

QUANTUM-SAFE SYSTEMS: COMPUTING, SECURITY & COMMUNICATION

30-09-2026 to 13-10-2026

Training Schedule

WEEK 1:

Introduction to Quantum Computing

- Fundamentals of quantum computing, evolution from classical to quantum paradigms
- Core principles, advantages, and key application areas

Quantum Mechanics for Computation

- Qubits, superposition, entanglement, quantum states
- Measurement and probabilistic outcomes in quantum systems

Mathematical Foundations for Quantum Logic

- Linear algebra essentials: vectors, matrices, inner products, linear operators
- Pauli matrices, eigenvalues, and eigenvectors used in quantum algorithms

Quantum Programming Ecosystem

- Overview of quantum computing platforms, simulators, and SDKs
- Designing and executing quantum circuits

Python Programming for Quantum Computing

- Basics of Python relevant to quantum computing: syntax, data types, control flow
- Core data structures, functions, and modular programming

Hands-on Session

- Introduction to quantum simulators
- Writing basic Python-based quantum programs
- Constructing simple quantum circuits

Quantum Gates and Circuit Design

- Single- and multi-qubit gates, circuit composition
- Entanglement generation, Bell states
- Visualization and simulation of quantum circuits using Qiskit

WEEK 2:

Quantum Algorithms

- Foundational quantum algorithms for search and optimization
- Quantum computational speed-up and algorithmic workflows
- Implementing Grover's Algorithm and simple quantum circuits on Qiskit

Quantum Communication Fundamentals

- Principles of quantum communication
- Quantum channels and entanglement-based communication
- Secure information transfer using quantum protocols

Quantum Communication Protocols (Hands-on Qiskit Implementation)

A. Quantum Teleportation

- Using entangled Bell pairs to transmit unknown quantum states
- Alice measures, sends classical bits, Bob applies Pauli operations
- Fully implementable on Qiskit simulators

B. Superdense Coding

- Send 2 classical bits using 1 qubit via entangled pair
- Circuit construction and simulation in Qiskit

C. Quantum Key Distribution (BB84 Protocol)

- Simulate BB84 QKD using quantum circuits, measurement, and classical post-processing
- Hands-on Qiskit examples (tutorials and pre-built circuits)

Hands-on Labs and Mini Project

- Guided lab exercises implementing quantum gates, algorithms, and communication protocols
- Case study: Simulate a secure communication scenario combining teleportation, superdense coding, and QKD
- Reinforce theoretical concepts through practical execution on Qiskit simulators

Course Summary

This training programme provides an introduction to Quantum-Safe Systems with emphasis on quantum computing, secure communication, and emerging cybersecurity technologies. The main objective of the course is to provide participants with exposure to quantum mechanics, quantum programming using Python and Qiskit, quantum algorithms, and secure communication protocols such as Quantum Teleportation, Superdense Coding, and Quantum Key Distribution (BB84). The programme also includes practical lab sessions to build hands-on experience in quantum circuit design and simulation for next-generation secure computing and communication systems.