ATIS-2025 Workshop and Training Unit Guide

Quantum Programming Techniques for Information Security

15–19 November 2025
2 hours/day
Hybrid (Global)
Hands-on with Qiskit

Main Content

1. Welcome

The ATIS-2025 Training Program on "Quantum Programming and Techniques for Information Security" is an intensive, five-day immersion that equips IT graduates and early-stage researchers with a rigorous foundation in quantum computation, secure quantum communication, quantum machine learning (QML), and quantum federated learning (QFL). You will move from core quantum information concepts to hands-on, security-oriented implementations using Qiskit and related frameworks, culminating in a capstone mini-project that integrates cryptography and learning.

What to expect:

- Hybrid delivery with global access; all sessions recorded.
- Concept-first lectures tightly coupled with structured, hands-on labs.
- Agile micro-assessments (daily mini-tasks) to consolidate learning.
- A capstone integration task that models real-world quantum-secure AI workflows.

Participants who complete all sessions and daily tasks will receive a Certificate of Achievement recognizing competency in theoretical and applied Quantum Computing and Information Security.

2. Who is the teaching team?

Program Chair: Dr Shiva Pokhrel (Deakin University, Australia)

Program Co-chairs: Dr Moayad Aloqaily, Dr. Bahaa Al-Musawi, Dr. Ali Hilal Ali, Dr. Safa Otoum

Lecturers and Module Leads: Shanika Nanayakkara, Dev Gurung, Baobao Song, Navneet Singh, Devashish Chaudhary, Swathi Chandrasekhar

Instructors and module leads:

- Day 1 (Quantum Information Foundations): Dev, Navneet, Baobao, Devashish
- Day 2 (Quantum Cryptography & Secure Communication): Shanika, Devashish, Swathi
- Day 3 (Quantum Machine Learning): Navneet, Swathi
- Day 4 (Quantum Federated Learning): Dev, Baobao, Shanika

- Day 5 (Advanced Applications & Capstone): All instructors

Program coordination:

- Program coordination and moderation will be shared by the Day Leads.
- Live session facilitation, Q&A moderation, and lab support will be provided in each session.

3. Administrative and registration information

- **Mode:** Hybrid (attend live online or onsite where available), recordings provided
- Communication: Check your registered email for meeting links, updates, and portal access
- **Learning Portal:** You will receive login details in your email
- **Support:** A help desk channel (Teams) will open 24 hours assistance

4. About this program

- **Audience:** IT graduates, early-stage researchers, and practitioners transitioning into quantum-secure systems
- **Prerequisites:**
  - Comfortable with linear algebra basics (vectors, matrices), complex numbers
  - Programming in Python (intermediate level)
  - Basic ML concepts (for Days 3–4 helpful but not mandatory)
- **Program goals:**
  - Build a principled foundation in quantum information and security
  - Apply Qiskit to implement key protocols and learning workflows
  - Understand integration of QKD, QML, and QFL into secure pipelines
  - Evaluate performance and reliability under noise and resource constraints

5. Program improvements and participant feedback

Based on prior ATIS cohorts and pilot workshops, we have:

- Expanded Hands-on Depth: Guided labs with annotated notebooks and post-session take-home variants

- Multi-timezone Support: Consolidated daily schedule with published conversions and recorded sessions
- Agile Mini-Tasks: Daily micro-assessments with rubrics and rapid feedback to reinforce retention
- Capstone Integration: An end-to-end mini-project emphasizing secure quantum-AI pipelines
- Tooling Readiness: Pre-flight environment checks and containerized options for minimal friction

6. Learning outcomes

On successful completion, participants will be able to:

1. Explain core concepts in quantum information (state vectors, operators, gates, measurements, and noise).
2. Implement and simulate quantum circuits and noise models in Qiskit.
3. Design, simulate, and evaluate quantum cryptographic protocols (BB84, teleportation) for secure communication.
4. Build and train basic QML models (VQCs, QNNs) with hybrid optimization using Qiskit Machine Learning.
5. Conceptualize and prototype Quantum Federated Learning workflows with secure aggregation considerations.
6. Integrate cryptography and learning components into a quantum-secure AI pipeline and evaluate fidelity, robustness, and throughput.

Alignment to professional capabilities:

- PC1: Quantum Foundations and Modeling
- PC2: Secure Communication and Cryptography
- PC3: Quantum-Ready Machine Learning
- PC4: Tools and Engineering Practice (Qiskit, Python)
- PC5: Critical Evaluation and Communication
- PC6: Ethics, Privacy, and Security-by-Design

7. Assessment and certification

Hurdle requirements (must complete to be eligible for certificate):

- Daily Mini-Tasks (Days 1–5): Submit via the ATIS Learning Portal by 24 hours after each session

- Engagement: Attend live OR watch recording and complete the embedded checkpoint quiz
- Capstone (Day 5): Integrated mini-project submitted by the end of Day 5

Grading and certification:
- Certificate of Achievement: Awarded upon successful completion of all daily tasks and the capstone
- Commendation (optional): Top submissions (based on rubric) may receive "Certificate with Distinction"

