



**Trinity College Dublin**  
Coláiste na Tríonóide, Baile Átha Cliath  
The University of Dublin



Rialtas na hÉireann  
Government of Ireland

**FUTURE JOBS**  
**IRELAND**  
Preparing Now for Tomorrow's Economy



# MSc in Quantum Science and Technology

90 Credits  
Full time over 12 months

The field of quantum science and technology is one of the most rapidly evolving fields in modern science and engineering. Quantum science deals with the behaviour of matter and light on the atomic scale. Quantum technologies exploit the physics of quantum systems to perform information processing at a rate which massively outperforms existing architectures.

Funded by the Government of Ireland's Human Capital Initiative, this course aims to develop graduates with the necessary skill set to contribute to this crucial and cutting edge sector.

### What our partners say

“We have seen an incredibly rapid development of the field. It is now clear that Quantum Technologies will soon revolutionise several core industrial activities with potentially an enormous economical return. We now clearly recognise talents shortage as one of the main bottlenecks for further expansion and development. This MSc is timely and addresses one of our more pressing needs.”

DR. INÉS DE VEGA  
HEAD OF QUANTUM INNOVATIONS IN IQM

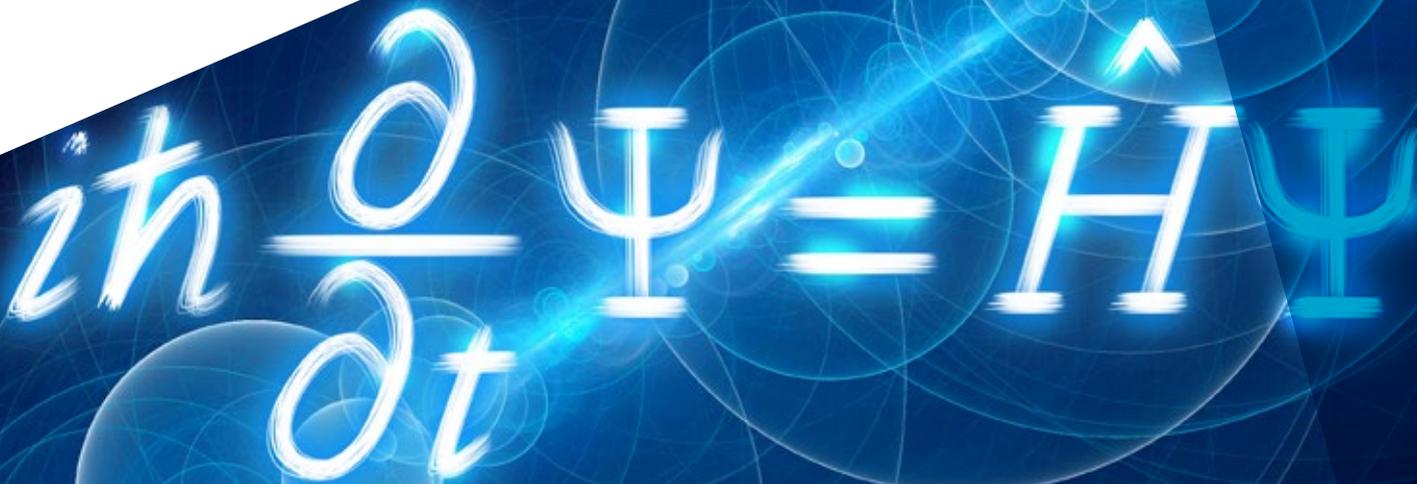


## About the Degree

This blended MSc focuses on quantum information theory, quantum computing and the physics of quantum hardware. Teaching will be led by the School of Physics staff who are recognised as international experts in the quantum science and technologies field. The programme is designed with both online and face-to-face components (blended) and incorporates an exciting range of industrial experts to speak about this rapidly growing area. This will allow students of the programme to gain a unique perspective on a diverse range of research and its implementation in the quantum industry.

