Special Topics Course Announcement Winter 2011

EECS 598-04: Introduction to Quantum Information and Computing

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Time and Place: Monday and Wednesdays 3 pm – 4:30 pm, 3433 EECS Bldg.

Credits: 3.

Prerequisites: Graduate standing in engineering, the physical sciences, computer science or mathematics and a basic knowledge of linear algebra.

Textbook: M. A. Nielsen and I. L. Chuang, Quantum Computation and Information, Cambridge (2000). Typed class notes.

Description:
Up until the beginning of the twentieth century, Newton's classical mechanics, Maxwell's electromagnetics and the laws of thermodynamics were deemed sufficient to describe the physical world. The failures of these classical theories to explain important physical phenomena produced revolutionary and unprecedented changes in thinking and led to the development of quantum mechanics in the first half of the twentieth century. It was long believed that information processing and computing were solely mathematical constructs and as such were independent of nature and the laws of quantum mechanics. In the 1980's this assumption was found to be untrue, and the consequences have been profound. The introduction of quantum mechanics into communications and computation has produced new paradigms and some unforeseen results in the fields of computation and communications. For example, quantum algorithms have now been found for factoring, computation of the discrete logarithm (Shor's algorithms 1994) and database searching (Grover's algorithm 1996). In contrast, there are no known practical (i.e., polynomial time) classical solutions for the former two problems, while Grover's search algorithm offers a provable quadratic speed-up over the best possible classical approach. This course is a mathematical introduction to the fields of quantum computing and quantum information. A basic working knowledge of linear algebra is a prerequisite, but no prior knowledge of quantum mechanics, classical computing or Shannon information theory is assumed. Graduate students in all areas of engineering, computer science, the physical sciences and mathematics should find this material of interest. This course was offered once before in the fall of 2008.

Topics:
Nielsen and Chuang chapters 1-5 and selected portions of chapters 8-12. Extended introduction and overview the field; linear algebra fundamentals; postulates of quantum mechanics; quantum circuits and gates; quantum computation and algorithms (including Shor's factoring algorithm), introduction to quantum error-correcting codes; quantum data compression (Von Neumann entropy and Schumacher's quantum noiseless channel theorem); quantum communications (as time-permits).

Grading: Regular homework assignments (60%), a midterm exam (20%), and a critique of a research paper (20%).