CO 481/CS 467/PHYS 467, Winter 2019

Introduction to Quantum Information Processing

Lectures:
Tuesdays and Thursdays 11:30am-12:50pm in MC4020

Instructor:
Debbie Leung
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Office: MC 6008
Office hours: See course website

Teaching assistants:	Office	Office hour
John Schanck	QNC 3321	See course website
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Course website: `https://learn.uwaterloo.ca/d2l/home/433697`

Textbooks: (all available on reserve at DC library)

Primary (detailed comprehensive textbook): M. Nielsen and I. Chuang, Quantum Computation and Quantum Information, Cambridge University Press (2000).

Supplemental (especially good for introduction and background): P. Kaye, R. Laflamme, and M. Mosca, An Introduction to Quantum Computing, Oxford University Press (2007).

Supplemental (especially good for algorithms and physical intuition): D. Mermin, Quantum Computer Science (An Introduction), Cambridge University Press (2007).

Evaluation (exact, no curving or redistribution):

5 assignments (10% each)
1 quiz (15%)
1 final exam (30%)
In class iclicker participation lectures 4-11, 13-24 (5%)

Assignments will be made available on the course website. Answers are due on *Crowdmark by 3:00am on the due dates* (Sun/Wed, tentatively January 27, Feburary 10, Feburary 27, March 17, and March 31). **Late assignments will not be graded nor credited.** You can (and should) submit and revise partial answers to Crowdmark any time before the due time.

You are encouraged to discuss homework problems with your peers, with the TAs, and with the course instructor. However, your solutions should be based on your own understanding and written independently in your own words. **Please acknowledge all sources of help on your assignments – failing to do so constitutes an academic offense.**

The quiz will be held in-class on Feburary 14. **Writing the quiz and scoring at least 35% is required to pass the course.** The final exam will be scheduled by the Registrar's Office.

Overview and objective:

Quantum information processing seeks to exploit quantum mechanical principles to provide a qualitatively different and more powerful way of processing information than is allowed by classical physics. This course aims to give a basic foundation in the field of quantum information processing. As this is a multidisciplinary subject, the course will cover basic concepts in theoretical computer science, information theory, and quantum mechanics, in addition to introducing core quantum information topics. This introduction will enable students to pursue further study in various aspects of quantum information processing.

Course description:

• Quantum information as pure states, quantum gates, quantum circuits and universality.

• Information theoretic consequences of quantum mechanics: entanglement, nonlocality, superdense coding and teleportation.

• Computational advantages of quantum mechanics: quantum algorithms for factoring and search.

• Quantum noise processes, mixed state quantum information, quantum error correction, fault-tolerance.

• Cryptographic consequences of quantum mechanics: for example, quantum secret sharing, quantum key distribution, quantum authentication, quantum authentication and key recycling.

Prerequisites:

Most accurately given by PMATH399 (offered first time W19). Proficiency in linear algebra (good performance in one of MATH 114, 115, 235, 245), proofs, and probability theory, elementary matrix analysis and enumeration, and **an open mind** are required. We accept students who have acquired similar knowledge elsewhere, or have the ability to learn the material during the course.

Avoidance of Academic Offences:

Students are expected to know what constitutes academic integrity, to avoid committing academic offenses, and to take responsibility for their actions. Students who are unsure whether an action constitutes an offense, or who need help in learning how to avoid offenses (e.g., plagiarism, cheating) or about rules for group work/collaboration should seek guidance from the course professor, TA, academic advisor, or the Undergraduate Associate Dean. The Office of Academic Integrity at the University of Waterloo maintains a website with a number of items of interest to students. In particular the pages on Academic Integrity for students (`https://uwaterloo.ca/academic-integrity/integrity-students`) provide various examples as well as a tutorial on the subject. For information on categories of offenses and types of penalties, students should refer to Policy #71, Student Discipline (`http://www.adm.uwaterloo.ca/infosec/Policies/policy71.htm`). Students who believe that they have been wrongfully or unjustly penalized have the right to grieve; refer to Policy #70, Student Petitions and Grievances (`http://www.adm.uwaterloo.ca/infosec/Policies/policy70.htm`), as well as Policy #72, Student Appeals (`http://www.secretariat.uwaterloo.ca/Policies/policy72.htm`).

Accommodation of disabilities:

AccessAbility Services, located in 1401 Needles Hall, collaborates with all academic departments to arrange appropriate accommodations for students with disabilities without compromising the academic integrity of the curriculum. If you require academic accommodations to lessen the impact of your disability, please register with AccessAbility Services at the beginning of each academic term.