Orientation + Seminar 1

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Class	Quantum Computing Fundamentals
Type	Seminar
Reviewed	☐
Date	@September 18, 2022
Materials	

Components of Final Grade:

- Homework = 50%
- Lab Attendance = 40%
- Course Evaluations (Completion) = 10%

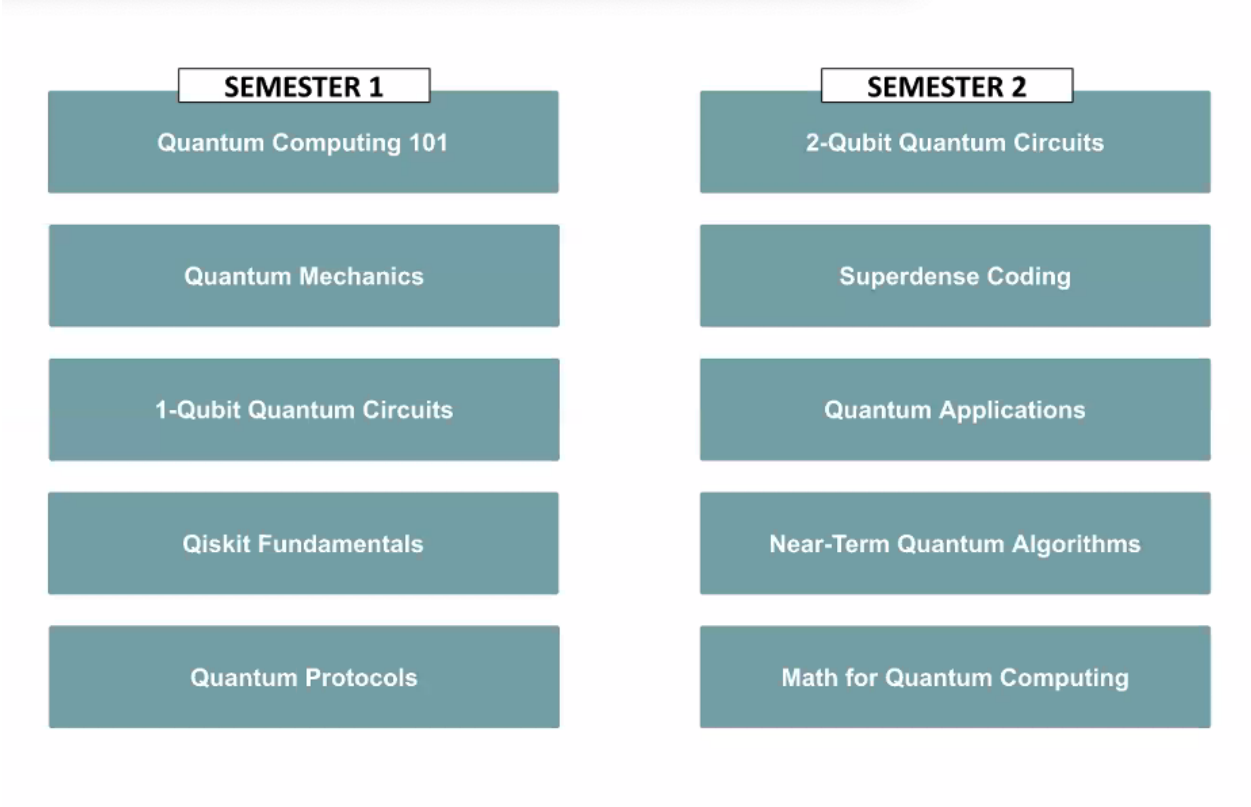
Course Holidays/Breaks:

- Thanksgiving: (Nov. 20 - 26, 2022)
- Winter Break: (Dec. 18 - Jan. 7, 2023)
- Spring Break: (April 9 - 15, 2023)

Communication:

- Primarily through Zoom, Email, and Canvas
- student@qubitbyqubit.org

Course Overview:



Post-Course Programs with QxQ:

- Early Quantum Career Immersion Program
- Alumni Opportunities

What is Quantum Computing?:

- Uses properties of quantum mechanics to solve computations that traditional computers cannot
- Quantum mechanics - describes how really small objects behave
  - Atoms, electrons, and more
  - These really small objects do not obey the law of classical physics
- Quantum World Properties:
  - Superposition
    - Objects can be in multiple states

        - Schrodinger’s cat: Cat is both alive and dead
    - Tunneling:
        - Objects can pass through physical barriers
    - Teleported:
        - Information can be teleported over large distances
- 3 important quantum mechanical properties in quantum computing
    - Superposition
    - Interference
    - Entanglement
        - Example: If objects are entangled, they’re answers will instantly be different
- Quantum computing harnesses these properties to make computing faster and more powerfully
    - But q-computers solve problems in a fundamentally different way
    - Traditional computers do inherently the same type of computations but may vary in the speed of computation
    - Q-computers take it a step further through quantum computation
- Purposes for q-computation:
    - Moore’s Law:
        - Squeezing more power into a computer means the smallest parts (bits) are getting smaller
        - Computing power is predicted by the law to exponentially double every year
        - The problem associated with the law is that the smaller size of the bits is approaching the size of atoms where the world of quantum mechanics beings to take shape
        - The growth is becoming to plateau and hit a limit in the future
- Why not use the quantum mechanics of really small bits?
    - First Quantum Revolution:

        - Scientists met and discussed that the physics of the small world was different than traditional physics
        - They developed the principles of quantum mechanics as a result
    - Quantum mechanics already integrated into day to day life already
    - Second Quantum Revolution:
        - Focused on controlling individual quantum systems and in turn develop powerful new technologies
        - Q-computing is part of a bigger field: Quantum information science and engineering (QISE)
            - Quantum sensing - more powerful sensors
            - Quantum networking - distributing information
- Application of Quantum Computing
    - Advantages over traditional computers:
        - problems that involve searching through lists
        - encryption related problems
        - simulating quantum mechanical systems
    - Applications in fields:
        - Finance
        - Cyber Security
            - Shor’s algorithm (a big enough of q-computer could hack into modern crypto systems)
            - Threaten to break commonly used encryption methods
            - Q-computers could create unhackable security networks
        - Biology
        - Chemistry
        - Aerospace
        - Robotics/Machine Learning

- Combatting Climate Change:
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- Main barrier in reaching new developments is dependent on how these large, less noisy q-computers can be developed
  - Hopeful estimate: 5-10 years
- The Current Quantum Ecosystem
  - ExxonMobile
  - BMW
  - Goldman Sachs
  - Cleveland Clinic & IBM Quantum