 May. Exam problems from earlier years.
Lecture 35, 24 May. Exam problems from earlier years.

EXAM 10 June 2024 at 15:00-19:00 hours.