

# Postgraduate Certificate

## Information and Quantum Computing





## Postgraduate Certificate Information and Quantum Computing

- » Modality: online
- » Duration: 6 weeks
- » Certificate: TECH Technological University
- » Schedule: at your own pace
- » Exams: online

Website: [www.techtitute.com/in/engineering/postgraduate-certificate/information-quantum-computing](http://www.techtitute.com/in/engineering/postgraduate-certificate/information-quantum-computing)



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01

# Introduction

Undoubtedly, one of the branches of physics with the greatest development and future professional success is quantum computing. Large companies and institutions are investing large sums of money in the creation of quantum computers with which to solve problems ranging from obtaining new drugs, modeling financial data, improving energy efficiency or greater information storage. This is why more and more engineering professionals are choosing to delve into this field. As a result of this, this program was created, which provides professionals with the most advanced knowledge in the postulates of quantum mechanics, traditional information or superconducting qubits. In addition, thanks to the Relearning system, you will be able to advance in a much more natural and progressive way through this 100% online program.



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*This 100% online Postgraduate Certificate will allow you to progress in Information and Quantum Computing, a branch of physics with a promising future"*

In the 1980s, different theories began to be developed that pointed to the possibility of performing quantum computations. During those years, the progress made by Paul Benioff, Richard Feynman, David Deutsch, Dan Simon, Charles Bennett and Lov Grover laid the foundations for the creation of quantum computers in the 1990s and at the beginning of the 21st century. Today, these advances have opened a wide range of possibilities for professionals who wish to advance their careers in this field.

That is why highly qualified profiles in Quantum Information and Quantum Computing are in demand by companies that move in this branch of physics, due to its benefits and applications to disciplines such as engineering, medicine or pharmacology. Considering this scenario of progress and the need for knowledge, TECH has created this Postgraduate Certificate that offers intensive teaching in this area.

A 100% online program, where professionals in just 6 weeks will achieve a solid learning about the mathematical foundations which are essential to understand the quantum principles, as well as the concepts of measurements, time evolution, entanglement and their applications. In addition, during this period, students will delve into classical and quantum information up to the advances achieved in quantum computation.

This educational institution offers a high-level teaching format that can be accessed comfortably by the professionals whenever they wish, from any electronic device (computer, mobile or Tablet) with an Internet connection. A freedom which also allows you to take a program that is in line with the current times and compatible with the most demanding responsibilities.

This **Postgraduate Certificate in Information and Quantum Computing** contains the most complete and up-to-date program on the market. The most important features include:

- ◆ Practical case studies are presented by experts in Physics
- ◆ The graphic, schematic, and practical contents with which they are created, provide scientific and practical information on the disciplines that are essential for professional practice
- ◆ Practical exercises where the self-assessment process can be carried out to improve learning
- ◆ Its special emphasis on innovative methodologies
- ◆ Theoretical lessons, questions to the expert, debate forums on controversial topics, and individual reflection assignments
- ◆ Content that is accessible from any fixed or portable device with Internet connection

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*Enroll now and access the most advanced knowledge about Quantum Computing and Simulation whenever you wish”*

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*You have 150 hours of the most relevant information on Quantum Information and Quantum Computing. Take a step forward and enroll now”*