The course syllabus covers many key areas in quantum information science including open quantum systems, quantum material science, physical implementation of quantum technology, quantum computation and algorithms. This MSc also includes a research project that can be undertaken either in the School of Physics or as an internship in an industrial setting.

This is one of the first programmes of its kind internationally and is distinctive in its structure, offering students a unique opportunity to combine knowledge and research expertise in quantum information science and material science.



# Course Structure

The MSc in Quantum Science and Technology consists of six taught modules worth 10 ECTS each. This includes a cross-cutting introductory module (online) which is designed to equip students with the foundational information necessary to progress through the remaining modules in the programme.

The curriculum is designed to allow students from physics, maths, computer science and engineering disciplines to gain the scientific and industrial knowledge required to contribute to the quantum sector. The programme structure includes online components, as well as group work, presentations, and individual research. The MSc's computational modules will have strong input from the Irish Centre for High-End Computing (ICHEC).

## MODULE 1: Introduction to Quantum Information Science

Introduction to quantum information theory

Core concepts e.g. no-cloning, teleportation and entanglement theory

## MODULE 2: Special topics and the quantum industry

Current challenges and opportunities in the quantum sector

Industrial and academic speakers

## MODULE 3: Open Quantum Systems

Dynamical aspects of quantum mechanics

Quantum technologies from an open system perspective

## MODULE 4: Quantum Material Science

Harnessing quantum effects in superconducting systems

The role of quantum materials and quantum nano-photonics in reducing the impact of thermal fluctuations and disorder

## MODULE 5: Physical implementations of quantum technology

The physical principles behind the operation of quantum devices

The criteria for application in technology

## MODULE 6: Quantum computation and algorithm

Introduction to quantum computation and algorithms

Writing elementary quantum programs

## MODULE 7: Quantum project/Internship

This module will enable students to develop key research skills and offer them the opportunity to understand how quantum researchers work in either an industrial or academic environment. Students will complete a cutting-edge research project and present their findings to the quantum researchers in the School.

# Career Opportunities

Graduates of this programme will be uniquely placed to work across the quantum science and technology sector as well as related areas of industry. For those interested in pursuing academic research, the School hosts many internationally recognised academics in quantum research. Graduates will also be eligible to pursue further study in other universities who are currently working in this and related research fields.

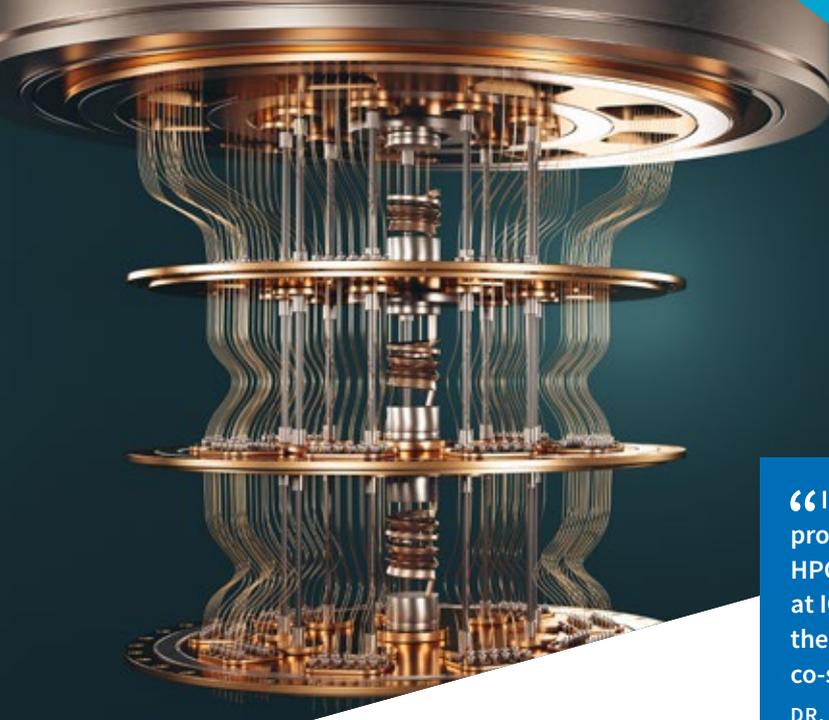
Trinity provides a distinctive education based on academic excellence and a transformative student experience that encourages students to be active participants in their learning. Through this programme, students will develop a unique range of knowledge, skills and attributes that will enhance their employability and prepare them for their future career journey.

