

# Postgraduate Certificate Mathematical Methods in Physics



## Postgraduate Certificate Mathematical Methods in Physics

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

Website: [www.techtute.com/us/engineering/postgraduate-certificate/mathematical-methods-physics](http://www.techtute.com/us/engineering/postgraduate-certificate/mathematical-methods-physics)

# Index

01

Introduction

---

*p. 4*

02

Objectives

---

*p. 8*

03

Structure and Content

---

*p. 12*

04

Methodology

---

*p. 16*

05

Certificate

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*p. 24*

01

# Introduction

In recent decades there has been a strong momentum of quantum technologies with applications in different industries and with a direct translation to everyday life. This has led to a revolution, which is expected to continue with a broad development in the coming years. For this reason, companies are increasingly demanding highly qualified profiles with solid knowledge in mathematical methods applied to this branch of physics. In view of this reality, this 100% online program is born, which provides students with the most exhaustive knowledge about pre-Hilbertian spaces, metric spaces or representations and particle physics. For this purpose, students will have access to multimedia pills 24 hours a day from any computer with an Internet connection.



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*Click and enroll in a 100% online Postgraduate Certificate that provides you with the most comprehensive knowledge on Mathematical Methods and their applications"*

Undoubtedly, quantum physics, its technological development and application in everyday life makes its study and understanding of great interest for specialists who want to enter this field with an unbeatable future projection. However, before being able to translate these theoretical concepts into practice, it is necessary to have a clear mastery of mathematical methods.

Thus, it is essential for the professionals to be able to understand the mathematical properties of a physical entity, in order to be able to correctly perform any calculation of quantum physics, particle physics or related to relativity. That is why TECH has created this Postgraduate Certificate in Mathematical Methods taught exclusively online and where in just 6 weeks students will acquire the essential learning they need to thrive in their professional field.

A program, where through video summaries, videos in detail, complementary readings or case studies, the student can delve into the pre-Hilbertian spaces, the topology of metric spaces, the Herbartian basis or linear operations. In addition, thanks to the Relearning system, students will be able to advance in a more natural way through a syllabus, which will lead them to dive into the Sturm-Liouville Theory, group theory and its application to physics.

This academic institution thus offers an excellent opportunity to pursue a flexible university program, which can be accessed comfortably, whenever and wherever you want. Students only need a computer, tablet or cell phone with Internet connection to be able to view the content of this program at any time. An ideal option for those seeking to combine quality education with their professional and/or personal responsibilities.

This **Postgraduate Certificate in Mathematical Methods in Physics** 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
- ◆ 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 self-assessment can be used 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 an Internet connection



*Thanks to the multimedia pills, you will learn the main mathematical formulations in a much simpler and more agile way"*

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*An ideal Postgraduate Certificate for those who wish to combine their personal responsibilities with an education that is at the forefront of academia"*

