MASSACHUSETTS INSTITUE OF TECHNOLOGY

Department of Physics & Department of Applied Math

MIT 6.443J / 8.371J / 18.409 / MAS.865

Quantum Information Science

February 5, 2008

General Information & Syllabus

General Information:

Prereq.: 2.111 / 18.435J / ESD.79

Units: 3-0-9

Advanced graduate course on quantum computation and quantum information. Prior knowledge of quantum mechanics and basic information theory is required. The first semester of this two-course sequence (2.111 / 18.435J) was taught by Seth Lloyd in the Fall of 2007, and covered quantum algorithms, quantum error correction, cryptography, and introduced fault tolerance. This semester, we will cover models of quantum computation, advanced quantum error correction codes, fault tolerance, quantum algorithms beyond factoring, properties of quantum entanglement, and quantum protocols.

Lectures:	Tuesday & Thursday 11am-12:30pm, Room 36-153
Instructors:	Prof. Isaac Chuang, 26-251 `<ichuang@mit.edu>`
	Prof. Peter Shor, 2-284 `<shor@math.mit.edu>` ; office hours by appointment
TA:	Andrew Cross `<awcross@mit.edu>`
Textbook:	Quantum Computation and Quantum Information, by Nielsen and Chuang
Grading:	Homework (4 problem sets) 40%, Project presentation 20% Project paper 40%
Schedule:	Final project paper due on May 15, 2008
Web site:	`http://web.mit.edu/cua/www/8.371`

Syllabus:

[**T 05-Feb**] Lecture 1: General introduction; Quantum operations

[**R 07-Feb**] Lecture 2: Quantum error correction - criteria and examples [PS#1 out]

[**T 12-Feb**] Lecture 3: Calderbank Shor Steane codes

[**R 14-Feb**] Lecture 4: Stabilizers ; stabilizer quantum codes [PS#2 out, PS#1 due]

[**T 19-Feb**] No class (Monday schedule)

[**R 21-Feb**] Lecture 5: CWS codes and nonabelian codes

[**T 26-Feb**] Lecture 6: Stabilizers II ; computing on quantum codes

[**R 28-Feb**] Lecture 7: concatenated codes ; the threshold theorem [PS#3 out, PS#2 due]

[**T 04-Mar**] Lecture 8: Cluster state quantum computation

[**R 06-Mar**] Lecture 9: Measurement and teleportation based quantum computation

[**T 11-Mar**] Lecture 10: Adiabatic quantum computatin

[**R 13-Mar**] Lecture 11: Qauntum algorithms on graphs; quantum random walks [PS#4 out, PS#3 due]

[**T 18-Mar**] Lecture 12: Quantum algorithms: the abelian hidden subgroup problem ; QFT over Sn

[**R 20-Mar**] Lecture 13: The nonabelian HSP ; hidden dihedral group ; positive and negative results

[**T 25-Mar**] Spring Break

[**R 29-Mar**] Spring Break

[**T 01-Apr**] Lecture 14: Channels I: Quantum data compression; entanglement concentration; typical subspaces

[**R 03-Apr**] Lecture 15: Channels II: Holevo's theorem ; HSW theorem ; entanglement assisted channel capacity [Project forms out, PS#4 due]

[**T 08-Apr**] Lecture 16: Channels III: quantum-quantum channels, mother/father protocol ; distillable entanglement

[**R 10-Apr**] Lecture 17: Entanglement as a physical resource

[**T 15-Apr**] Lecture 18: Quantum games

[**R 17-Apr**] Lecture 19: Quantum protocols - quantum communicatin complexity ; distributed algorithms [Project forms due]

[**T 22-Apr**] MIT Holiday: Patriot's day

[**R 24-Apr**] Lecture 20: Quantum cryptography

[**T 29-Apr**] Project meetings

[**R 01-May**] Project meetings

[**T 06-May**] Project presentations

[**R 08-May**] Project presentations

[**T 13-May**] Project presentations

[**R 15-May**] All final project papers due