Chapter numbers refer to “Quantum Computing: A Gentle Introduction”, by E. Rieffel & W. Polak

01/22 Week 1 (Chap. 2) lecture 1

- Key concepts of Quantum mechanics illustrated by 2-slit experiment: particle/wave duality, effect of measurement on quantum state, role of uncertainty principle,
- 4 postulates of quantum mechanics
- Quantum states as vectors in Hilbert space, ket and bra notation, inner product, operators (brief)
- Superposition principle, finite dimensional Hilbert spaces

01/27 - 01/29 Week 2 (Chap. 3, Chap. 4) lectures 2 and 3

- Measurement principle, Qubits, physical realizations
- Bloch sphere
- QKD 1 (BB84)

02/03 - 02/05 Week 3 (Chap. 5) lectures 4 and 5

- Operators, Schrodinger equation, unitary evolution,
- Operations on Bloch sphere, Pauli operators, quantum gates, quantum circuits
- Multiple qubits, tensor products, entanglement, LOCC
- Bell measurements and inequalities

02/10 - 02/12 Week 4 (Chaps. 6, 7) lectures 6 and 7

- QKD2, no cloning, superdense coding, teleportation
- Universality, quantum circuits
- Reversible computation, Boolean functions, quantum analogs of classical gates

02/19 Week 5 (Chap. 7) lecture 8

- Deutsch-Jozsa algorithm
- Quantum-classical separation, complexity classes

02/24 - 02/26 Week 6 (Chaps. 7, 8) lectures 9 and 10

- Walsh-Hadamard, DJ revisited, Bernstein-Vazirani algorithm
- **Midterm 1: Wednesday, February 26**

03/02 - 03/04 Week 7 (Chap. 9) lecture 11

- Quantum Fourier Transform, Simon's algorithm
- Shor’s algorithm for factoring

03/09 - 03/11 Week 8 (Chap. 10) lectures 12 and 13

- Quantum Phase Estimation (QPE) for energy eigenvalues and eigenvectors
- Grover's quantum search algorithm

03/16 - 03/18 Week 9 (Chap. 10, Chap. 11) lectures 14 and 15

- Mixed states, density operators, decoherence and dephasing
- Open quantum systems, superoperators, Kraus maps
- Qubit error models

03/23 - 03/29 Week 10 Spring break

03/30 - 04/01 Week 11 lecture 16

- Classical and quantum error correction codes
- **Midterm 2: Wednesday April 1**

04/06 - 04/08 Week 12 (Chap. 11, Chap. 12) lectures 17 and 18

- Quantum error correction with stabilizer formalism
- Fault tolerance and threshold theorem
- Benchmarking quantum computers - state, process and gate tomography

04/13 - 04/15 Week 13 (Chap. 13) lecture 19

- Adiabatic Quantum Computing, Quantum Simulations
- Quantum Supremacy

04/20 - 04/22 Week 14

- Experimental QC with trapped ions - guest lecturer
- Experimental QC with superconducting qubits - guest lecturer
-

04/27 - 04/29 Week 15

- Project presentations
- Project presentations