Under the Third Level Graduate Scheme, the Irish Government allows both EU and non-EU/EEA students to seek employment 24 months after completing their postgraduate study.

“ IBM is strongly supportive of growing the Ireland quantum ecosystem and sees this MSc programme as very important. IBM looks forward to collaborating with Trinity College Dublin and will contribute to the delivery of content and consider placement and internships for students enrolled on this MSc program. ”

DR. ANTHONY J. ANNUNZIATA  
IBM Q NETWORK GLOBAL LEAD





“ ICHEC is excited to support this MSc programme by providing access to national HPC and quantum computing platforms at ICHEC, delivery lectures as part of the programme modules and hosting/ co-supervising projects of students. ”

DR. VENKATESH KANNAN  
IRISH CENTRE FOR HIGH-END COMPUTING (ICHEC)

“ The second quantum revolution is going to have a tremendous economic impact in the coming years, and an emerging quantum industry is already attracting considerable investment. Yet, companies in quantum technologies are struggling to find qualified employees. The MSc in Quantum Science and Technologies ... will provide young quantum scientists with the right skillset and training to place Ireland at the forefront of this new exciting technological era. At Algorithmiq Ltd, we are looking forward to interact with TCD for research collaborations and training. ”

PROF. SABRINA MANISCALCO  
CHAIR OF THEORETICAL PHYSICS, UNIVERSITY OF TURKU, FINLAND

“ Riverlane is set to expand significantly in the coming years and is in need of talent that has a very strong numerical/ programming skills with experience in quantum computers and quantum technologies. Finding this talent will be one of the major bottlenecks for Riverlane in the coming years. This MSc is timely and addresses one of our most pressing needs. ”

DR. LEONIE MUECK  
CHIEF PRODUCT OFFICER, RIVERLANE, UK

# Entry Requirements

This programme is suitable for graduates who have achieved an upper second class honours degree or the international equivalent in either physics, maths, computer science or engineering.

A minimum GPA of 3.0/4.0, approximately equivalent to an overall grade of 70-75%, is required for entry.

## Application

Applications will be accepted until June 30<sup>th</sup> (non-EU applicants) and July 31<sup>st</sup> (EU applicants). Final decisions on all applications will be made by July 31<sup>st</sup>. However, as entry is highly competitive, early application is advised.