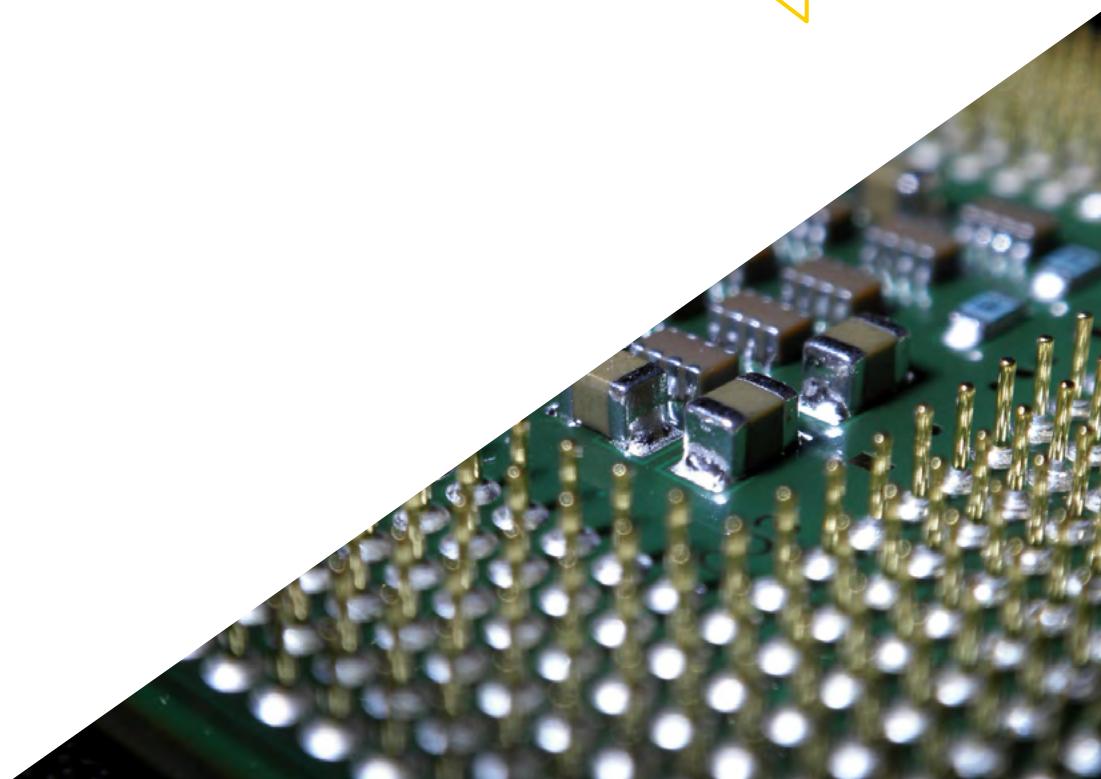
*No in-person attendance, nor classes with fixed schedules. Thus, you will be able to gain the learning you are looking for about classical and quantum information.*

*Gain the most comprehensive knowledge on the RSA encryption method and its use for encrypting information.*

The program's teaching staff includes professionals from the sector who contribute their work experience to this educational program, as well as renowned specialists from leading societies and prestigious universities.

The multimedia content, developed with the latest educational technology, will provide the professional with situated and contextual learning, i.e., a simulated environment that will provide immersive education programmed to learn in real situations.

