INTRODUCTION TO QUANTUM INFORMATION SCIENCE

Quantum phenomena provide computing and information handling paradigms that are distinctly different and arguably much more powerful than their classical counterparts. In the past quarter of the century, much progress has been made on the theoretical side, and experiments have been carried out in which quantum computational operations were executed on a very small number of quantum bits. The NSF has declared this general area to be one of the 10 big ideas for future investments. In June 2018, the science committee of the House of Representatives unanimously approved the National Quantum Initiative Act (H.R. 6227), which would create a 10-year federal effort aimed at boosting quantum science.

This course will provide an introduction to the theory of quantum computing and information. The topics that will be covered include 1) the fundamental elements of quantum information processing (qubits, unitary transformations, density matrices, measurements); 2) entanglement, protocols for teleportation, the Bell inequality, 3) basic quantum algorithms such as Shor's factoring and Grover's search, and 4) basic quantum data compression and error correction. The course material will be accessible to undergraduate and graduate students with a variety of backgrounds, e.g., electrical engineers, physicists, mathematicians, and computer scientists.

Learning Objective:
The students will learn the fundamentals of quantum information science, as well as a selected number of more advanced topics of their individual interests.

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Office hours: TBD & by appointment,

Class time and place: M&W, 3:20 PM – 4:40 PM, SEC 207

Prerequisites: Calculus, linear algebra, and probability at an undergraduate level as well as familiarity with complex numbers are required. Prior exposure to quantum mechanics and information/coding theory is helpful but not essential.

Grading: homework 20%, 3 midterm exams 15% each, project 35%.

Text: N. D. Mermin, *Quantum Computer Science: An Introduction,* Cambridge Univ. Press (2007).

Recommended reading:
L. Susskind and A. Friedman, *Quantum Mechanics: The Theoretical Minimum*.
J. Preskill, *Lecture Notes for Physics 229: Quantum Information and Computation.*
F. W. Byron and R. W. Fuller, *Mathematics of Classical and Quantum Physics*

Course notes: given per week in separate documents on the class (Sakai) web page.

Remarks: The topics outlined above are very common for a quantum information science course at the advanced-undergraduate/graduate level. Such courses have been taught at several universities for many years, e.g., for almost two decades at Cornell based on the class textbook. Students are encouraged to choose their project topics according to their own (research) interests.