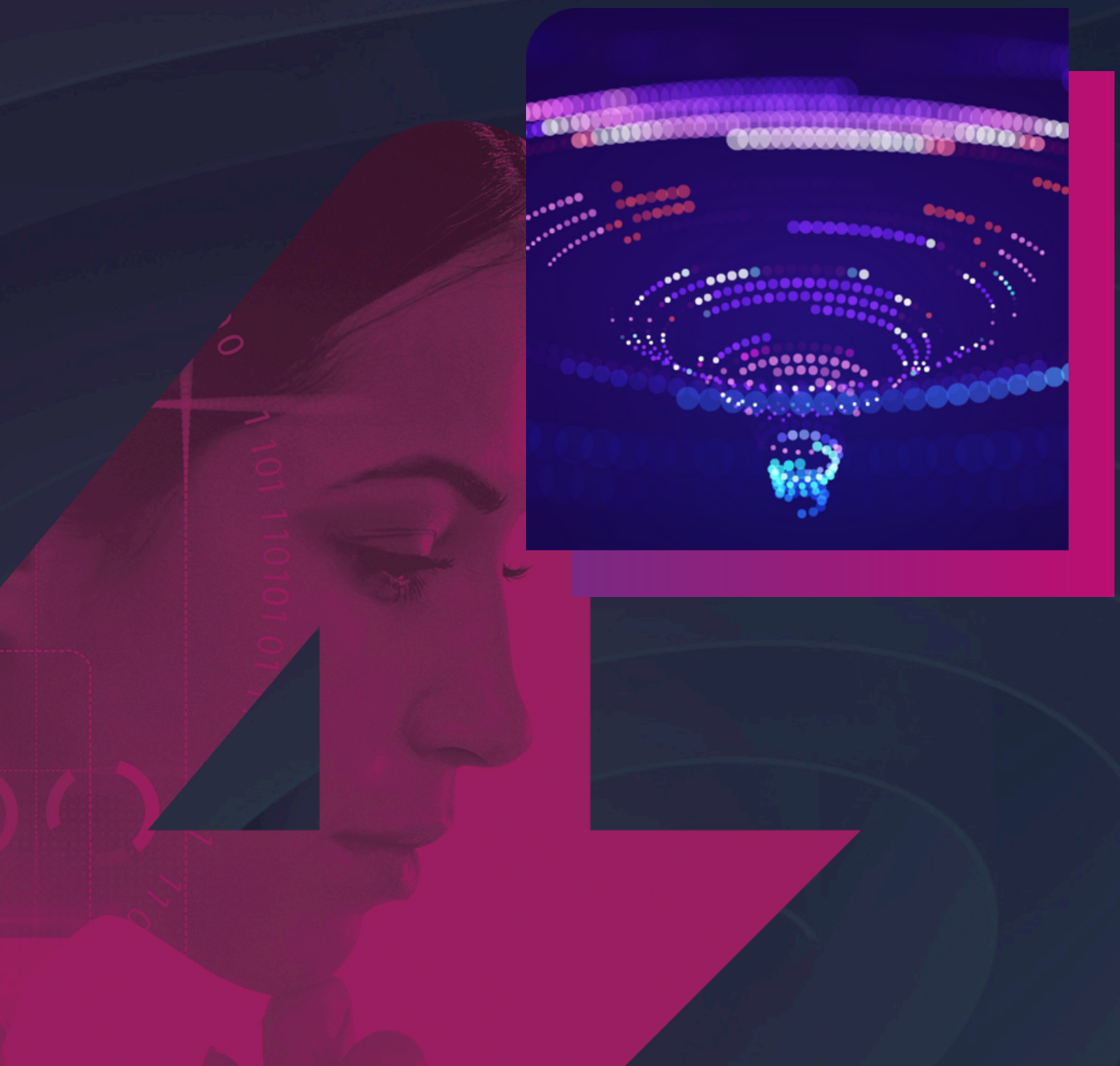
Digital Business
Evolving your digital future

Quantum Computing

Transform your business with advanced computational theory and practical skills



Revolutionise business with advanced computational theory

Master cutting-edge technologies and develop practical skills for solving advanced computational problems.

Quantum computing is an evolving field that will revolutionise and expand computational power through quantum mechanics. With quantum systems now accessible via cloud platforms, this module offers a deep dive into the theoretical foundations and applications of quantum computing.

You'll gain hands-on skills in designing and applying algorithms to address computational challenges. The course also covers the current state and future possibilities of quantum computing, assessing its impact across industries and preparing you for its business use cases.

Learning objectives

This module covers the core principles of quantum computing, offering practical skills to design and implement algorithms for tackling complex computational challenges. By course completion, you'll not only understand the foundational theories but also be equipped to drive innovation in today's digital landscape. Here's what you'll accomplish:

Analyse quantum computing principles and their application in solving complex business optimisation problems.

Critically assess various quantum algorithms for business use cases, such as cryptography and machine learning, and recommend suitable methodologies

Design and implement quantum-based solutions (e.g. circuit model of quantum gates) to real-world business problems using quantum programming frameworks.

Research, evaluate, and communicate technical quantum computing concepts effectively to non-technical stakeholders, emphasising business impact.