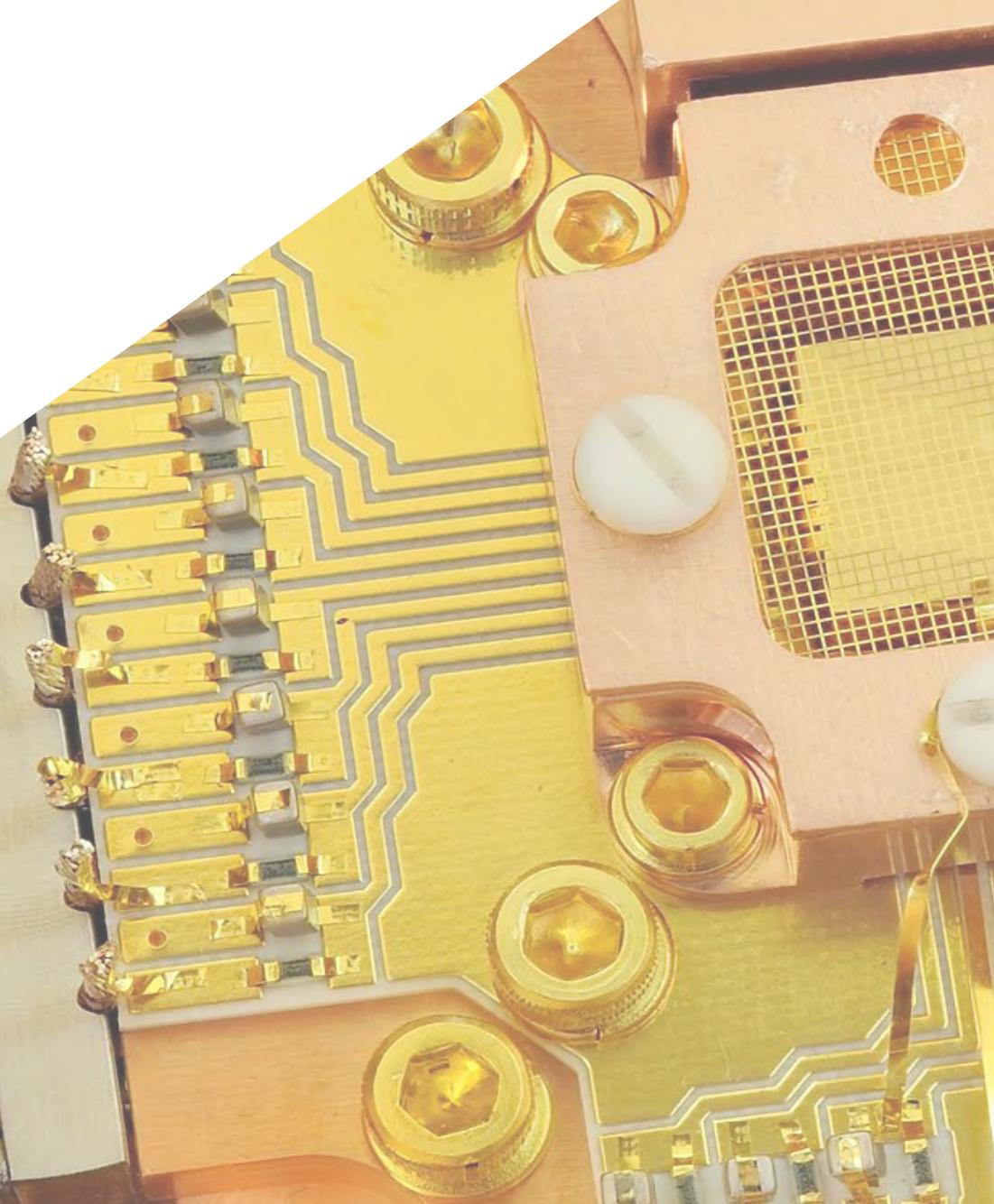
This program is designed around Problem-Based Learning, whereby the professional must try to solve the different professional practice situations that arise throughout the program. For this purpose, the student will be assisted by an innovative interactive video system created by renowned and experienced experts.



02

# Objectives

TECH puts all its efforts into the careful selection of the teaching team of all the programs and into the teaching materials to which the specialists will have access 24 hours a day. In this way, it is intended that professionals gain an intensive and attractive learning experience that motivates them to obtain the knowledge they need about Quantum Information and Quantum Computing to prosper in their professional field.



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*Case studies elaborated by specialists will lead you to learn about the most common applications of quantum information"*