Your application should consist of the following documents

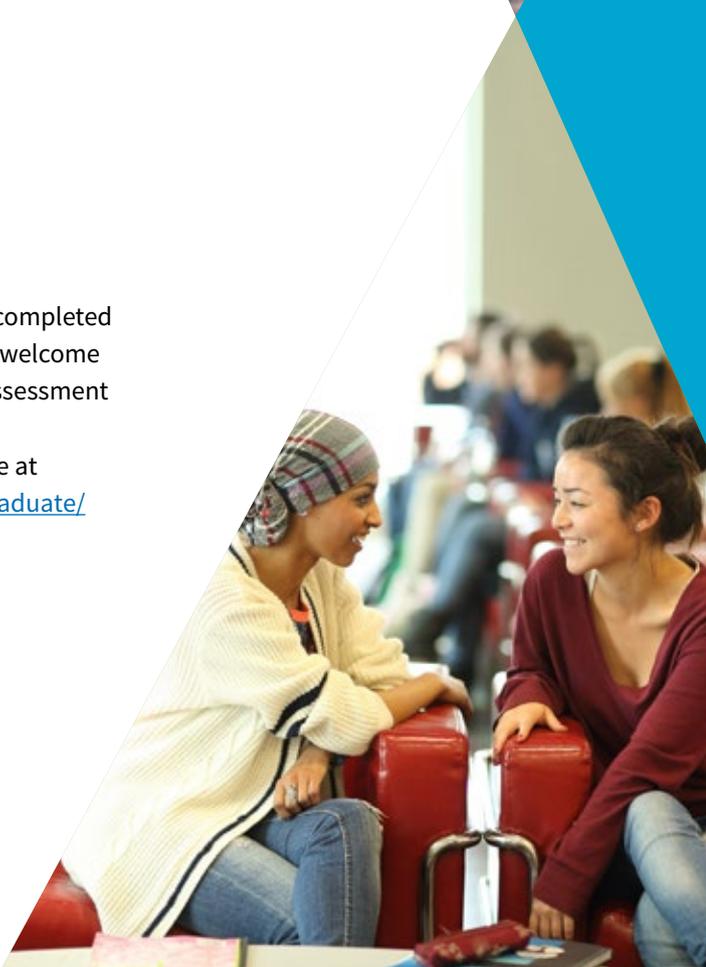
- ▶ Cover letter outlining your interest in the degree.
- ▶ Curriculum Vitae.
- ▶ Transcript of academic results.
- ▶ Copies of degree certificates.
- ▶ Contact details of two academic references.
- ▶ English language certificate if necessary (see below).

Applicants whose first language is not English or who have not completed their undergraduate degree through the medium of English are welcome but may be required to demonstrate their English through an assessment or interview with the Course Director prior to a final decision on admission. Trinity's English language requirements are available at <http://www.tcd.ie/study/apply/admission-requirements/postgraduate/>

For more information on course applications, please see <https://www.tcd.ie/Physics/quantumtech/>

## Course Fees

The fee levels for the current academic year are available at [www.tcd.ie/academicregistry/fees-and-payments/](http://www.tcd.ie/academicregistry/fees-and-payments/)



# Top reasons

## to study an MSc in Quantum Science and Technology at Trinity College Dublin

1. Teaching on this MSc will involve **significant input from start ups, SME's and international companies** located on the island of Ireland e.g. Microsoft and IBM.
2. Trinity students receive a **world-class education** in a research-centred, collaborative environment.
3. **Trinity is recognised as one of the world's leading research – intensive universities.** Students will engage with academics who are internationally recognised leaders in the quantum research field. Trinity is also the only Irish member of the prestigious **League of 22 European Research Universities (LERU)**.
4. **Trinity is Ireland's premier university and ranks in the top 100 in 18 subjects.**
5. Trinity continuously ranks highly for **Graduate Employability** and is committed to preparing its students for the ever-changing challenges of the 21<sup>st</sup> century workplace.
6. Trinity encourages innovation and an entrepreneurial spirit, providing incubation programmes for student-led companies, and has been named as **Europe's leading university for producing venture backed entrepreneurs.** Trinity ranks 92<sup>nd</sup> in the world for Graduate Employability\* and is committed to preparing its students for the ever-changing challenges of the 21<sup>st</sup> century workplace.
7. **Ireland is the gateway to Europe.** Companies such as **Google, Apple, LinkedIn and Paypal** have located their **European Headquarters** in Ireland.
8. The Trinity campus is located in the heart of one of the **most popular and safest cities in the world.** Dublin is a vibrant and multicultural European capital, which ranks as the 34<sup>th</sup> best student city in the world.

\*QS World University Graduate Employability Rankings 2020



# Contact us

Prospective students should contact the course director at the details below.

Course Director: Prof John Goold

Email: [quantum@tcd.ie](mailto:quantum@tcd.ie)

Twitter: [@TCD\\_QuantumSciTech](https://twitter.com/TCD_QuantumSciTech)

[www.tcd.ie/Physics/quantumtech/](http://www.tcd.ie/Physics/quantumtech/)

