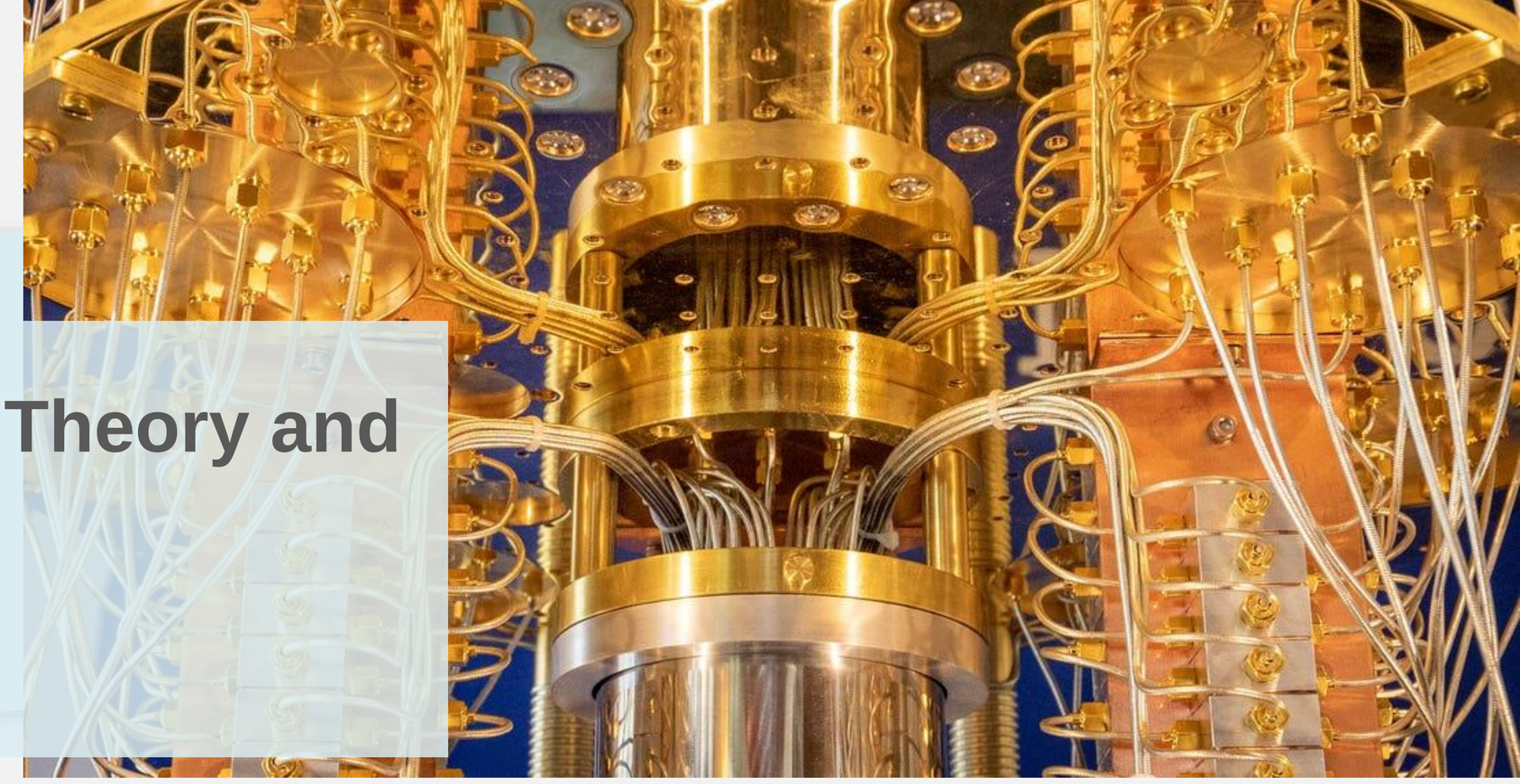
UNIVERSITÉ Concordia UNIVERSITY



Quantum Information Theory and Coding

Outline

Why Quantum Computing?

Quantum computers have revolutionized computation by making certain types of classically intractable problems solvable. What makes quantum computers so powerful is performing calculations based on the state of Quantum bits (Qubits) before their state is measured. This allows quantum computers to work in very huge state space and hence process exponentially more data compared to classical computers. Any collapse of these states due to interaction with the environment results in this huge space collapsing to the classical state space of size 2^n. In order to perform at their best, quantum computers should be protected against state space collapse (decoherence). Therefore, the use of error correction is essential in quantum computing. The superiority of quantum computers has an adverse effect on the commonly used cryptosystems. By making factoring several orders of magnitude faster crypto schemes such as RSA will be put at risk. Fortunately, quantum computing offers new approaches to cryptography safe in the post-quantum era.

Given the accelerating progress in quantum computing hardware and the recent advances in the development of algorithms for sorting, cryptography, and error control coding, this course opens an avenue to new information technologies beyond the current limitations. Throughout this course, you will receive a solid grounding in quantum information theory, quantum coding, and quantum cryptography. Additionally, the course will cover the programming and implementation of quantum computers.

The goals of this course:

- **Familiarizing students with programing quantum devices.**
- **Enabling students to participate in the development of new quantum computers.**

The course will cater to:

Computer scientists, electrical engineers, physics and mathematics students.

Areas to be covered:

- **Basic Ideas of Quantum Mechanics**
- **Mathematical Formulations in Quantum Computations**
- **Quantum Information Theory**
- **Quantum Teleportation**
- **Quantum Error-Correction**
- **Quantum Stabilizer and CSS Codes**
- **Modern Cryptography**
- **Quantum Parallelism**
- **Quantum Fourier Transform and its Applications**
- **Quantum Cryptography**

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Course Information:

Quantum Information Theory & Coding (COEN 691)

Time and Place: Online, Fall 2022

Instructor: Prof. M. R. Soleymani