CO 481/CS 467/PHYS 467   Winter 2014
Introduction to quantum information processing

Course website

http://www.math.uwaterloo.ca/~amchilds/qip-intro

Coordinates

Tuesday/Thursday, 10:00–11:20 am, QNC 0101

Instructor

Andrew Childs
Email: amchilds@uwaterloo.ca
Office: QNC 3126
Office hours: Monday 10–11 am and Thursday 12:30–1:30 pm (or by appointment)

Teaching assistants

	Email	Office	Office hours
Yuval Sanders	ysanders@uwaterloo.ca	QNC 4124	Wednesday 10–11 am
John Schanck	jschanck@uwaterloo.ca	QNC 3321	Monday 3:30–4:30 pm

Overview

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 and physics 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

Basics of computational complexity; basics of quantum information; quantum phenomena; quantum circuits and universality; relationship between quantum and classical complexity classes; simple quantum algorithms; quantum Fourier transform; Shor factoring algorithm; Grover search algorithm; physical realization of quantum computation; error correction and fault tolerance; quantum key distribution.

For a detailed lecture schedule with recommended readings, see the course website.

Prerequisites

One of MATH 114, 115, 235, 245; Level at least 4A; Not open to General Mathematics students.

Text

Primary: P. Kaye, R. Laflamme, and M. Mosca, *An Introduction to Quantum Computing*, Oxford University Press (2007). Three copies are on reserve in the Davis Center Library (one library copy plus two copies under call number UWD 1493).

Supplemental: M. A. Nielsen and I. L. Chuang, *Quantum Computation and Quantum Information*, Cambridge University Press (2000). Two copies are on reserve in the Davis Center Library (one library copy plus one copy under call number UWD 1490).

Evaluation

Your final grade will be determined as follows:

Assignments   10% each (50% total)
Midterm   25%
Project   25%

Assignments

There will be 5 homework assignments during the course. Assignments will be made available on the course website and will be due in class on Tuesdays. Solutions will be posted on the course website soon after the due date, so extensions will not be granted. Graded assignments will be returned in class.

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 should be written independently. You are asked to acknowledge all sources of help on your assignments.

Exam

A midterm exam will be held on Thursday, February 13, from 8:00–9:50 pm in QNC 0101.

Project

Students will be expected to write an expository paper on a topic of their choice from the quantum information literature. Further details, including a list of possible project topics, will be posted on the course website. Students should email the instructor by February 27 indicating their chosen topic. Papers will be due by the date of the last lecture, April 3.

Avoidance of academic offenses

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-waterloo-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 (https://uwaterloo.ca/secretariat/policies-procedures-guidelines/policy-71). Students who believe that they have been wrongfully or unjustly penalized have the right to grieve; refer to Policy #70, Student Petitions and Grievances (https://uwaterloo.ca/secretariat/policies-procedures-guidelines/policy-70), as well as Policy #72, Student Appeals (https://uwaterloo.ca/secretariat/policies-procedures-guidelines/policy-72).

Accommodation of disabilities

AccessAbility Services (https://uwaterloo.ca/disability-services/), located in Needles Hall, Room 1132, 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.