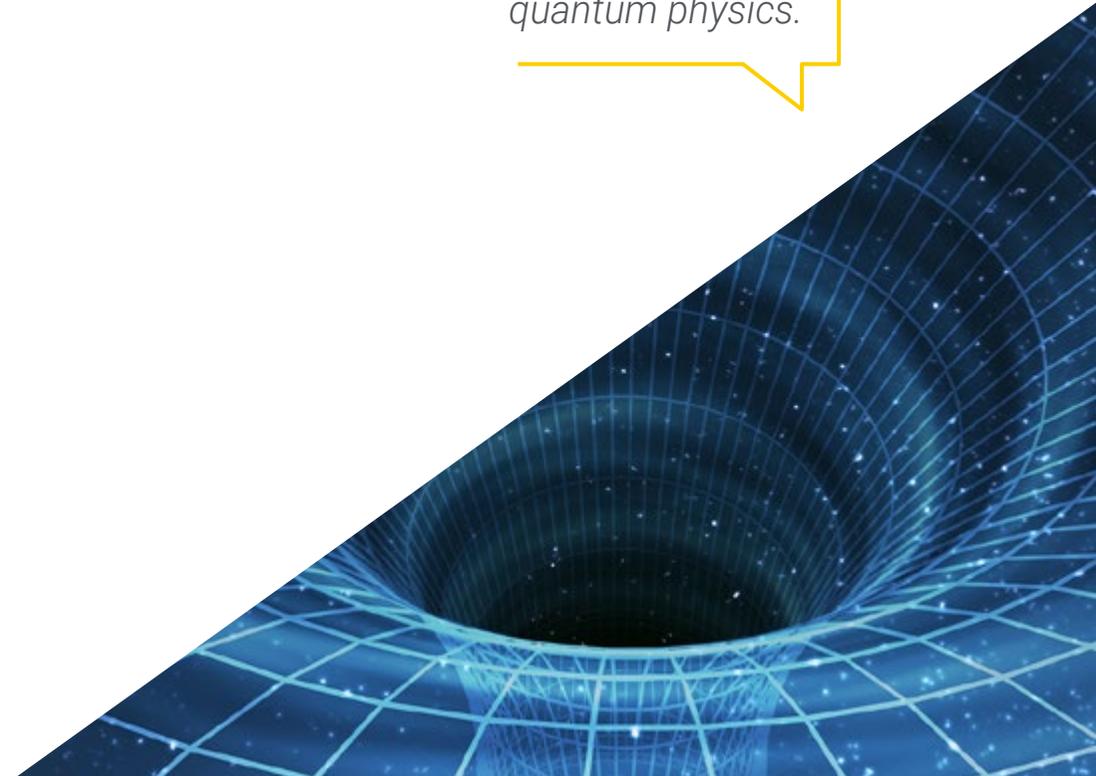
The program's teaching staff includes professionals from the sector who contribute their work experience to this educational program, as well as renowned specialists from leading societies and prestigious universities.

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

The design of this program focuses on Problem-Based Learning, by means of which the professionals must try to solve the different professional practice situations that are presented throughout the academic course. For this purpose, the students will be assisted by an innovative interactive video system created by renowned experts.

*This 100% online university program will take you in just 6 weeks to get into the most important theorems to solve the Sturm-Liouville theory.*

*Click and enroll in a Postgraduate Certificate that will allow you to master the main mathematical methods in Physics necessary to get a foothold in the field of quantum physics.*



02

# Objectives

One of the maxims of this academic institution is to offer its students a quality education. For this purpose, it offers the most innovative pedagogical tools and case studies, which favor learning and the student's approach to methodologies that can be easily applied in their daily performance. Likewise, the faculty that integrates this Postgraduate Certificate will resolve any doubts that may arise about the syllabus during the course of this program.



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*You will be able to solve any doubts you may have about the syllabus of this Postgraduate Certificate with a highly specialized team"*



