

PHYS 85200-3: Introduction to Hardware & Algorithms of Quantum Computing

Larry S. Liebovitch PhD,

<http://people.qc.cuny.edu/faculty/Larry.Liebovitch/Pages/Default.aspx>

The Graduate Center, City University of New York, 365 Fifth Avenue, New York NY

January 31, 2020 – May 22, 2020: Fridays 2:00 – 4:00 PM, Room 4419

Learning Goals: To Understand the Theory and Use of Quantum Computers

- *hardware and how it works*
- *algorithms needed to solve problems*
- *applications in cryptography and machine learning*

Recommended Textbooks

Quantum Computation by Nielsen and Chuang, 10th Anniversary Edition, Cambridge University Press, 2011.

Quantum Computer Science: An Introduction by N. David Mermin, Cambridge University Press, 2007.

Learn Quantum Computation using Qiskit by IBM <https://community.qiskit.org/textbook/>

IBM-Q: <https://quantum-computing.ibm.com/support/guides/user-guide>

Grading Policy

20% Homework

80% Course Projects

1. Code a quantum algorithm in Qiskit and run it on the IBM Q simulator and IBM quantum computer
2. Report on the quantum computing being done at a company or government lab

Week	Friday	Topic	Nielsen & Chaung	Mermin	IBM	Other
1	1/31/20	1. Introduction & Overview	pp 1-12			https://drive.google.com/file/d/17FRAzCqBDk71jHjCm-usvzz-0GpD6PqFU/view
2	2/7/20	2. Review of Quantum Mechanics	pp 60-97	pp 1-21, 159-167		
3	2/14/20	3. Quantum Gates: Matrices and Hardware	pp 172-200	pp 36-41	https://qiskit.org/textbook/preface.html	
4	2/21/20	4. Programing a Quantum Computer: Qiskit: Quantum Circuits			https://quantum-computing.ibm.com/support	
5	2/28/20	5. Hardware: Nick Bronn from IBM	pp 277-352			
6	3/6/20	6. Cryptography & Shor's Algorithm	pp 582-604	pp 63-87		
7	3/13/20	COVID-19, class canceled				
8	3/20/20	7. Basis of "Quantum Supremacy"	pp 28-36	pp 41-62	https://qiskit.org/textbook/preface.html	
9	3/27/20	8. Machine Learning Quantum Machine Learning			https://qiskit.org/textbook/ch-applications/vqe-molecules.html	
10	4/3/20	9. Bell's Theorem, No Cloning Theorem	pp 111-119	pp 39-40, 136-137, 154-158	https://quantum-computing.ibm.com/support	
11	4/10/20	NO CLASS	Spring Recess			
12	4/17/20	10. Positive Operator Valued Measurement: Dov Fields from CUNY	pp 90-93			
13	4/24/20	11. Complexity of Algorithms: Classical and Quantum: Bryce Fuller from IBM	pp 135-169			
14	5/1/20	12. Student Project Presentations				
15	5/8/20	13. Student Project Presentations				