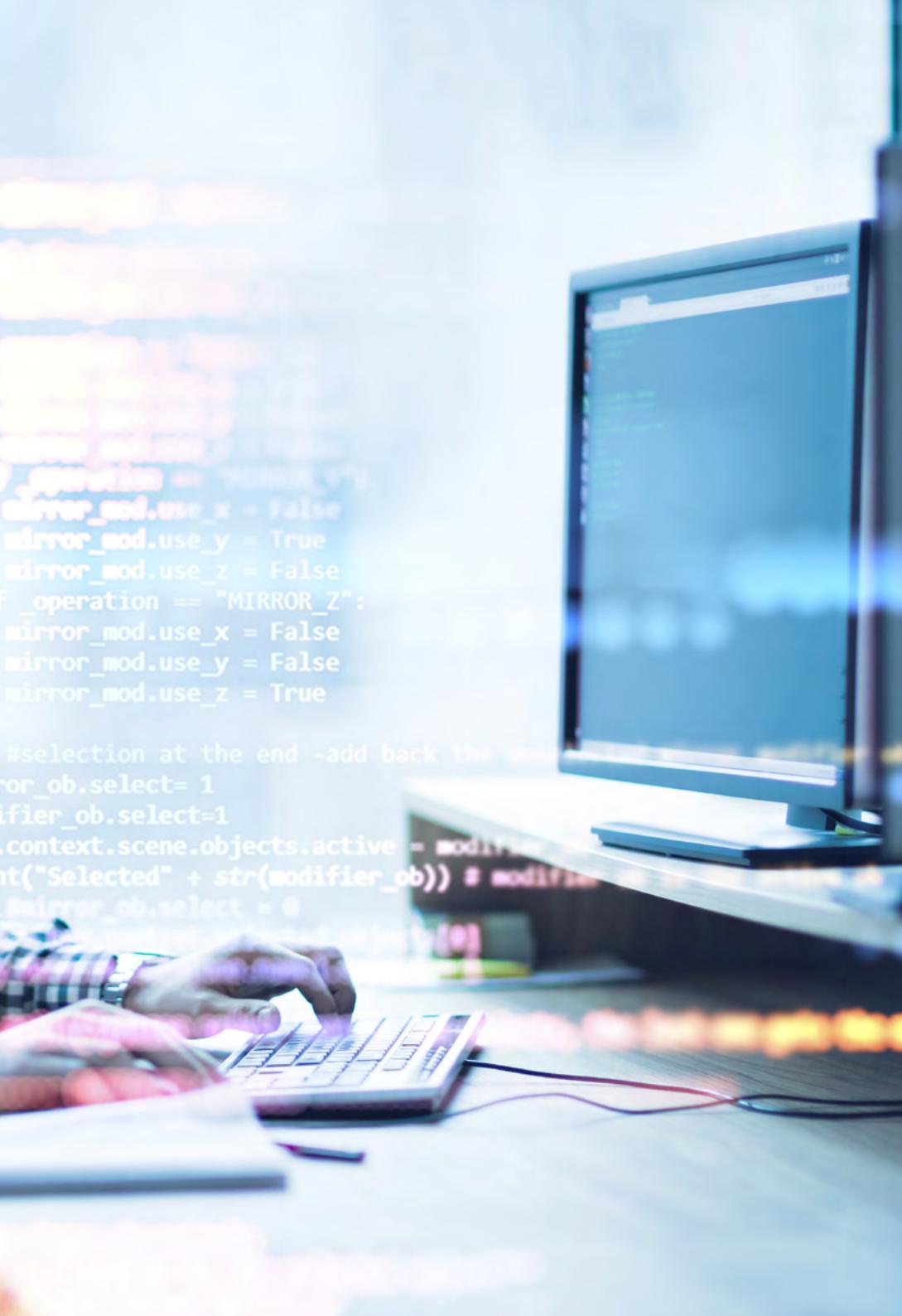
## General Objectives

- ◆ Obtain basic notions about semi-quantum and quantum theories of light-matter interaction
- ◆ Acquire basic notions of classical and quantum information

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*Get the knowledge foundation  
you need in Information and  
Quantum Computing through a  
100% online and flexible program”*





## Specific Objectives

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- ♦ Identify the most common algorithms for quantum encryption of information
- ♦ Know the most common quantum information implementations
- ♦ Perform properly a statistical interpretation of the mixed states

03

# Course Management

This academic program includes the most specialized teaching staff in the current educational market. They are specialists selected by TECH to develop the whole syllabus. In this way, starting from their own existence and the latest evidence, they have designed the most up-to-date content that provides a guarantee of quality in such a relevant subject.



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*TECH offers the most specialized  
teaching staff in the field of study.  
Enroll now and enjoy the quality  
you deserve”*

## International Guest Director

Dr. Philipp Kammerlander is an experienced expert in quantum physics, with high prestige among members of the international academic community. Since joining the Quantum Center in Zurich as Public Program Officer, he has played a crucial role in the creation of collaborative networks between institutions dedicated to quantum science and technology. Based on his proven results, he has assumed the role of Executive Director of that institution.

Specifically from this professional work, this expert has been involved in the coordination of various activities such as workshops and conferences, collaborating with various departments of the Swiss Federal Institute of Technology in Zurich (ETH). He has also been instrumental in fundraising and in the creation of more sustainable internal structures that help the rapid development of the functions of the center he represents.

In addition, he addresses innovative concepts such as the theory of quantum information and its processing. On these topics he has designed curricula and led their development in front of more than 200 students. Thanks to his excellence in these areas, he has received notable distinctions such as the Golden Owl Award and the VMP Assistant Award that highlight his commitment and ability in teaching.

In addition to his work at the Quantum Center and ETH Zurich, this researcher has extensive experience in the technology industry. He has worked as a freelance software engineer, designing and testing business analytics applications based on the ACTUS standard for smart contracts. He has also been a consultant at abaQon AG. His diverse background and significant achievements in academia and industry underscore his versatility and dedication to innovation and education in the field of quantum science.