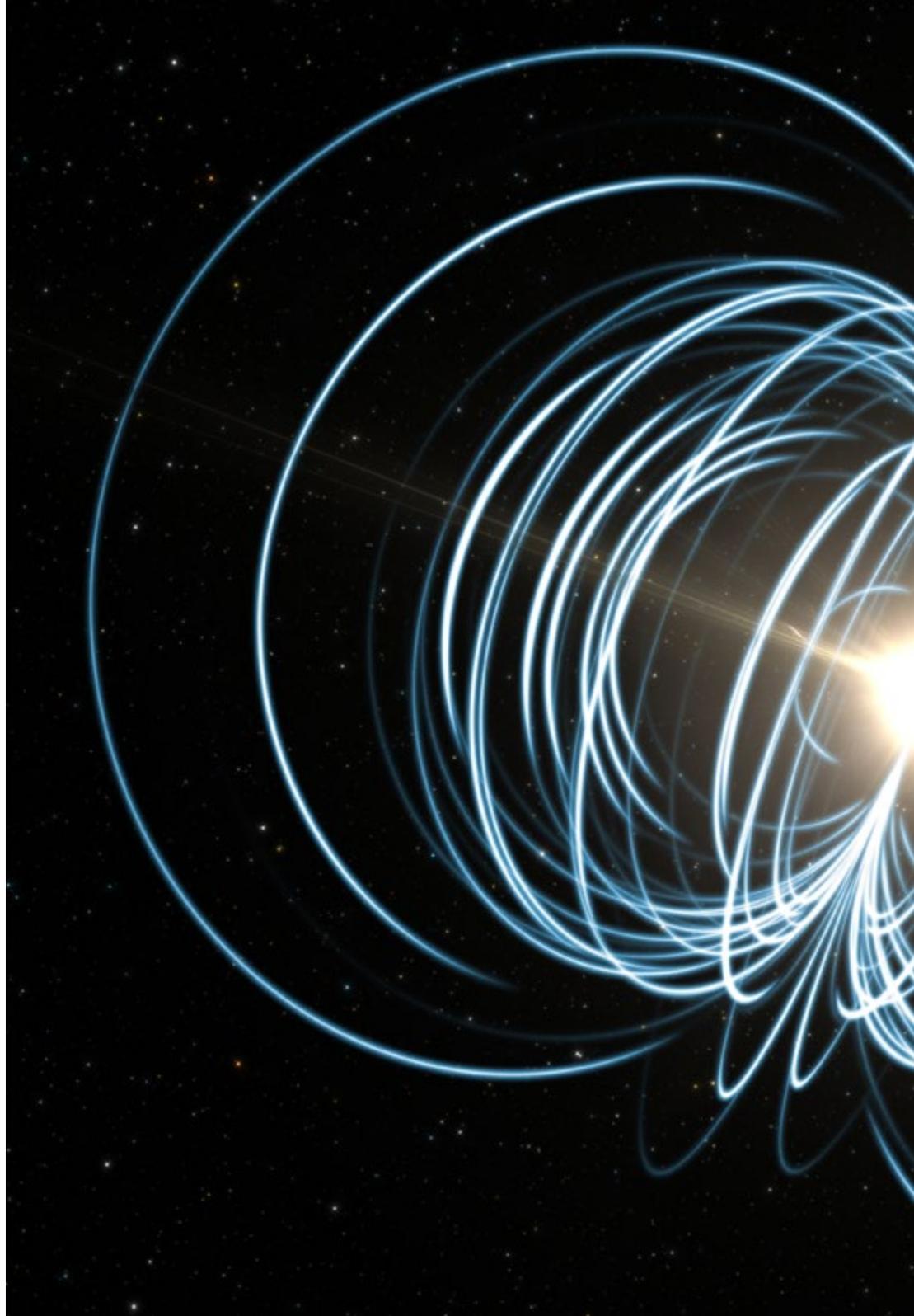
## General Objectives

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- ◆ Solve problems effectively by applying mathematical methods
- ◆ Knowing group theory, group representation, tensor calculus and its applications to physics



*In only 6 weeks you will be able to master the main concepts and calculations of group theory and its applications in physics"*





## Specific Objectives

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- ◆ Obtain basic notions of metric and Hilbert spaces
- ◆ Acquire knowledge about the characteristics of linear operators and the Sturm-Liouville theory
- ◆ Understand the Okubo Theorem and Eightfold Ways

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 effectiveness of the Relearning System has led TECH to use it in all its qualifications. Thus, thanks to this method, the students who study this university program will learn vector spaces, metric spaces, group theory or representations in a much more agile way. In addition, it will reduce the long hours of study that are so frequent in other courses. These advantages will make it much easier to overcome and achieve success with this Postgraduate Certificate in Mathematical Methods.



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*A syllabus with a theoretical-practical approach that you can access 24 hours a day from any electronic device with an Internet connection. Enroll now”*

