Quantum Computing: Foundations to Frontier
CSC2451HF/MAT1751HF

Essentials.

- **Instructor**: Henry Yuen
- **Course website**: `http://www.henryyuen.net/classes/fall2018`
- **Piazza site**: `http://piazza.com/utoronto.ca/fall2018/csc2451mat1751`
- **Place and time**: Bahen 1220, Wednesdays 2-5pm
- **Office hours**: by appointment

Description. This graduate course will give a broad overview of the field of quantum computing. We will start with a crash course in the fundamentals of quantum computing (qubits, quantum circuits, basic quantum algorithms such as Grover's search algorithm and Shor's factoring algorithm). Armed with the basics, we will then explore topics at the frontier of quantum computing: quantum simulation, quantum cryptography, connections with physics, quantum machine learning algorithms, and quantum supremacy. Students will make project presentations at the end of the course.

Prerequisites. This is a theoretical course that requires mathematical maturity and a strong background in linear algebra and probability theory. No background in physics is required. Some familiarity with algorithms and complexity is a plus, but also not required.

Grading. Grades will be determined by:
50% project
40% problem sets
10% participation (lecture scribing, asking good questions in class and participating in Piazza discussions)

Project. The course project is an important part of the class. With a partner, you will choose a topic at the frontier of quantum computing, read the relevant papers, and write a 10-15 page report of what you have learned. The report can be an in-depth survey, or better yet can be original research. Finally, in the last class session, you will give a $\sim$15 minute project presentation.

I will separately provide a list of suggested project topics, as well as additional guidelines.

Problem sets. There will be approximately 4 problem sets. Collaboration on problem sets is encouraged, but please limit the groups to size three or less. Your writeups should also have the names of your collaborators.

Scribe notes. One way to fulfill the participation grade is to scribe either the first half of lecture, or the second half. The scribe notes need to be written up in LaTeX using the provided template, and sent to me within 48 hours of the lecture. These notes will be posted on the course website, and will be a useful resource not only for students in the class, but for other researchers!

Questions and answers. We will use Piazza for course announcements, problem sets, solutions, finding homework/project collaborators, and help with homework. Questions you may have for me should be posted on Piazza, as usually many others are wondering the same thing!

Textbooks. There is no official textbook for the course, but here are some recommended ones:

- *Quantum Computation and Quantum Information* by Michael Nielsen and Isaac Chuang
- *An Introduction to Quantum Computing* by Phillip Kaye, Raymond Laflamme, and Michele Mosca
- *Quantum Computing Since Democritus* by Scott Aaronson

There are lots of quality courses online with lecture notes; links can be found at

`http://henryyuen.net/resources/`

Important dates.

- **September 12**: First meeting of the course
- **September 24**: Last day to add course for credit
- **October 17**: Project proposal due
- **October 29**: Last day to drop course without penalty
- **November 7**: No class, reading week
- **December 5**: Project presentations, last meeting of the course