## Dr. Kammerlander, Philipp

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- Executive Director of the Quantum Center Zurich, Switzerland
- Professor at the Swiss Federal Institute of Technology Zurich, Switzerland
- Manager of public programs between different Swiss institutions
- Freelance Software Engineer at Ariadne Business Analytics AG
- Consultant at abaQon AG
- Doctorate in Theoretical Physics and Quantum Information Theory at the ETH Zurich
- Master's Degree in Physics at the ETH Zurich

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*Thanks to TECH, you will be able to learn with the best professionals in the world”*

03

# Structure and Content

The syllabus of this postgraduate certificate has been designed with the main objective of offering professionals the most advanced knowledge in Quantum Information and Computing. Thus, in the 150 teaching hours of this program, you will learn the most relevant mathematical and quantum concepts, as well as all those theorems and theories that have given rise first to classical information and subsequently to quantum information. Thanks to the teaching tools used in this program, professionals will learn this subject in a much more dynamic way.



```
if _operation == "MIRROR_X":  
    mirror_mod.use_x = False  
    mirror_mod.use_y = True  
    mirror_mod.use_z = False  
elif _operation == "MIRROR_Z":  
    mirror_mod.use_x = False  
    mirror_mod.use_y = False  
    mirror_mod.use_z = True  
  
#selection at the end  
mirror_ob.select= 1  
modifier_ob.select=1  
bpy.context.scene  
print("Selected")  
#mirror  
#one = True
```

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Multimedia material, with which you will gain a more enriching learning in the generation, propagation and detection of single photons, are available”

**Module 1. Information and Quantum Computing**

- 1.1. Introduction: Mathematics and Quantum
  - 1.1.1. Complex Vector Spaces
  - 1.1.2. Linear Operators
  - 1.1.3. Scalar Products and Hilbert Spaces
  - 1.1.4. Diagonalization
  - 1.1.5. Tensor Product
  - 1.1.6. The Role of Operators
  - 1.1.7. Important Theorems on Operators
  - 1.1.8. Checked Quantum Mechanics Postulates
- 1.2. Statistical States and Samples
  - 1.2.1. The *Qubit*
  - 1.2.2. Density Matrix
  - 1.2.3. Two-Part System
  - 1.2.4. Schmidt Decomposition
  - 1.2.5. Statistical Interpretation of the Mixing States
- 1.3. Measurements and Temporary Evolution
  - 1.3.1. Von Neumann Measurements
  - 1.3.2. Generalized Measurements
  - 1.3.3. Neumark Theorem
  - 1.3.4. Quantum Channels
- 1.4. Interwoven and its Applications
  - 1.4.1. ERP States
  - 1.4.2. Dense Coding
  - 1.4.3. State Teleportation
  - 1.4.4. Density Matrix and its Representations
- 1.5. Classic and Quantum Information
  - 1.5.1. Introduction to Probability
  - 1.5.2. Information
  - 1.5.3. Shannon Entropy and Mutual Information
  - 1.5.4. Communication
    - 1.5.4.1. The Bynary Symmettric Channel
    - 1.5.4.2. Channel Capacity
  - 1.5.5. Shannon Theorems
  - 1.5.6. Difference between Classic and Quantum Information
  - 1.5.7. Von Neumann Entropy
  - 1.5.8. Schumacher Theorem
  - 1.5.9. Holevo Information
  - 1.5.10. Accessible Information and Holevo Limit
- 1.6. Quantum Computing
  - 1.6.1. Turing Machines
  - 1.6.2. Circuits and Classification of Complexity
  - 1.6.3. Quantum Computer
  - 1.6.4. Quantum Logic Gates
  - 1.6.5. Deutsch-Josza and Simon's Algorithm
  - 1.6.6. Unstructured Search; Grover's Algorithm
  - 1.6.7. RSA Encryption Method
  - 1.6.8. Factorization: Shor Algorithm
- 1.7. Quantum Theory of the Light-Matter Interaction
  - 1.7.1. Two-Level Atom
  - 1.7.2. AC-Stark Splitting
  - 1.7.3. Rabi Oscillations
  - 1.7.4. Light Dipole Force



