Quantum Information and Computing
Math 6252/Phys 6852

Instructor
Dr. Stephanie Curnoe
Office: Room C3013, Phone 864-8888

Schedule
12:30-1:45 Tuesdays and Thursdays Room C3067
Another 50 minutes/week, time and place to be decided
The course will have two 75 minute and one 50 minute lecture slots per week. In a typical week, the longer classes will be traditional lectures (and may be shortened to 50 minutes) while the third class will be devoted to discussion and problem-solving.

Textbook
Quantum Computing From Linear Algebra to Physical Realizations by Mikio Nakahara and Tetsuo Ohmi

Recommended reference
Quantum Computation and Quantum Information by Michael A. Nielsen and Isaac L. Chuang

Outline
The objectives of this course are to provide students with an introduction to the theory of quantum computing and to enable students to access a real quantum computer. The topics that will be covered in this course are

1. Linear Algebra: Hilbert space, Hermitian operators, eigenvalue problems (Chapter 1 of textbook)
2. Postulates of Quantum Mechanics (Chapter 2)
3. Qubits and Quantum Key Distribution (Chapter 3)
4. Quantum gates and quantum circuits (Chapter 4)
5. Quantum algorithms (Chapter 5)
6. Quantum Integral Transforms (Chapter 6)

7. Search Algorithm (Chapter 7)
8. Shor's Algorithm (Chapter 8)
9. Physical realizations of quantum computers (class projects; Chapters 11-16)
10. Programming and accessing real quantum computers (Xanadu Quantum Codebook)

Evaluation Scheme
Xanadu Quantum Codebook solutions: 10%
Other assignments: 10%
Lecture: 20%
Test 1 (February 15): 15%
Test 2 (March 21): 15%
Final examination: 30%

Xanadu Quantum Codebook solutions: PennyLane is a python-based software package for programming quantum computers created by Xanadu, a Canadian quantum computing company. Xanadu's online textbook, Xanadu Quantum Codebook, contains many exercises in the form of programming challenges using PennyLane. Students will complete modules I.1 to I.15 during the course, with a few problems assigned each week. The solutions to these problems will be discussed during the class, as described above. Students will submit their solutions (can be hard-copy or electronic) to all of the problems in the first module (modules I.1 to I.15). Additional modules aligned with the course material may also be assigned.

Lecture: Each graduate student will deliver one lecture during the course that describes a physical realization of a quantum computer. The student will create lecture notes (to be submitted) for a 50 minute lecture and deliver it to the class. Computer slides may be used, however the discussion should be detailed (not superficial) and should include a physical description and underlying theory of a real quantum computer. The dates and topics of the lectures will be assigned as early as possible.

Tests: The tests will be usual, closed-book exams, held during the regular lecture time.

Final exam: The final exam will be held within the final exam period.

Important Dates

Thursday, February 15: test 1
Monday, February 19 to Friday, February 23: no classes (midterm break)
Thursday, February 29: last day to drop the course
Thursday, March 21: test 2
Friday, April 5: last class
Wednesday, April 10 to Friday, April 19: final exams

Prerequisites

The expected background for this course is a senior undergraduate course in quantum mechanics (such as PHYS 4850) and/or linear algebra.