MASSACHUSETTS INSTITUE OF TECHNOLOGY

Media Laboratory

MAS.961 Quantum Information Science September 6, 2001

General Information & Syllabus

General Information:

Prereq.: 2.111; 8.05; 6.401 or MAS.862

Units: 3-0-9

Advanced graduate course on quantum computation and quantum information. Topics include quantum circuits, quantum Fourier transform and search algorithms, physical implementations, the quantum operations formalism, quantum error correction, stabilizer and Calderbank-Shor-Steane codes, fault tolerant quantum computation, quantum data compression, entanglement, and proof of the security of quantum cryptography. Prior knowledge of quantum mechanics and basic information theory is required.

Lectures:	Tuesday & Thursday 2-3:30pm, Room 24-307
Instructor:	Prof. Isaac Chuang, E15-424 `<ichuang@media.mit.edu>`; Tue 3:30-4:30pm
Teaching Assistants:	Andrew Childs, 6-409A `<amchilds@mit.edu>`; Wed 2-3pm
	Aram Harrow, E15-427 `<aram@mit.edu>`; Wed 3:30-4:30pm
Secretary:	Murray Whitehead, E15-435, `murrayw@media.mit.edu`
Textbook:	Quantum Computation and Quantum Information, by Nielsen and Chuang
Grading:	Homework (5 problem sets) 60%, Project paper 40%
Schedule:	Final project paper due on Dec. 11
Web site:	`http://www.media.mit.edu/quanta/mas961`

Syllabus:

[**T 06-Sep**] Entrance exam

[**T 11-Sep**] Lecture 1: Review

[**R 13-Sep**] Lecture 2: Quantum circuits; universal gate sets; Solovay-Kitaev theorem [PS#1 out]

[**T 18-Sep**] Lecture 3: Quantum Fourier transform and phase estimation algorithms, order-finding and factoring

[**R 20-Sep**] Lecture 4: Hidden subgroup algorithms; quantum simulation

[**T 25-Sep**] Guest lecture (Andrew Childs: Quantum computation in continuous time)

[**R 27-Sep**] Lecture 5: Quantum search algorithms; quantum counting [PS#2 out, PS#1 due]

[**T 02-Oct**] Lecture 6: Hamiltonians and physical implementations; Jaynes-Cummings model

[**R 04-Oct**] Lecture 7: Quantum operations formalism; decoherence; open quantum systems

[**T 09-Oct**] MIT Holiday

[**R 11-Oct**] Lecture 8: Generalized meas.; distance measurements for quantum info. [PS#3 out, PS#2 due]

[**T 16-Oct**] Lecture 9: Quantum error correction; Shor code; quantum Hamming bound

[**R 18-Oct**] Lecture 10: Calderbank-Shor-Steane codes; stabilizer codes

[**T 23-Oct**] Guest lecture

[**R 25-Oct**] Lecture 11: Fault-tolerant quantum computation [PS#4 out, PS#3 due]

[**T 30-Oct**] Lecture 12: Quantum information theory; Holevo theorem; quantum data compression

[**R 01-Nov**] Lecture 13: Distributed quantum computation; cryptographic primitives; quantum bit escrow

[**T 06-Nov**] Guest lecture

[**R 08-Nov**] Lecture 14: Entanglement, PPT criterion, Schmidt number, Hill-Wooters [PS#5 out, PS#4 due]

[**T 13-Nov**] Lecture 15: Quantum cryptography; BB84, Ekert protocol, privacy and coherent information

[**R 15-Nov**] Lecture 16: Information-theoretic proof of the security of the Bennett-Brassard 84 protocol

[**T 20-Nov**] Guest lecture

[**R 22-Nov**] MIT Holiday, Thanksgiving

[**T 27-Nov**] Project meetings [PS#5 due]

[**R 29-Nov**] Project meetings

[**T 04-Dec**] Guest lecture

[**R 06-Dec**] Project meetings

[**T 11-Dec**] Final project paper due