Quantum Programming Foundations

ONLINE • PART-TIME • LEVEL 8 NFQ – 5 ECTS

ICHEC
Irish Centre for High-end Computing

OLLSCOIL NA GAILLIMHE
UNIVERSITY OF GALWAY

Unleash your unstoppable potential, with Technology Ireland ICT Skillnet

Technology is ever-changing. No matter what stage you are at in business or your career, there is always more to learn.

At Technology Ireland ICT Skillnet, our vision is to create **progressive futures**, helping organisations to **transform at scale** and individuals to **develop a competitive edge**, through the **power of learning**.

For almost two decades, Ireland's leading technology companies have trusted us to build the critical skills needed to thrive in a rapidly evolving market.

Let us connect you to the infinite possibilities shaping the world of tomorrow.

Supercharged skills

Each of our programmes are designed, developed, and validated by specialists from academia and industry, working together, with a constant focus on:

1 **Creating opportunity and momentum** for experienced professionals and those starting out or transitioning career.

2 Delivering learning solutions in a way that **balances work and study**.

3 Providing practical skills, along with the theoretical, allowing businesses to **navigate new frontiers in the world of tech**.

6,000+
companies supported

14,000+
learners upskilled

30+
professional programmes

Online, blended, and
in-company training supports

Government-subsidised
programme fees, up to 100%

Quantum Programming Foundations
Embrace the quantum computing revolution

Staying ahead in the rapidly evolving quantum computing landscape demands more than just keeping pace, it requires visionary leadership and cutting-edge technical skills. As industries worldwide embrace quantum computing's disruptive potential, the demand for adept technical leaders and developers who can harness its power is skyrocketing.

Our pioneering Level 8 (5 ECTS) Quantum Programming Foundations course, delivered in collaboration with the Irish Centre for High-End Computing (ICHEC) and University of Galway, empowers you to be at the forefront of this revolution, arming you with a deep understanding of quantum computing tools, its capabilities and potential applications.
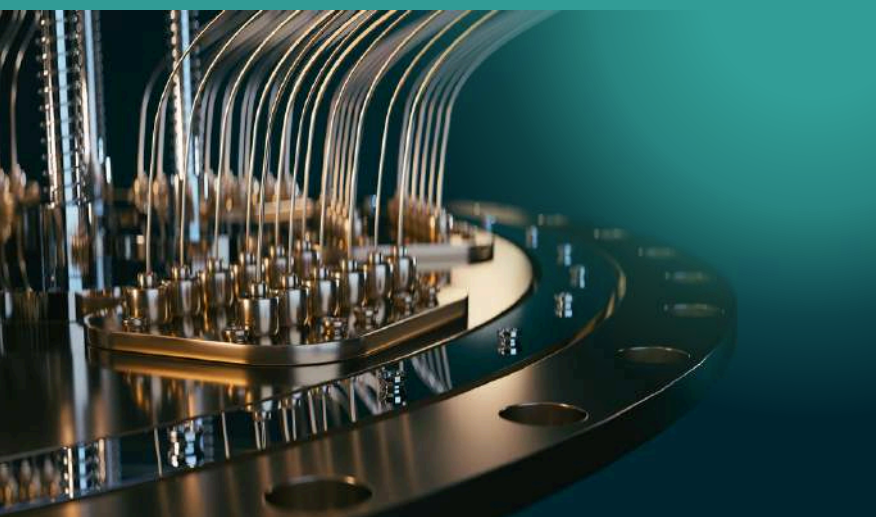
Whether you're a seasoned technical professional or a visionary technical leader, this course equips you with the knowledge and skills to navigate the quantum landscape, and to unlock its immense potential for your organisation, with confidence.

Join our Quantum Programming Foundations learning pathway and become part of a dynamic community of like-minded professionals, all passionate about harnessing the power of quantum computing.

