

# Advanced Quantum Computing Course

## Semester Final Project Requirements

### Part 1: Quantum Algorithms

For paper assignments, I ask students to select their own topic. However, here are some suggested topics:

- A specific algorithm (preferably one not in the textbook) such as:
  - Quantum Fourier Transform
  - Feynman's algorithm
  - Brassard-Høyer-Tapp algorithm (BHT)
  - Aharonov–Jones–Landau algorithm
- An application of quantum algorithms such as:
  - Variational Quantum Eigensolver (VQE) and chemical simulations
  - Quantum algorithm for linear systems of equations (HHL)
- A class of algorithms such as:
  - Quantum Error Correction
  - Quantum Machine Learning
  - Quantum Walks
  - Quantum Key Distribution
  - Superdense Coding
  - Quantum Annealing
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### Part 2: Quantum Information Theory

Students will write a paper discussing challenges to quantum computing. I am looking for a deep dive into whatever topic you choose, demonstrating that you have mastered that topic. The student can choose the specific topic. Papers should be at least 2000 words and use IEEE format. Potential topics include

- Quantum Information Theory
  - Applications of quantum information theory to some field
  - Quantum relative entropy
  - Quantum cognition
  - Holevo's theorem
  - Nielsen's theorem
  - Quantum computer memory

- Quantum depolarizing channel
- Quantum Machine Learning

## Part 3: Programming Project

This is a programming assignment. However, you have a choice in how you do it::

- Take an algorithm we covered in class and implement it in three separate programming languages. Then write a brief paper comparing and contrasting the implementation and the differences in the programming languages. You will turn in the source code and the paper.
- Choose an algorithm we have not covered, implement it in the programming language of your choice, along with a paper describing the algorithm, and explaining your choice of algorithm and programming language.

Either way deliverables will be a paper and working source code.