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PY 536 - QUANTUM COMPUTING

Fall 2019

Books:

Required Texts:

• M. A. Nielsen and I. L. Chuang, *Quantum Computation and Quantum Information* (Cambridge University Press). This is a comprehensive and accessible introduction to the subject.

Recommended Texts and Other Sources:

There are many helpful references available to complement the text, including:

• David Mermin's course pages: `http://people.ccmr.cornell.edu/ mermin/qcomp/CS483.html` This is a pedagogical introduction to quantum computing, but does not focus on physical implementations.

• John Preskill's course pages: `http://www.theory.caltech.edu/people/preskill/ph229/` This is an excellent source of information and further references.

There are a number of relevant articles that I will point out as we cover the different topics in class.

Information:

Grading

The grades will be based on homework, a final paper (4 pages in double column, in the American Physical Society Physical Review format), and an accompanying 15min oral presentation (followed by questions) on the same topic as the final paper. This is how your final grade will be computed:

Homework	**30%**
Oral presentation	**30%**
Final Paper	**40%**

Academic conduct

You can collaborate with other students in doing the homework, preparing your oral presentation, and carrying out the research for your final paper. However, the write-up that you hand in for your homeworks and final paper, as well as the slides that you present, should represent your own personal effort. It is the responsibility of all students to know and understand the provisions of the CAS Academic Conduct Code.

COURSE OUTLINE

1. Overview
   - Motivation and basic ideas
   - Quantum bits (qubits)
   - Quantum gates and computation
   - Quantum algorithms
2. Classical computation
   - Turing machines
   - Computational complexity
   - Complexity classes
3. Quantum circuits
   - Qubit operations and quantum gates
   - Universal quantum gates
4. Quantum computation
   - Quantum computational complexity
   - Quantum algorithms
   - Quantum Fourier transform
   - Shor's factorization algorithm
   - Quantum search algorithms
5. Physical implementations
   - Atom traps
   - Josephson junctions
   - The decoherence problem
   - Topological quantum computing
6. Quantum Information – if time allows (depends on the number of students's oral presentations)
   - Entropy and information
   - Von Neumann entropy
   - Quantum cryptography