Introduction to Quantum Computing

WEEK 1: Modern Cryptography and Shor's Algorithm

The course officially kicks off!

In the first week of this course, you'll learn about the history and uses of modern cryptography and the RSA cryptosystem. You'll then explore the Quantum Fourier Transform and its use in Shor's algorithm to compromise RSA.

The week concludes with a deep dive on prototype demonstrations of Shor's algorithm.

Entrance Survey	**5 min**
Pre-Assessment	**10 min**
Get Started	**35 min**
• Welcome	2 min
• Course Schedule	4 min
• Course Collaboration Tools	5 min
• Course Webinar	5 min
• Who's in the Course	2 min
• Who's Teaching the Course	3 min
• Grading and Completion Criteria	3 min
• Certificate Information and CEUs	2 min
• Course Structure and Learning Experience	3 min
• Learning Objectives and Pedagogy	3 min
• Software Requirements/IBM Q Experience	1 min
Modern Cryptography and Shor's Algorithm	**3-4 hours**
• Introduction	10 min
• Modern Cryptography	15 min
• RSA Cryptosystem, Factoring, and Shor's Algorithm	20 min
• Deep Dive: Cryptography and Shor's Algorithm	35 min
• Case Study: Demonstrations of Shor's Algorithm	45 min
• Check Your Understanding Questions	15 min
• Graded Activity	30 min
• Key Images	3 min

WEEK 2: Quantum Cryptography

In Week 2, you'll continue your exploration of cryptography by examining secure communication schemes enabled by quantum mechanics.

You'll learn about single and entangled photons, their generation and detection, and their use in quantum key distribution.

The week concludes with quantum- enabled random number generators and quantum teleportation.

Quantum Cryptography — 4-5 hours

• Introduction	15 min
• Post-Quantum Cryptography	15 min
• Single Photon Schemes	20 min
• Entangled Photon Schemes	30 min
• Random Number Generators	30 min
• Quantum Repeaters	30 min
• Check Your Understanding Questions	20 min
• Graded Activity	20 min
• Key Images	3 min

WEEK 3: The Quantum Hamiltonian Simulation Problem and Algorithm

The third week of the course focuses on quantum simulation.

You'll learn about Hamilton simulation, phase estimation, and their applications to quantum chemistry, including a case study on variation quantum eigensolvers.

The Quantum Hamiltonian Simulation Problem and Algorithm

4-5 hours

• Webinar with Dr. William Oliver	1 hr.
• Introduction	15 min
• Hamilton Simulation	25 min
• Quantum Simulation: Chemistry	30 min
• Case Study: VQE in Practice	30 min
• Check Your Understanding Questions	20 min
• Self- and Peer-Assessment Activity	1.5 hours
• Graded Activity	30 min
• Key Images	3 min

WEEK 4: Quantum Optimization

The fourth week of the course will focus on quantum optimization.

You'll start the week by learning about adiabatic quantum computing and quantum annealing. You'll then explore a specific example of a digital simulation: Grover's algorithm.

Finally, you'll put into practice what you have learned in the IBM Quantum Experience practicum.

Quantum Optimization	4-5 hours
• Introduction	5 min
• Adiabatic Quantum Computing	45 min
• Quantum Annealing & Polynomial-Speedup Quantum Algorithms	45 min
• Digital Simulation: Grover's Algorithm	25 min
• Lab Practicum: Grover's Algorithm	2 hours
• Check Your Understanding	30 min
• Graded Activity	30 min
• Key Images	3 min
• Acknowledgements	2 min
• Exit Survey	10 min
• Post-Assessment	5 min

After the Course Ends…

Download your certificate.

Last Day of the Course

- Course ends at 23:30 UTC

Two Days after the Course Ends

- Download your Course Certificate from your student dashboard.

90 Days after the Course Ends

- Course closes and all content is archived.