CSCE 785:
Quantum Computer Science
https://cse.sc.edu/~fenner/csce785/
Course homepage
Course notes on Dropbox/Blackboard (not on the web)
One midterm, one final

Topics
Programming — IonQ
HW Qiskit (IBM)
(O'Reilly: Qiskit Pocket Guide, IBM Quantum)

October 4: Afternoon
IonQ presentation

Topics:
1. Quantum circuits, algorithms
2. Quantum communication protocols
3. Quantum error correction/mitigation

1. Early quantum algos (proof of concept)
Quantum Fourier transform and
Phase estimation
Factoring integers
Quantum search
& simulating physical systems
2. Quantum communication:
Quantum Key Distribution (BB84 protocol)
& Quantum position verification (QPV)

3. Error correction
Quantum Error-correcting codes — stabilizer codes

Physics offers Phys 744
Math 764 Quantum Information Theory

Some History
Feynman 1980s? — classical (nonquantum) computers can't feasibly simulate quantum systems, so what about a quantum computer?
David Deutsch — Quantum Turing Machine (QTM)
1980s
Late 80s? Bernstein & Vazirani: Quantum computational complexity

Late 90s–early 90s
Quantum Circuit model — now standard adopted model of quantum computation
Andrew Yao — QTMs and circuits are equivalent
Peter Shor (early 90s)
Factoring integers is feasible on quantum computer

Shor, Calderbank, Steane, ...
Good quantum error-correcting codes

1996 — Grover (Lov Grover) quantum search in $O(\sqrt{N})$ time

1984 — Bennett, Brassard
Quantum Key Distribution

2000s
Stabilizer codes for error-correction (Gottesman, Aharonov)
Toric codes (Kitaev)
Surface codes (Bravyi, Kitaev)
Color codes (?)
Anyonic quantum computing

Implementations
Superconducting (IBM, ...)
Ion traps, neutral atom traps (IonQ, ...)
NMR — Photonic/optical (Quantinuum, ...)
Adiabatic evolution (Dwave)