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Introduction to Quantum Computing

WEEK 1: Introduction to Quantum Computing

The course officially kicks off!

The first part of Week 1 is a historical introduction to classical and quantum computing.

In the second part, you will learn and practice some of the basic concepts of quantum computing, including a section on mathematical tools necessary for the following weeks.

In the third and final part of this week, you will be introduced to quantum algorithms and quantum computing approaches.

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?	3 min
• Who's Teaching the Course?	4 min
• Grading and Completion Criteria	3 min
• Certificate Information and CEUs	3 min
• Course Structure and Learning Experience	3 min
• Learning Objectives and Pedagogy	3 min
• Software Requirements	1 min
Introduction to Quantum Computing	**3-4 hours**
• Introduction & Types of Computing	25 min
• History of Classical Electronic Computing and Quantum Computing	15 min
• How Is a Quantum Computer Different?	45 min
• Quantum Gates	35 min
• Universal Quantum Algorithms	10 min
• Quantum Simulation, Emulation, and Annealing	15 min
• Check Your Understanding Questions	30 min
• Graded Activity	30 min
• Key Images	3 min

WEEK 2: Leading Qubit Modalities

In Week 2, you will learn the requirements for the physical realization of a quantum computer and for achieving quantum communication.

Next, you will learn about one of the most significant obstacles in quantum computing – decoherence, or the loss of information.

Then you will learn and compare the most current qubit modalities.

Finally, in the case studies, you will gain more experience in the two leading modalities: Trapped ions and superconductor qubits. Here, you will not only learn more about the theory, but you will also hear scientists describe and show their laboratories.

Leading Qubit Modalities	**4-5 hours**
• What Makes a Good Qubit Modality?	15 min
• Qubit Robustness	25 min
• Qubit Modalities	35 min
• Case Study: Trapped-Ion Quantum Computers	40 min
• Case Study: Superconducting Qubit Quantum Computers	50 min
• Check Your Understanding Questions	30 min
• Graded Activity	30 min
• Key Images	3 min

WEEK 3: Applications of Quantum Information

In the first part of this week, you will learn about quantum algorithms and the computational power of quantum computers, also called quantum advantage and quantum speed-up.

In the second part, you will learn about the fundamentals of quantum communication and current communication protocols, including quantum key distribution.

In the third part of this week, you will go through a case study presenting industry perspectives of quantum computation, including IBM, Google, Microsoft, QCI, IonQ, Rigetti, and D-Wave.

Finally, in this week's Deep Dive, you will learn in more detail about computational complexity.

Applications of Quantum Information	**4-5 hours**
• Webinar with Dr. William Oliver	1 hr.
• Quantum Algorithms and Their Potential Speed-Up	30 min
• Quantum Communication	35 min
• Case Study: Industry Perspectives	25 min
• Deep Dive: Introduction to Computational Complexity	35 min
• Self and Peer Assessment Activity	1.5 hours
• Check Your Understanding Questions	30 min
• Graded Activity	15 min
• Key Images	3 min

WEEK 4: A Simple Quantum Algorithm in Practice

In the first part of Week 4, you will learn about the classical and quantum circuit models and compare them at a high level.

Then, you will learn about the Deutsch-Josza Algorithm, with examples for one and two qubit systems.

Next, you will learn about quantum software and programming tools for quantum computers. Specifically, you will be introduced to OpenQASM and its GUI interface composer.

Finally, you will participate in the IBM Quantum Experience or IBM QE. Here, you will practice what you learned about OpenQASM, and use it to implement the Deutsch-Josza Algorithm in a real quantum computer.

A Simple Quantum Algorithm	4-5 hours
• Circuit Models	10 min
• The Deutsch-Jozsa Quantum Algorithm	10 min
• Quantum Software	15 min
• IBM QE: QASM	40 min
• Lab: IBM QE: Deutsch-Jozsa Algorithm	2 hours
• Check Your Understanding Questions	30 min
• Graded Activity	30 min
• Key Images	3 min
• Post-Assessment	10 min
• Exit Survey	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 Course 2 Ends

- Course closes and all content is archived.