- 1.8. Quantum Theory of the Light-Matter Interaction
  - 1.8.1. Quantum States of the Electromagnetic Field
  - 1.8.2. Jaynes-Cummings Model
  - 1.8.3. The Problem of Decoherence
  - 1.8.4. Treatment of Weisskopf-Wigner Model of Spontaneous Emission
- 1.9. Quantum Communication
  - 1.9.1. Quantum Cryptography: BB84 and Ekert91 protocols
  - 1.9.2. Bell Inequalities
  - 1.9.3. Generation of Individual Photons
  - 1.9.4. Propagation of Individual Photons
  - 1.9.5. Detection of Individual Photons
- 1.10. Quantum Computing and Simulation
  - 1.10.1. Neutral Atoms in Dipolar Traps
  - 1.10.2. Cavity Quantum Electrodynamics
  - 1.10.3. Ions in Paul Traps
  - 1.10.4. Superconducting Cubits

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*With this program, you will comfortably learn the Classical and Quantum Theories of light-matter interaction from your computer with Internet connection"*

04

# Methodology

This academic program offers students a different way of learning. Our methodology uses a cyclical learning approach: **Relearning**.

This teaching system is used, for example, in the most prestigious medical schools in the world, and major publications such as the **New England Journal of Medicine** have considered it to be one of the most effective.



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*Discover Relearning, a system that abandons conventional linear learning, to take you through cyclical teaching systems: a way of learning that has proven to be extremely effective, especially in subjects that require memorization"*



## Case Study to contextualize all content

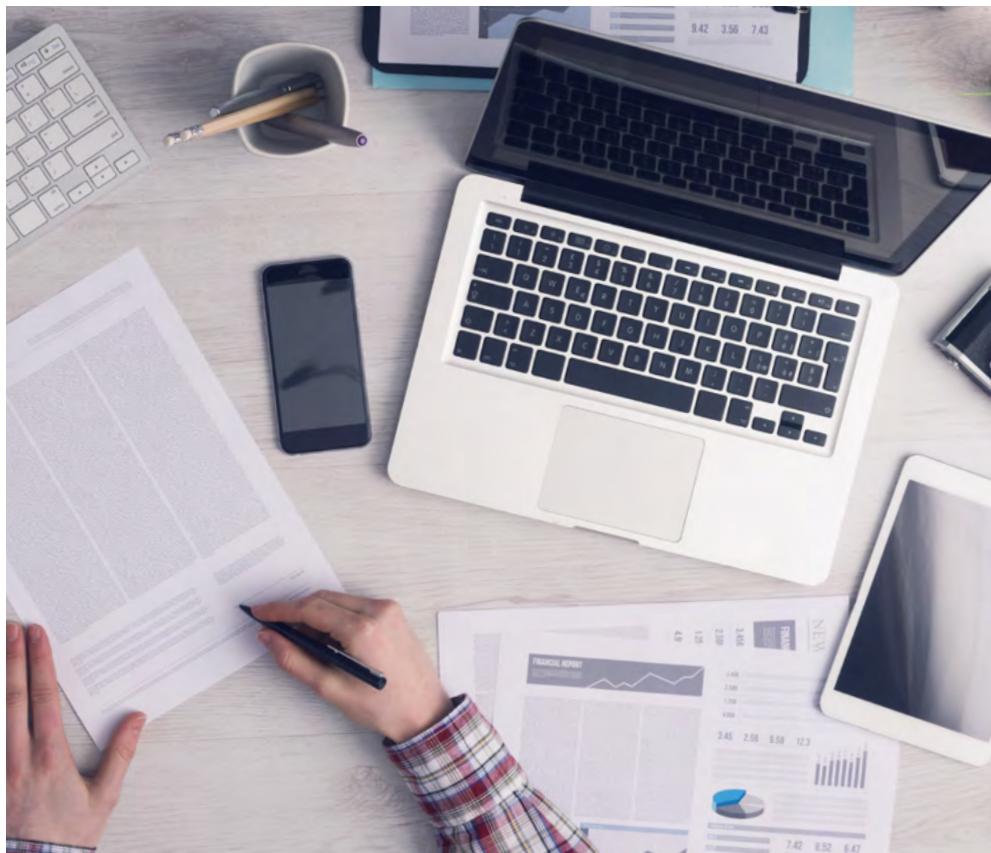
Our program offers a revolutionary approach to developing skills and knowledge. Our goal is to strengthen skills in a changing, competitive, and highly demanding environment.

