Quantum Computing Fundamentals Training

Duration: **3 Day**

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As the field of quantum computing continues to evolve and advance, there is a growing need for professionals with the knowledge and skills to tackle the complex challenges and opportunities it presents.

This comprehensive course is designed to provide participants with a thorough understanding of the fundamental principles and practical applications of quantum computing. Through a blend of theoretical and hands-on learning, participants will gain a deep appreciation for the potential of this cutting-edge technology and be equipped with the skills needed to make a real impact in the field.

Whether you are a researcher, security practitioner, engineer, or simply interested in this exciting and rapidly evolving field, this course offers a unique and valuable opportunity to gain the knowledge and skills needed to succeed in the quantum era.

Topics covered in the course;

- Introduction to quantum computing
- Postulates of Quantum Mechanics
- Bloch sphere
- IBM Quantum Entanglement
- Quantum Gates
- No Cloning Theorem
- Quantum algorithms
- Programming in Qiskit

Prerequisites

Learners should be familiar with matrix multiplication, vectors, and complex numbers.

What You Will Learn

You will;

- Gain the skills to accurately calculate the probabilities of quantum states
- Obtain the knowledge and tools necessary to effectively illustrate quantum bits
- Have the ability to write quantum circuits using the Qiskit language
- Become proficient in utilising the Quantum Computer of IBM

Training Outline

Day 1

Introduction to Quantum Computing

- Introduction of the course

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- Motivations behind quantum computing
- Description of a Quantum Phenomenon

The Postulates of Quantum Mechanics

- Four postulates
- Quantum bits (qubits)
- Quantum registers (quregisters)
- Quantum gates
- Extracting information from quantum registers (Measurements)

IBM Quantum

- Entanglement
- Implementation examples for qubits

Elements of classical digital technology

- Logical gates and circuits
- Synchronous Sequential circuits

Day 2

Quantum Gates

- One Qubit Gates
- Two (or more) Qubits Gates

Quantum Circuit Model

- Quantum Circuit: Overview
- The beam-splitter experiment

How to prepare a superposition?

- Preparing an arbitrary quantum state

No cloning theorem

- No Cloning Theorem - Proof

Quantum Algorithms

- Receipt of quantum algorithm design
- Initialization
- Quantum parallelism
- Amplitude amplification
- Measurement
- Classical post-processing
- Algorithms with polynomial speedup
- Grover's algorithm

Day 3

Quantum Algorithms

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- Algorithms with superpolynomial speedup
- The Deutsch-Jozsa Algorithms
- Quantum Fourier Transform
- Phase estimation
- Deutsch-Jozsa algorithm and phase estimation
- Quantum Counting
- Shor's Algorithms
- Quantum optimization

Programming Quantum Computers

- The main approaches
- Qiskit
- Q#
- IBM Quantum
- Xanadu Quantum Computer

Summary and outlook

- Post quantum cryptography
- Quantum communications