Feedback:
- Rapid feedback is provided on each daily task within 24–36 hours
- Office hours and forum Q&A available for clarifications and iterative improvement

Late submissions:
- Up to 12 hours grace with no penalty if requested via the portal before the deadline
- Beyond 12 hours: acceptance at the discretion of the teaching team due to the short program timeline

Academic integrity:
- Submit your own work; cite any external code or sources used
- We may request brief demos or explanations to validate understanding

8. Daily schedule and time zones

Day 1 (Sat 15 Nov 2025)
- Melbourne (AEDT, UTC+11): 6:40 PM
- Iraq (Baghdad, UTC+3): 10:40 AM
- UAE (Dubai, UTC+4): 11:40 AM
- India (IST, UTC+5:30): 1:10 PM
- China (Beijing, CST, UTC+8): 3:40 PM

Days 2–5 (Sun–Wed, 16–19 Nov 2025) — same time each day
- Melbourne (AEDT, UTC+11): 7:00 PM
- Iraq (Baghdad, UTC+3): 11:00 AM
- UAE (Dubai, UTC+4): 12:00 PM
- India (IST, UTC+5:30): 1:30 PM
- China (Beijing, CST, UTC+8): 4:00 PM
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Note: Links and calendar invite with your local time will be emailed after registration.

9. Your learning experience

- Format per day (approx. 120 minutes):
    - 60 minutes: Conceptual lecture + live demos
    - 45 minutes: Guided hands-on lab (Qiskit)
    - 15 minutes: Q&A, daily task briefing, and wrap-up
- Optional: Post-session office hours / lab clinic (30 minutes)
- Delivery: Hybrid; all sessions recorded and shared within 4 hours
- Collaboration: Discussion forum and help desk channel for peer support and instructor guidance

Typical time commitment:

- Live session: 2 hours/day
- Daily mini-task: 30–60 minutes/day
- Total over 5 days: ~12–15 hours

10. Technology and setup

Minimum requirements:

- Laptop with 8 GB RAM (16 GB recommended), stable internet
- Python 3.10+ and pip
- JupyterLab/Notebook or VS Code with Python extension
- Qiskit core and Qiskit Machine Learning
- Optional: IBM Quantum account (for managed backends) and Git

Quick start (local):

```
python -m venv qenv
source qenv/bin/activate   # Windows: qenv\Scripts\activate
pip install --upgrade pip
pip install qiskit qiskit-machine-learning matplotlib numpy scipy
pip install jupyterlab
jupyter lab
```

Verification snippet:

```
from qiskit import QuantumCircuit, Aer, execute
qc = QuantumCircuit(1,1)
qc.h(0); qc.measure(0,0)
```

```
result = execute(qc, Aer.get_backend('qasm_simulator'), shots=1024).result()
print(result.get_counts())
```

11. Learning resources

Essential:

- Qiskit Textbook: https://qiskit.org/learn
- Qiskit API Docs: https://qiskit.org/documentation/
- Qiskit Machine Learning: https://qiskit.org/ecosystem/machine-learning/
- Core slide decks, annotated notebooks, and lab guides (provided daily via portal)

Recommended:

- Nielsen & Chuang, "Quantum Computation and Quantum Information"
- Watrous, "The Theory of Quantum Information"
- Arute et al., "Quantum supremacy using a programmable superconducting processor," Nature
- Overviews on QKD, VQCs, and QFL (curated reading list in portal)

12. Key dates

- Program window: 15–19 November 2025 (5 consecutive days)
- Session times: See "Daily schedule and time zones"
- Daily mini-task deadlines: Due 24 hours after each session
- Capstone submission: Due by 7:00 pm 26 Nov 2025 (local time shown in portal)
- Certificates issued: After 10+ business days after submission

13. Daily activities and assessments

Day 1: Quantum Information Foundations

Instructors: Dev, Navneet, Baobao, Devashish

- Concepts:
  - Qubits, multi-qubit states, Dirac notation
  - Gates: H, X/Y/Z (Pauli), CNOT, Toffoli
  - Unitary evolution, measurement postulates
  - Noise models: depolarizing, amplitude/phase damping; decoherence
- Hands-on (Qiskit):
  - Build/visualize single- and multi-qubit circuits
  - Simulate state evolution and measurement statistics
  - Explore superposition/entanglement on simulators
  - Add noise models and analyze effects
- Daily mini-task:
  - Create a 2–3 qubit circuit exhibiting entanglement
  - Compare ideal vs noisy outcomes and briefly interpret Bloch vectors or counts
- Outcome:
  - Foundational literacy with circuits, measurement, and noise in Qiskit

