MASSACHUSETTS INSTITUE OF TECHNOLOGY

Department of Physics & Department of Applied Math

MIT 18.435 / 8.370 / 2.111

Quantum Information Science I

September 7, 2017

General Information & Syllabus

General Information:

Units: 3-0-9

Provides an introduction to the theory and practice of quantum computation. Topics covered: physics of information processing; quantum logic; quantum algorithms including Shor's factoring algorithm and Grover's search algorithm; quantum error correction; quantum communication and cryptography. Prior knowledge of quantum mechanics helpful but not required. First course in a sequence of two core quantum information science courses at MIT.

Lectures:	Tuesday & Thursday 1pm-2:30pm, Room 4-370
Instructors:	Prof. Peter Shor, 2-375 `<shor@math.mit.edu>`
	Prof. Isaac Chuang, 26-251 `<ichuang@mit.edu>`;
	office hours – see Stellar page
TA:	Ryuji Takagi `<rtakagi@mit.edu>`
Textbook:	Quantum Computation and Quantum Information, by Nielsen and Chuang
Grading:	Homework (8 problem sets) 40%, Midterm exam 20% Final exam 30%, Participation 10%
Schedule:	Midterm exam – Tuesday October 24, 2017
Web site:	https://lms.mitx.mit.edu/courses/course-v1:MITx+8.370r+2017_Fall/about

Late Policy. Problem sets will due online at 7pm. It is possible to hand in a problem set late, with a 10% decrease in your grade, until 7pm on the following day. We will not accept assignments turned in after the solutions are posted without a note from S^3.

Collaboration Policy. Collaboration on homework is permitted, you should first think about the problems on your own. You must list the names of your collaborators on your submitted homework, or state that you had none.

Student Support Services. If you are dealing with a personal or medical issue that is impacting your ability to attend class, complete work, or take one of the exams, please discuss this with Student Support Services (S^3). The deans in S^3 will verify your situation, and then discuss with you how to address the missed work. Students will not be excused from coursework or be given credit for homework more than one day late without verification from Student Support Services. You may consult with S^3 in 5-104 or at 617-253-4861. Also, S^3 has walk-in hours Monday-Friday 9:00–10:00am.

Syllabus:

Unit 1: Quantum and classical computing fundamentals

[9/7] Lecture 1.1: Introduction to quantum computation

[9/12] Lecture 1.2: Classical logic

[9/14] Lecture 1.3: Intro to QM - states

[9/19] Lecture 1.4: Intro to QM - time evolution

[9/21] Lecture 1.5: Intro to QM - measurement and tensor products

[9/26] Lecture 1.6: Quantum weirdness

Unit 2: Simple quantum protocols and algorithms

[9/28] Lecture 2.1: Teleportation and superdense coding

[10/3] Lecture 2.2: Quantum Circuit Model and Deutsch-Jozsa

[10/5] Lecture 2.3: Simons algorithm

[10/10] Lecture 2.4: no class (Columbus day)

[10/12] Lecture 2.5: Quantum Fourier Transform

[10/17] Lecture 2.6: Phase estimation

[10/19] Lecture 2.7: Shor's algorithm

[10/24] Midterm exam

Unit 3: Quantum noise, codes and communication

[10/26] Lecture 3.1: Classical error correcting codes

[10/31] Lecture 3.2: Quantum noise models

[11/2] Lecture 3.3: Nine-qubit quantum code

[11/7] Lecture 3.4: Criterion for quantum codes

[11/9] Lecture 3.5: Quantum CSS codes I

[11/14] Lecture 3.6: Quantum CSS codes II

[11/16] Lecture 3.7: Quantum key distribution

Unit 4: Models of quantum computation

[11/21] Lecture 4.1: Measurement and quantum algorithms

[11/23] Lecture 4.2: no class (Thanksgiving)

[11/28] Lecture 4.3: Distributed quantum algorithms I

[11/28] Lecture 4.4: Distributed quantum algorithms II

[11/30] Lecture 4.5: Noise, computation, and fault-tolerance

[12/5] Lecture 4.6: Quantum fault-tolerance

[12/7] Lecture 4.7: Adiabatic quantum computing I

[12/12] Lecture 4.8: Adiabatic quantum computing II

[12/TBD] Final exam