uOttawa

MAT 4995 (also offered as MAT 5341) Quantum Computing

Winter 2018
Mondays 13:00–14:30 & Wednesdays 11:30–13:00
Tabaret (TBT); Room 315

Instructor: Dr. Anne Broadbent
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Office Location: 585 King Edward (KED), room 204-C; phone x2104
Office Hours (tentative): Mondays 14:30–15:00 (after class, in TBT) &
Wednesdays 13:30–14:30 (in my office) or by appointment

Teaching Assistant: Marc-Olivier Proulx
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Syllabus

Learning Objectives
By the end of this course, students will be able to:

- recognize the differences between classical and quantum information in the context of computation;
- predict the outcomes of quantum operations on closed quantum systems;
- understand and construct quantum circuits;
- explain and apply paradigms of quantum information theory such as the no-cloning theorem, teleportation, entanglement, quantum algorithms and quantum error correction;
- understand and explain the advantages and limitations of quantum information in the context of cryptography;
- identify a number of advanced topics in quantum information processing as presented by classroom peers;
- **(MAT5341 only)** select, summarize and defend an advanced topic in quantum information processing; relate and compare this topic with material in the course;

Official Course Description: Space of quantum bits; entanglement. Observables in quantum mechanics. Density matrix and Schmidt decomposition. Quantum cryptography. Classical and quantum logic gates. Quantum Fourier transform. Shor's quantum algorithm for factorization of integers.

Target Audience: This course is open to all those who are curious about information processing in a quantum world. Students may have a background in Mathematics, Physics or Computer Science (this list is not exhaustive). No prior knowledge of quantum physics will be assumed, although a certain mathematical maturity (see below) is required.

Prerequisites: [Linear Algebra (MAT2141 or MAT3341) AND 12 course credits in mathematics (MAT) at the 3000 level or above] OR [Permission of instructor].

Textbook: I recommend that you come prepared to class, having read the assigned readings that will be from the following textbook:

- Michael A. Nielsen, Isaac L. Chuang. *Quantum Computation and Quantum Information.* Available online via the uOttawa library `http://orbis.uottawa.ca/record=b4377427~S0*eng`.

Note, however, that the scope of the above textbook is much broader than the scope of MAT 4996; when possible, I will also assign readings from an alternative textbook (with a scope closer to the scope of this course, but that does not cover some topics that we will cover in class):

- Phillip Kaye, Raymond Laflamme, Michele Mosca. *An introduction to quantum computing.* Available online via the uOttawa library `http://orbis.uottawa.ca/record=b3584631~S0*eng`.

Another online reference that is very pertinent for this course is:

- John Watrous. *Introduction to Quantum Computing (notes from Winter 2006)* `https://cs.uwaterloo.ca/~watrous/LectureNotes.html`.

Grade Distribution:

	MAT 4995	MAT 5341
Assignments	20%	10%
Project	—	10%
Midterm Exam	30%	30%
Final Exam	50%	50%
TOTAL	100%	100%

Letter Grade Distribution: Based on the course evaluations, your final letter grade will be obtained by truncating your cumulative average, and then converting according to the following scheme: A+: 90–100; A: 85–89; A-: 80–84; B+: 75–79; B: 70–74; C+: 65–69; C: 60–64; D+: 55–59; D: 50–54; E: 40–49; F: 0–39.

Important Dates

First class:	Jan. 8
Midterm: (in class)	Feb. 12
Reading week (no class):	Feb. 19–23
Last class:	April 9
Final Exam:	TBD (during the final exam period)

Assignments will generally posted on Monday and due on the following Monday. There will be approximately 5-6 assignments, thus more or less one every two weeks.

MAT 5341 (graduate-level course evaluation:) You will be graded on the same assignments, midterm and final exam as MAT4995, but may be asked to answer more questions and show a higher level of comprehension than the 4995-level students. In addition, you will be graded on a project, that will consists in both a written and oral component. Details are provided in a separate document.

Further course information:

1. **Exams:**
   - The midterm and exam are closed book, closed notes.
   - **No makeup midterm will be given.** Students with an accepted medical note will be allowed transfer the weight of the midterm evaluation to the final.
2. **Preparing your solutions:** In all work that you submit (assignments, midterms, exam, etc.), your answers will be evaluated according to your problem-solving process. This means that *you must show all your work*. It is not sufficient to simply state an answer. You will be graded on the clarity, conciseness and accuracy of your entire process of finding a solution.
3. **Collaboration:** Students are expected to work on assignments independently. Discussion amongst students is encouraged, but each student must write up his or her own solution. If you have extensively consulted a reference in order to prepare your solution, you must cite this reference.
4. **Academic Integrity:** Academic fraud is an act by a student that may result in a false academic evaluation of that student or of another student. You are responsible for being aware of and following the University Regulation to this effect: `https://www.uottawa.ca/vice-president-academic/academic-integrity`. When in doubt, direct your questions to the professor or teaching assistant.
5. **Attendance:** I expect that you will attend class. In the event that this is not possible, please note that students are responsible for all missed work, regardless of the reason for absence. It is also the absentee's responsibility to get all missing notes or materials.