Day 2: Quantum Cryptography & Secure Communication

Instructors: Shanika, Devashish, Swathi

- Concepts:
  - Quantum vs classical cryptography; quantum threat models
  - QKD protocols (BB84, E91), teleportation, superdense coding
  - Authentication, eavesdropping detection; post-quantum context
- Hands-on (Qiskit):
  - Simulate BB84 (basis choices, sifting, QBER)
  - Teleportation demo with fidelity measurement
  - Model eavesdropping and analyze error rates
- Daily mini-task:
  - Implement a BB84 simulation with noise and report QBER vs noise level
- Outcome:
  - Practical insight into secure quantum communication workflows

Day 3: Quantum Machine Learning (QML)

Instructors: Navneet, Swathi

- Concepts:
  - Data encoding (angle, amplitude), feature maps
  - Variational circuits (VQCs), QNN architectures
  - Hybrid optimization, gradients, barren plateau intuition
  - Evaluating accuracy, loss, resource trade-offs
- Hands-on (Qiskit Machine Learning):
  - Encode a simple dataset; build/train a QNN classifier
  - Tune circuit depth and optimizer; compare metrics
- Daily mini-task:
  - Train a small QNN on a binary dataset and report accuracy and training loss curves
- Outcome:
  - Ability to design and evaluate basic QML models

Day 4: Quantum Federated Learning (QFL)

Instructors: Dev, Baobao, Shanika

- Concepts:
  - Federated learning basics; privacy and communication efficiency
  - Quantum extensions: shared entanglement, hybrid aggregation
  - Resource allocation, convergence, and robustness
- Hands-on (Hybrid Qiskit + classical control):
  - Simulate multiple "clients" with local QNNs
  - Implement a simple parameter aggregation (FedAvg-style)
  - Track convergence, fidelity, and inter-client variability
- Daily mini-task:
  - Run a 3-client QFL simulation and visualize accuracy per round
- Outcome:
  - Conceptual and practical grasp of secure distributed quantum learning

Day 5: Advanced Applications & Capstone Integration

Instructors: All Teachers (Offline/Project-focused session; live support available)

- Concepts:
  - Integrating QKD with QML/QFL in secure pipelines
  - Metrics: fidelity, throughput, robustness; hybrid cloud considerations
  - Use cases: finance, healthcare, autonomous systems; Quantum Internet outlook

- Hands-on (Capstone):
    - Design and implement a mini-project integrating cryptography and learning
    - Demonstrate quantum-secure data exchange between federated nodes
    - Present results, metrics, and trade-offs in a short report/notebook

Each daily task is assessed on a 4-point scale:

Criterion	Weight	Excellent (4)	Satisfactory (3)	Needs Improvement (2)	Incomplete (1)
Correctness	40%	Implementation runs without errors; outputs match expectations	Minor errors that don't affect core logic	Significant errors in logic or output	Does not execute or missing key components
Understanding	30%	Clear interpretation of results; demonstrates conceptual grasp	Basic interpretation present; mostly accurate	Superficial or partially incorrect interpretation	No interpretation or fundamental misunderstanding
Code Quality	20%	Well-structured, commented, follows best practices	Readable with some documentation	Poorly structured or undocumented	Unreadable or copy-paste without adaptation
Analysis	10%	Insightful observations; connects to theory	Basic observations present	Minimal analysis	No analysis provided

Pass threshold: Average score ≥ 2.5 across all daily tasks

Capstone Project Rubric (Day 5)

Assessed on a 10-point scale:

Capstone Project Rubric (Day 5)

Criterion	Weight	Exemplary (9-10)	Proficient (7-8)	Developing (5-6)	Insufficient (0-4)
Integration	30%	Seamlessly combines QKD + QML/QFL with clear security guarantees	Integrates 2+ components with functional workflow	Partial integration; components somewhat disconnected	Missing integration or non-functional
Technical Implementation	30%	Robust code; handles edge cases; demonstrates advanced Qiskit use	Correct implementation; meets all requirements	Basic implementation with some errors	Major errors or incomplete
Analysis & Evaluation	25%	Comprehensive metrics; discusses trade-offs, noise impact, scalability	Reports key metrics with reasonable discussion	Limited metrics or superficial analysis	No meaningful evaluation
Communication	15%	Clear narrative; excellent documentation; insightful presentation	Good structure; adequate explanation	Unclear documentation or presentation	Poor communication or missing explanation

Pass threshold: Total score ≥ 50/100

Distinction threshold: Total score ≥ 80/100 AND demonstration of creative extension or exceptional insight

14. Accessibility, conduct, and integrity

- Accessibility: Captioned recordings; slides provided in accessible formats. Notify the program team of any additional requirements after registration.
- Code of conduct: Be respectful, inclusive, and professional in all interactions. Follow facilitator instructions during labs.
- Integrity: Submit original work. Cite libraries, papers, or code you reference. We may request brief demos to validate understanding.

15. Contact and support

- Before Day 1: You will receive (a) portal credentials, (b) meeting links, and (c) the help desk channel invite via your registered email.
- During the program: Use the help desk channel in the portal or raise a ticket via the “Support” tab for technical and academic assistance.
- Certificates: Issued digitally to your registered email after verification of completion.

We look forward to learning with you and building the foundations of quantum-secure systems together.

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