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*At TECH, you will experience a learning methodology that is shaking the foundations of traditional universities around the world”*



*You will have access to a learning system based on repetition, with natural and progressive teaching throughout the entire syllabus.*



*The student will learn to solve complex situations in real business environments through collaborative activities and real cases.*

This TECH program is an intensive educational program, created from scratch, which presents the most demanding challenges and decisions in this field, both nationally and internationally. This methodology promotes personal and professional growth, representing a significant step towards success. The case method, a technique that lays the foundation for this content, ensures that the most current economic, social and professional reality is taken into account.

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*Our program prepares you to face new challenges in uncertain environments and achieve success in your career”*

The case method is the most widely used learning system in the best faculties in the world. The case method was developed in 1912 so that law students would not only learn the law based on theoretical content. It consisted of presenting students with real-life, complex situations for them to make informed decisions and value judgments on how to resolve them. In 1924, Harvard adopted it as a standard teaching method.

What should a professional do in a given situation? This is the question that you are presented with in the case method, an action-oriented learning method. Throughout the program, the studies will be presented with multiple real cases. They will have to combine all their knowledge and research, and argue and defend their ideas and decisions.

## Relearning Methodology

TECH effectively combines the Case Study methodology with a 100% online learning system based on repetition, which combines 8 different teaching elements in each lesson.

We enhance the Case Study with the best 100% online teaching method: Relearning.

*In 2019, we obtained the best learning results of all online universities in the world.*

At TECH, you will learn using a cutting-edge methodology designed to train the executives of the future. This method, at the forefront of international teaching, is called Relearning.

Our university is the only one in the world authorized to employ this successful method. In 2019, we managed to improve our students' overall satisfaction levels (teaching quality, quality of materials, course structure, objectives...) based on the best online university indicators.





In our program, learning is not a linear process, but rather a spiral (learn, unlearn, forget, and re-learn). Therefore, we combine each of these elements concentrically.

This methodology has trained more than 650,000 university graduates with unprecedented success in fields as diverse as biochemistry, genetics, surgery, international law, management skills, sports science, philosophy, law, engineering, journalism, history, and financial markets and instruments. All this in a highly demanding environment, where the students have a strong socio-economic profile and an average age of 43.5 years.

*Relearning will allow you to learn with less effort and better performance, involving you more in your training, developing a critical mindset, defending arguments, and contrasting opinions: a direct equation for success.*

From the latest scientific evidence in the field of neuroscience, not only do we know how to organize information, ideas, images and memories, but we know that the place and context where we have learned something is fundamental for us to be able to remember it and store it in the hippocampus, to retain it in our long-term memory.

In this way, and in what is called neurocognitive context-dependent e-learning, the different elements in our program are connected to the context where the individual carries out their professional activity.

This program offers the best educational material, prepared with professionals in mind:



#### **Study Material**

All teaching material is produced by the specialists who teach the course, specifically for the course, so that the teaching content is highly specific and precise.

These contents are then applied to the audiovisual format, to create the TECH online working method. All this, with the latest techniques that offer high quality pieces in each and every one of the materials that are made available to the student.



#### **Classes**

There is scientific evidence suggesting that observing third-party experts can be useful.

Learning from an Expert strengthens knowledge and memory, and generates confidence in future difficult decisions.



