

Training Schedule

WEEK-1

Day 1: Fundamentals of Quantum Computing

- Introduction to Quantum Computing
- Qubits, superposition, entanglement, and quantum gates
- Basic quantum gates: Pauli-X, Pauli-Y, Pauli-Z, Hadamard, and CNOT gates
- Quantum circuits and measurement basics
- Hands-on: Setting up quantum computing environments

Day 2: Python Programming for Quantum Computing

- Python essentials for quantum and scientific computing
- Functions, loops, object-oriented concepts
- Use of NumPy, SciPy, and Matplotlib for linear algebra and visualization
- Jupyter notebooks for interactive quantum experimentation

Day 3: Quantum SDKs and Development Platforms

- Overview of quantum software stacks and cloud quantum ecosystems
- Introduction to Qiskit: architecture and installation
- Building and executing quantum circuits
- Simulating quantum operations and visualizing results
- Hands-on: Execution of basic quantum programs

Day 4: Quantum Data Representation and Encoding

- Quantum state representations: state vectors, density matrices, tensors
- Encoding classical data into quantum states
- Introduction to quantum feature representations
- Quantum Principal Component Analysis (QPCA)
- Hands-on: Representing classical data in quantum states using Qiskit and PennyLane

Day 5: Quantum Circuits and Core Algorithms

- Concept and design of quantum circuits
- Manipulation of quantum states using gates
- Overview of basic quantum algorithms
- Grover's Search Algorithm: theory and implementation
- Hands-on: Implementing Grover's algorithm

WEEK-2

Day 6: Machine Learning Basics

- Machine Learning Foundations
- Supervised Vs Unsupervised learning
- Key Machine Learning Algorithms
- Hands-on: Building a simple ML model

Day 7: Quantum Machine Learning – Concepts & Hybrid Models

- Introduction to Quantum Machine Learning (QML)
- Types of QML: supervised, unsupervised, and hybrid approaches
- Variational Quantum Circuits (VQCs)
- Hybrid quantum–classical learning workflows
- Challenges in training QML models (noise, barren plateaus – overview)

Day 8: Advanced Quantum Optimization & Healthcare Applications

- Variational Quantum Eigensolver (VQE)
- Quantum Approximate Optimization Algorithm (QAOA)
- Hands-on: Implementing QAOA/VQE for optimization problems
- Quantum computing in healthcare
- Quantum-assisted early disease diagnosis
- Hands-on: Healthcare-related quantum ML classification use case

Day 9: Quantum Networking and Quantum Communication

- Quantum Key Distribution (QKD) principles and protocols
- Quantum teleportation and superdense coding

- Vision and challenges of the Quantum Internet
- Hands-on: Simulation of quantum-secure communication protocols

Day 10: Industry Visit & Evaluation

- Guest lecture by industry expert.
- Industry visit to Quantum NMR Lab at IISER Mohali
- Written Quiz and feedback

Course Summary

The course covers quantum computing fundamentals, quantum circuits, algorithms, and quantum SDKs in the first week, followed by quantum machine learning, optimization, healthcare applications, quantum networking, and big data analytics in the second week. Participants will gain hands-on experience with Qiskit, PennyLane, and quantum-enhanced algorithms, preparing them for real-world quantum applications through theory, practical exercises, and assessments.