At a glance

Start Date
Please enquire for next start date

Award
Level 8 NFQ (5 ECTS)

Delivery
Online

Duration
1 x semester (12 weeks)

Fees
Skillnet subsidised: €1,080
Non-subsidised: €1,350

Course Partners
The Irish Centre for High-End Computing (ICHEC) and University of Galway

Overview

The Quantum Programming Foundations course has been designed with an industry advisory board composed of both Irish indigenous and global organisations across quantum technology development, financial services, engineering, aerospace, electronic devices, pharmaceuticals, quantum technologies, IT solutions, services and consulting, ensuring recognition and relevance across sectors and disciplines.

This course presents the capabilities of quantum technologies and its potential impact in both the short and medium terms, and beyond. It will ensure that you are informed of the latest trends, methods and tools to equip you to take advantage of the opportunities that quantum computing provides.
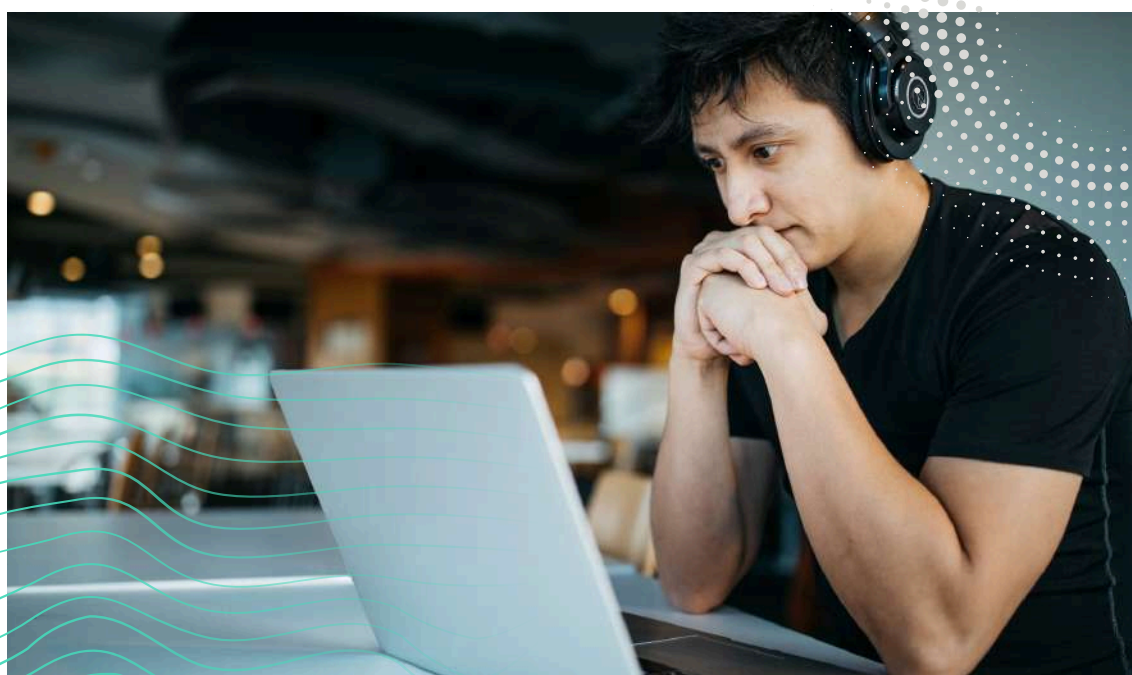
How is the course delivered?

This course is delivered online. The course runs for one semester (12 weeks) and is delivered via synchronous and asynchronous directed activities, using state of the art technologies and teaching techniques to support the virtual classroom.

The total weekly workload is 9.25 hours per week, with 5.25 contact hours.

Recorded lectures will be scheduled for 1 hour per week.

There will be a 2 hour live tutorial session per week with open class discussion based on lecture content and tutorial worksheet provided, and there will be an additional 2 hour asynchronous lab session where students individually complete exercises with near realtime support during business hours provided by ICHEC tutors.

