State University of New York Polytechnic Institute
CS 528 : Quantum Computing

Instructor:	Dr. Chen-Fu Chiang
Term:	Spring 2019
Time:	MW 2:00 pm - 3:15 pm
Location:	Kunsela Hall C006
Office Hours:	MW: 10:30 am - 11:30 am | 3:30 pm - 4:30 pm
	F: 10:40 am - 11:50 am (MAT 115 recitation) | by appointment
Office:	Kunsela C225
Email:	chiangc@sunypoly.edu
Phone:	315-792-7379

Required Text

An Introduction to Quantum Computing
Phillip Kaye, Raymond Laflamme and Michele Mosca
Oxford, ISBN-10: 019857049X

References

Quantum Computation and Quantum Information
M. Nielsen and I. Chuang
Cambridge University Press, ISBN-10: 9781107002173

Quantum Algorithms via Linear Algebra: A Primer
R. Lipton and K. Regan
MIT Press, ISBN-10: 9780262028394

Useful Online Lecture Notes

Quantum Computing Lecture Notes by Stephen Fenner
Quantum Computing Lecture Notes by Ronald de Wolf
Quantum Computing Lecture Notes by Mark Oskin

Prerequisites

1. This course is self-contained and students are encouraged to work together in study groups.
2. It is expected the students have some background in matrix linear algebra and probability.

Course Description

Quantum information and computation exploits quantum mechanical rules to process information. As a new branch of interdisciplinary science, it has both fundamental and technological implications. This course is designed to introduce graduate computer science students (or advanced undergraduate students) to the fundamentals of quantum computing and its applications.

Student Learning Outcomes
Upon completion of this course the student should be able to:

- Describe the Foundations of Quantum Systems
- Interpret the Quantum Circuit Model
- Explain the Physical Principles of Quantum Computation
- Apply the Core Quantum Algorithms

Topics

- Linear Algebra & the Dirac Notation
- Qubits and the Framework of Quantum Mechanics
- Quantum Circuit Model
  1. Quantum Gates
  2. Universal Sets of Quantum Gates
  3. IBM Qiskit software or Microsoft Q# programming language
- Superdense Coding and Quantum Teleportation
- Quantum Algorithms
  1. Deutsch algorithm, Deutsch-Jozsa algorithm
  2. Bernstein-Vazirani algorithm, Simon's algorithm
  3. Quantum Fourier Transform, Phase Estimation
  4. Amplitude Amplification Algorithms: Grover's Algorithm, Quantum Counting
  5. Discrete Time Quantum Walk and Continuous Time Quantum Walk
  6. Quantum Gradient Descent
- Quantum Machine Learning and Quantum Artificial Intelligence
- If time allows, we will explore topics such as Quantum Cryptography

Grading (Tentative)
The lecture format will be the basic mechanism used in the course. Computer demonstrations in the classroom will be used whenever appropriate. Assessment of student performance will use a criterion-referenced model which will include written assignments (30%), regular examinations (midterm 25%), presentation along with a short report regarding either quantum algorithms or implementation via quantum programming languages (20%), and a comprehensive final exam (25%). Late assignment will not be accepted unless you have made prior arrangements with me. The acceptable format of your solution will be specified in the assignment. All examinations are closed-book. A typical grading scale will be as follows:

Percent	Grade
[89.5 - 100]	A
[79.5 - 89.5)	B
[69.5 - 79.5)	C
[59.5 - 69.5)	D
Below 59.5	F

(+/- modifiers will also be used ; for instance, [95.5-100]: A+, [92.5-95.5): A, [89.5-92.5): A-)

Attendance Policy
Attendance and active class participation are required. Be prepared to participate by asking and answering questions during class meetings. Please send me an email if you know you have to miss a class.

Academic Integrity/Policy
Plagiarism and Cheating of any kind on an examination, quiz, or assignment will result at least in an F for that assignment (and may, depending on the severity of the case, lead to an F for the entire course).

I will assume for this course that you will adhere to the academic creed of this University and will maintain the highest standards of academic integrity. In other words, do not cheat by giving answers to others or taking them from anyone else. The code of academic conduct is detailed in the SUNY Poly student handbook. Make-ups are only given under extreme circumstances. I will adhere to the standards of academic integrity, so please do not ask me to change (or expect me to change) your grade illegitimately or to bend or break rules for one person that will not apply to everyone.

Accommodations for Students with Disabilities registered at SUNY Polytechnic Institute
Accommodations for Students with Disabilities In compliance with the Americans with Disabilities Act of 1990 and Section 504 of the Rehabilitation Act, SUNY Polytechnic Institute is committed to ensuring comprehensive educational access and accommodations for all registered students seeking access to meet course requirements and fully participate in programs and activities. Students with documented disabilities or medical conditions are encouraged to request these services by registering with the Office of Disability Services. For information related to these services or to schedule an appointment, please contact the Office of Disability Services using the information provided below.

Evelyn Lester, Director
Office of Disability Services
lestere@sunypoly.edu
(315) 792-7170

Utica Campus
Peter J. Cayan Library, L145

Albany Campus
Suite 309, Students Services Office
NanoFab South