#### **Practising Skills and Abilities**

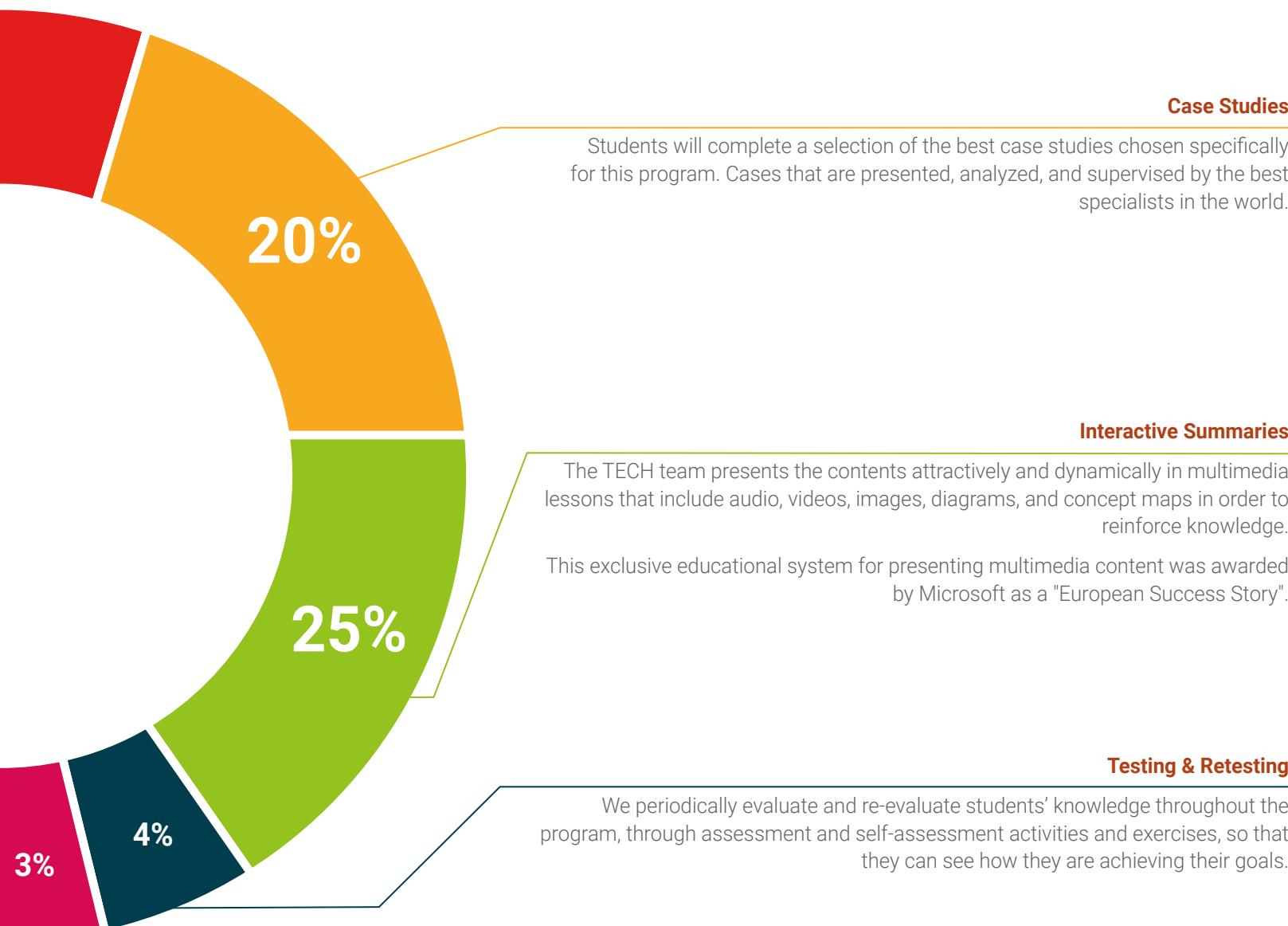
They will carry out activities to develop specific skills and abilities in each subject area. Exercises and activities to acquire and develop the skills and abilities that a specialist needs to develop in the context of the globalization that we are experiencing.



#### **Additional Reading**

Recent articles, consensus documents and international guidelines, among others. In TECH's virtual library, students will have access to everything they need to complete their course.





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# Certificate

The Postgraduate Certificate in Quantum Computing guarantees students, in addition to the most rigorous and up-to-date education, access to a Postgraduate Certificate issued by TECH Technological University.



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*Successfully complete this program and receive your university qualification without having to travel or fill out laborious paperwork"*

This **Postgraduate Certificate in Information and Quantum Computing** contains the most complete and up-to-date program on the market.

After the student has passed the assessments, they will receive their corresponding **Postgraduate Certificate** issued by **TECH Technological University** via tracked delivery\*.

The certificate issued by **TECH Technological University** will reflect the qualification obtained in the Postgraduate Certificate, and meets the requirements commonly demanded by labor exchanges, competitive examinations and professional career evaluation committees.

**Title: Postgraduate Certificate in Information and Quantum Computing**

Official N° of Hours: **150 h.**



\*Apostille Convention. In the event that the student wishes to have their paper certificate issued with an apostille, TECH EDUCATION will make the necessary arrangements to obtain it, at an additional cost.



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