Lecturer supervised learning (contact and non-contact) for continuous assessment is 27 hours per semester. There are 2 hours of non-scheduled self paced directed e-Learning with materials and resources provided. Students are encouraged to engage with this content each week before their live class to build an understanding and to prompt questions.

Who is this course for?

Our course empowers technical professionals like you with in-depth insights into quantum programming, enabling you to make informed strategic decisions and lead with confidence.

Ideal candidates for this course are:

- **Technical managers** leading teams in IT-related departments

- **Scientists (computational, AI, data)** aiming to leverage quantum computing for advanced analytics

- **Engineers** interested in exploring the practical applications of quantum computing

- **Innovation leaders** driving research and development efforts in technology-focused industries

- **Entrepreneurs** looking to integrate quantum technologies into their ventures

- **Business analysts** seeking to understand the strategic implications of quantum technologies

- **Project managers** overseeing technology-driven initiatives

- **CTOs and CIOs** responsible for shaping the technology roadmap of their organisations

Content breakdown

Topic 1: Demystifying Quantum Computing

This topic introduces the era of high-performance computing and its impact, positioning where quantum computing fits and explaining how the quantum computing ecosystem looks.

Topic 2: Integrating High-Performance and Quantum Computing

This topic covers both the fundamental and technical reasons for integrating classical and quantum computing, and what will be involved to integrate them together.

Topic 3: From Bits to Qubits

This topic recaps classical bits and uses it to introduce quantum bits. The introduction of quantum bits addresses qubits, quantum measurement, quantum gates, and other features of quantum computing.

Topic 4: Realising Quantum Computing Systems

This topic covers different types of quantum computing hardware, the physical components involved in building quantum computing systems, the engineering challenges in building quantum computing systems, and roadmaps of hardware companies that are building these systems.

Topic 5: Accessing Quantum Computing Systems

This topic covers how to execute quantum programs, followed by introducing quantum computing software simulators, different approaches to accessing quantum systems, tightly-integrated quantum stacks vs. heterogenous quantum stacks, and publicly funded systems at national and European levels.

Topic 6: Software and Tools for Quantum Programming

This topic introduces a map of components in the quantum computing software layers (high level quantum languages / SDK / Tools, and low level quantum languages and libraries). It covers quantum programming stacks, quantum orchestrators, specialised quantum software projects and bespoke quantum programming stacks.

Topic 7: Landscape of Quantum Algorithms

This topic introduces what a quantum algorithm is, covering early quantum algorithms (Grover's algorithm, Shor's algorithm) and NISQ (Noisy Intermediate-Scale Quantum) algorithms. Different types of quantum algorithms and their applications for simulation of physics and chemistry systems, search and optimisation, and machine learning are also covered.

Assessment

Continuous Assessment - 60% of Award

- Report outlining your understanding of quantum computing, hybrid quantum-HPC use case applications and HPC-QCS systems.

- Implement a problem scenario by performing operations on qubit using quantum gates on a selection of quantum computing systems or environments.

- Demonstrate quantum algorithms on a selected quantum computing platform of choice from the presented quantum software development environments.

Oral, Audio Visual or Practical Assessment - 40% of Award

- Interview to discuss Continuous Assessment Report.

- Interview to discuss implementation completed in Continuous Assessment.

Outcomes for you

The Quantum Programming Foundations course will introduce you to core practical skills, equipping you to assess the evolution and use-cases for quantum computing, towards creating a roadmap for your technical and skills development activities required for your organisation to adopt quantum computing.

You will be able to:

Understand the value chain and value proposition of quantum programming and computing alongside classical high-performance computing.

Experiment with access to different types of quantum hardware and software emulators from public and commercial quantum computing systems.

Evaluate the capabilities, limitations and potential areas for applying quantum technologies, by identifying key high-level tipping points to reach practical quantum computing.

Compare and contrast different components in the quantum computing software layers, along with different ways of using or building quantum programming stacks.

Differentiate between types of quantum computing hardware, their physical components, and engineering challenges in building them.

