Introduction to Quantum Information Processing (AM871/CO681/CS667/PHYS767/QIC710, Fall 2010)

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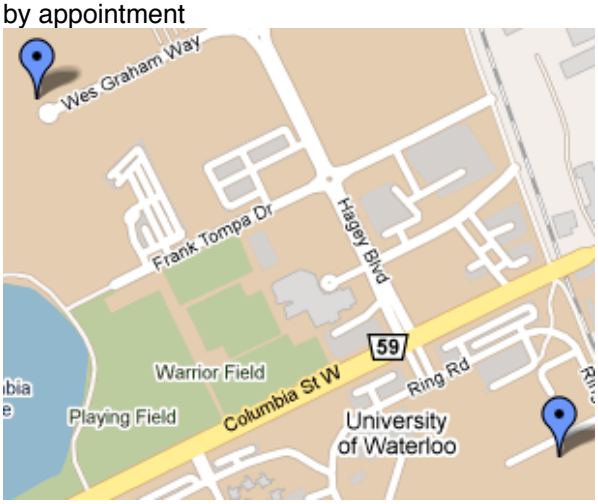
Office Hours: Monday 1:30pm in RAC 2113, or by appointment



Lectures: Tuesday, Thursday 2:30-3:50pm in RCH 109
Course Website: www.cs.uwaterloo.ca/~breic/teaching/2010qic710

Useful Supplementary Material:

Textbooks:

- *An Introduction to Quantum Computing* by Kaye, Laflamme and Mosca
- *Quantum Computation and Quantum Information* by Nielsen and Chuang

Lecture Notes:

- John Preskill: www.theory.caltech.edu/~preskill/ph229
- David Mermin: people.ccmr.cornell.edu/~mermin/qcomp/CS483.html

Course Description: Review of basics of quantum information and computational complexity; Simple quantum algorithms; Quantum Fourier transform and Shor factoring algorithm: Amplitude amplification, Grover search algorithm and its optimality; Completely positive trace-preserving maps and Kraus representation; Non-locality and communication complexity; Physical realizations of quantum computation: requirements and examples; Quantum error-correction, including CSS codes, and elements of fault-tolerant computation; Quantum cryptography; Security proofs of quantum key distribution protocols; Quantum proof systems. Familiarity with theoretical computer science or quantum mechanics will also be an asset, though most students will not be familiar with both.
Prerequisites: MATH 235 or equivalent (e.g. PHYS 364 & 365); STAT 230 or equivalent. This course cannot be taken for credit by students who have taken CO 481 / CS 467 / PHYS 467.

Homework: There will be six or seven homework assignments, concentrated in the first half of the semester.
Midterm exam: There will be a take-home midterm examination, dates TBA.

Course Outline:
Lectures 1-3: Quantum theory, quantum circuits, teleportation, super-dense coding
Lectures 4-11: Deutsch-Josza algorithm, quantum Fourier transform, Shor's factoring algorithm, phase-estimation, Grover's search algorithm and amplitude amplification
Lectures 12-17: Density matrices, POVMs, entanglement, Bell's inequality
Lectures 15-16: Quantum information: entropy, fidelity
Lectures 17-19: Quantum error correction
Lecture 20-21: Quantum cryptography, key distribution security, bit commitment, coin-flipping, interactive proofs

IQC Shuttle Schedule

IQC	DC	NH
8:45	8:55	9:00
9:10	9:20	No Shuttle
9:40	9:50	9:55
10:05	10:15	10:20
10:30	10:40	10:45
10:55	11:05	11:10
11:20	11:30	11:35
11:45	11:55	No Shuttle
	Lunch	
		1:05
1:15	1:25	1:30
1:40	1:50	1:55
2:05	2:15	2:20
2:30	2:40	2:45
2:55	3:05	3:10
3:20	3:30	No Shuttle
4:00	4:10	4:15
4:25	4:35	4:40
4:50	4:55	No Shuttle