Criteria — are you eligible?

- **Language proficiency:** Minimum B2 English proficiency, or 2 years' work or education in an English-speaking environment. IELTS: 6.0; TOEFL PBT: 600; TOEFL CBT: 200; TOEFL iBT: 100. Alternatively, proficiency may be assessed via a test or interview.

- **Education:** Relevant EQF Level 6 qualification required in a relevant field including but not limited to: computer science, IT, engineering, maths, business, or economics. Without this you will have an interview and assessment to evaluate certifications, qualifications or professional experience.
  *EQF levels explained

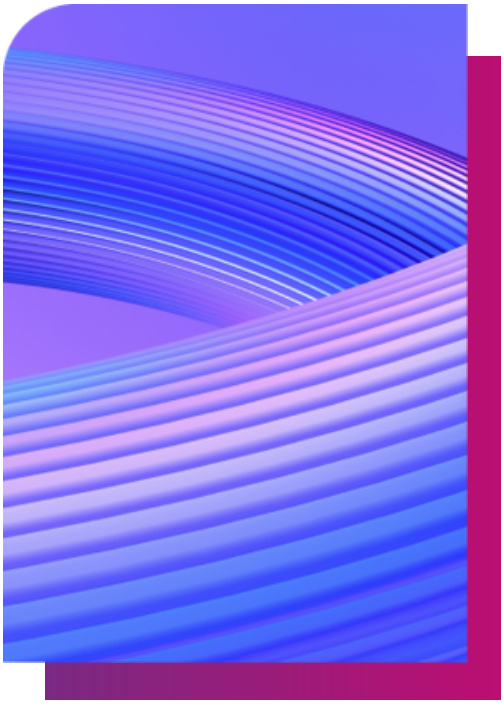
- **Residency:** This EU co-funded programme is open to all EU27, EEA, UK and Ukrainian nationals with a passport or valid ID from one of these countries.

Quantum Computing

Unlock new career paths and digital opportunities

This module introduces professionals to the strategic potential of quantum computing across sectors like finance, logistics, and cybersecurity.

Learners will gain practical insight to support innovation and digital transformation, preparing for roles such as technology advisor or R&D specialist. Ideal for those aiming to stay ahead of emerging technological developments.



An innovative online learning experience

This comprehensive online course integrates lectures, seminars, flipped classrooms, case studies, virtual labs, problem-based learning (PBL), peer reviews and collaborative work. Your progress is measured through both formative and summative assessments.

- Formative assessments offer valuable feedback to enhance your learning strategy, while exams, projects and exercises evaluate your knowledge, skills and competencies. Grading is 50% continuous assessment and 50% proctored exam.

Time commitment

- Classroom and demonstrations: 24 hours
- Practical work/tutorials: 24 hours
- Independent learning: 92 hours
- Total: 140 hours

Credit points

- 5 ECTS

Full course content

Quantum Computing is a 5 ECTS module delivered over 12 weeks, 2 hours of live class time and 2 hours of asynchronous content to be done in the student's own time. Here's a schedule of the topics we'll cover:

- **Introduction**
  - Results from the theory of quantum mechanics
  - Spin and polarisation
  - Measurements/Observables
  - Randomness and probability
  - Bits and Qubits
  - Quantum parallelism and interference
- **Linear Vector Spaces, Hilbert Spaces, and Matrix Representations**
  - Review of linear spaces
  - Hilbert spaces
  - Dirac <bra|ket> notation
  - Operations and operators
  - The Bloch Sphere
  - Pauli Matrices
  - Orthogonal and unitary matrices
  - Operations and operators
  - Eigenvectors and eigenvalues
- **Quantum Circuits**
  - Logic Gates
  - Reversibility
  - Multi-qubit Gates
  - Diagrammatic representation
  - Deutsch's Algorithm
- **Programming for Quantum Computing**
  - Programming environments
  - Language support
  - Simulation
  - Quantum Computing cloud services
  - Coprocessor
- **Entanglement**
  - Entangled states
  - Bell's Inequalities
  - Using the CNOT gate
  - No Cloning Theorem
  - Quantum Teleportation
- **Quantum Information Theory**
  - Elements from the Classical Information Theory
  - Information and Entropy
  - Quantum Information Processing and Error-Correcting Codes
  - Quantum Communications Channels
- **Applications**
  - Quantum Cryptography
  - Quantum Key Distribution
  - Ekert Protocol
  - BB84 Protocol
  - Dense coding
- **Business / Domain Applications**
  - Applications of QC in Pharma, Finance, Cybersecurity, Machine Learning, Chemistry, etc.
  - Business Strategy & Innovation with QC
- **Quantum Fourier Transform**
  - Fourier Series
  - Discrete Fourier Transform
  - Quantum Fourier Transform
- **Quantum Algorithms**
  - Deutsch-Josza Algorithm
  - Simon's Algorithm
- **Quantum Algorithms**
  - Grover's Search Algorithm
  - Schor's Algorithm
- **Emerging Topics**
  - Quantum Hardware
  - Quantum Supremacy
  - Data Security
  - Quantum ML

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Thank You!

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