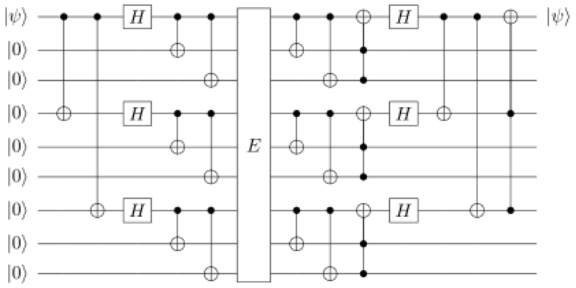
# Quantum Information and Error Correction
# Math 577-2, Spring 2012 - Special Topics Graduate Course
# taught by Marek Rychlik, Professor of Mathematics

- Quantum computing
- Classic and quantum information theory
- Classic and quantum error correcting codes




**Course Contents**

In recent years quantum information processing has gained prominence as the prospect of the quantum computer is becoming a reality. Quantum information is stored in a coherent state of a quantum system. Quantum state is, by its nature, fragile. Protecting quantum information from being lost is subject to the laws of both quantum physics and mathematics. In classical theory of error correcting codes, we protect several bits of information by adding a few redundant bits, called *parity check bits* added to the transmitted message. Elimination of errors in the received message is performed by using *syndromes*, certain combinations of bits of the received message which allow error detection and correction. The task of protecting quantum information is more formidable and relies upon fascinating phenomena such as *entanglement*, which also enables communications with speeds greater than light, and suitable analogues of the concepts of parity check bits and syndromes. About 15 years ago Peter Shor invented a *quantum circuit* (see figure above) consisting of 9 qubits (subsequently improved to 5 qubits) which allows for perfect reconstruction of 1 qubit of quantum information. Today, quantum information is a vibrant field, rich in interaction of ideas from mathematics and quantum physics. We will start with these fundamental ideas, and proceed to study the subject up to its current state.

**Target audience**

Students interested quantum computing and its emerging applications, including future mathematicians, electrical engineers and computer scientists, with both academic and industrial job goals.

**Textbooks and other course materials**

The general textbook, "Quantum Computation and Quantum Information" by Michael A. Nielsen and Isaac L. Chuang. ISBN: 0521635039, will be used. Additionally, a number of research papers of the vast number of papers written in the areas of classical and quantum error correcting codes will be used in lectures and student assignments.

**Prerequisites and Requirements**

Familiarity with Hilbert spaces or foundations of Quantum Mechanics. Some experience with algorithms and computing. Student is expected to attend lectures, read and deliver a research paper agreed upon with the instructor and complete 4-5 homework assignments.

**How to enroll**

Please express your interest by contacting **both** *sutton@math.arizona.edu* at the Math Graduate Office and me (the instructor) by e-mail at *rychlik@email.arizona.edu* **as soon as possible**, or by **October 7, 2011, 5pm**.