Examine different types of quantum algorithms and their application in different problem areas, along with the potential advantage of each quantum algorithmic type.

Analyse the features of bits and qubits from phenomenological perspective, comparing their similarities and differences.

Evaluate the requirements for the practical application of quantum algorithms.

Award

Participants will receive a Certificate in Quantum Programming awarded by University of Galway upon successful completion of the course.

"This course is a must for anyone looking to stay ahead in the rapidly evolving field of quantum technology."

Past Learner (2023)

Funding eligibility

The fees for this course are part-funded by Technology Ireland ICT Skillnet. The reduced course fee is €1,080.

Applicants must be working in a private or commercial semi-state organisation registered in the Republic of Ireland (Business, Consultant, Freelancer) to avail of the grant-aided fees. As a government-funded training network, we can only support those meeting these criteria.

Applicants who do not meet our grant-aid criteria can apply directly to ICHEC (University of Galway) and pay the full fee of €1,350, if places are available.

Please speak with our programme team to learn more about the availability of funding.

info@**ictskillnet**.ie

What our course participants have to say

Participating in the cutting edge Quantum Programming Foundations course exceeded all my expectations. The extent and scope of knowledge provided was remarkable, covering the latest advancements in quantum computing and technology.

It wasn't just the curriculum that was impressive; the opportunity to learn from and network with peers was invaluable. The diverse group of participants brought together a wealth of perspectives and insights, greatly enhancing the learning experience.

Upon completing the course, I have gained not only advanced knowledge but also valuable connections that I am certain will be advantageous in my professional career.

Course delivered in partnership with:

ICHEC
Irish Centre for High-end Computing

OLLSCOIL NA GAILLIMHE
UNIVERSITY OF GALWAY

The Irish Centre for High-End Computing (ICHEC) at the University of Galway is Ireland's national centre for High-Performance Computing (HPC) providing e-infrastructure, services and expertise to academia, industry and the public sector supported by the Department of Further and Higher Education, Research, Innovation and Skills and the Higher Education Authority. Established in 2005, ICHEC is also the National HPC Competence Centre in Ireland under the EuroHPC Competence Centre (EuroCC) initiative.

University of Galway is an award-winning university in the heart of Galway city. Ranked among the top 2% of universities in the world, courses include business, law, medicine, arts, science, engineering, and more, all built on a thriving campus centered around a strong community. University of Galway has grown massively in size and reputation over the past 175 years, with a student population today of over 18,000.

Ready to develop your career through Quantum Programming?

Our team is ready to answer any questions you might have regarding this course. Send an email to info@ictskillnet.ie or use the enquiry form on our course page and one of our programme leads will be delighted to assist you.

Start your learning journey today with Technology Ireland ICT Skillnet by clicking on the Learn More button.

Learn More

Embrace the future with confidence, with Technology Ireland ICT Skillnet as your training partner.

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Programme pillars

Our wide range of programme channels allows you to access training in the latest technologies driving business development.

- Artificial Intelligence
- Cloud
- Cybersecurity
- Data Analytics
- Innovation & Transformation
- Leadership
- Quantum
- Software Architecture
- Software Development

Industry approved

With the support of our Industry Steering Group, made up of some of Ireland's most progressive companies, you can be assured that our programmes will provide you with the most relevant and cutting-edge skills that industry demands.

Fidelity INVESTMENTS · **Hertz** · Liberty Information Technology · **ERICSSON**

IBM · **CISCO** · **hp** · Technology Ireland Ibec

Certification you can trust

Through our strategic partnerships with some of Ireland's most influential higher education institutions, we offer a range of certificate, diploma, and masters programmes, with awards accredited on the National Framework of Qualifications.

TU DUBLIN · Atlantic Technological University · MTU · DCU · Maynooth University

UNIVERSITY OF LIMERICK OLLSCOIL LUIMNIGH · National College of Ireland · University of Galway · TUS · UCD

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UNLEASH YOUR
UNSTOPPABLE POTENTIAL