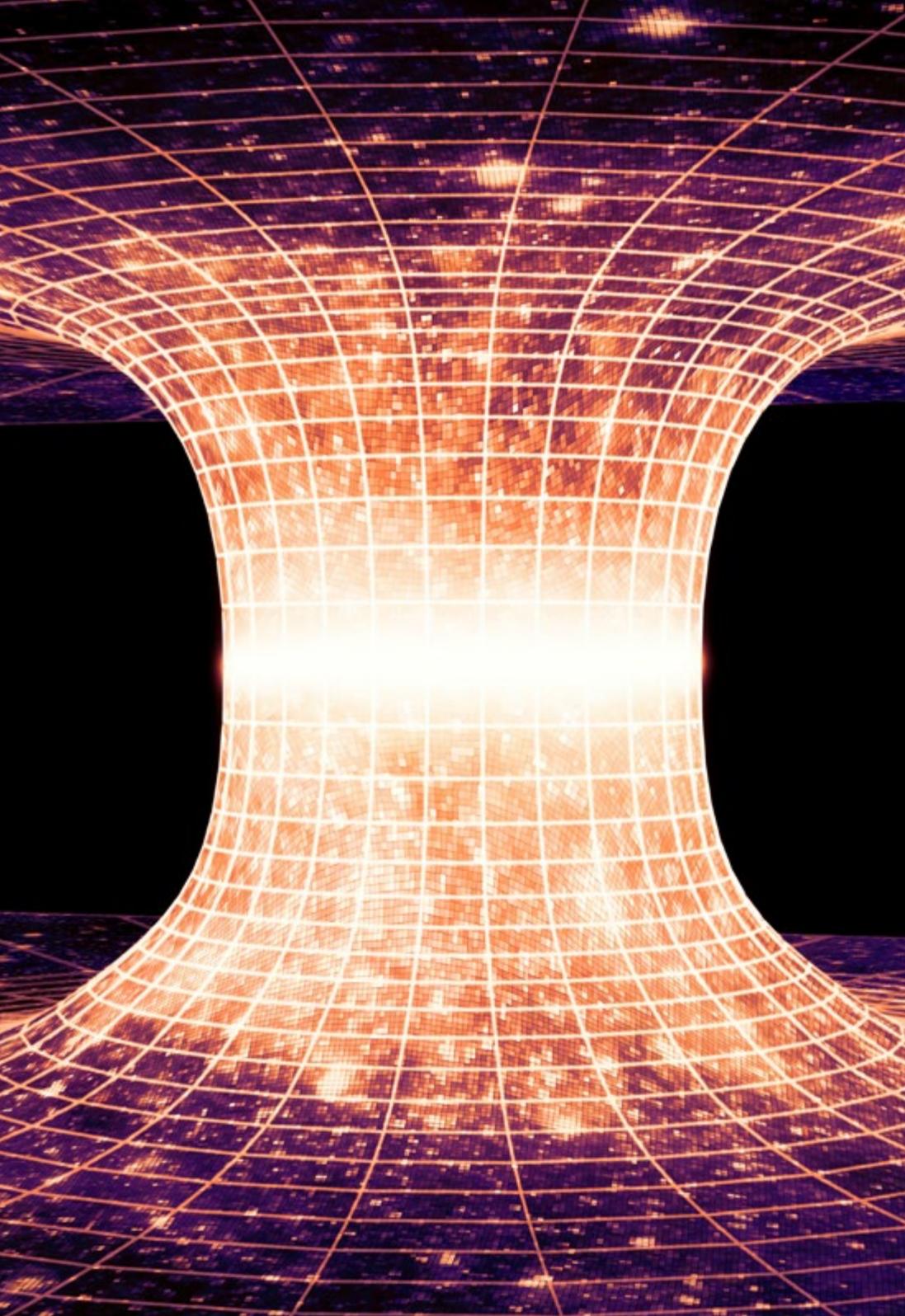
## Module 1. Mathematical methods

- 1.1. Prehilbertian Spaces
  - 1.1.1. Vector Spaces
  - 1.1.2. Positive Hermitian Scalar Product
  - 1.1.3. Single Vector Module
  - 1.1.4. Schwartz Inequality
  - 1.1.5. Minkowsky Inequality
  - 1.1.6. Orthogonality
  - 1.1.7. Dirac Notation
- 1.2. Topology of Metric Spaces
  - 1.2.1. Definition of Distance
  - 1.2.2. Definition of Metric Space
  - 1.2.3. Elements of Topology of Metric Spaces
  - 1.2.4. Convergent Successions
  - 1.2.5. Cauchy Successions
  - 1.2.6. Complete Metric Space
- 1.3. Hilbert Spaces
  - 1.3.1. Hilbert Spaces: Definition
  - 1.3.2. Herbatian Base
  - 1.3.3. Schrödinger versus Heisenberg. Lebesgue Integral
  - 1.3.4. Continuous Frames of a Hllbert Space
  - 1.3.5. Change of Basis Matrix
- 1.4. Linear Operations
  - 1.4.1. Linear Operators: Basic Concepts
  - 1.4.2. Inverse Operator
  - 1.4.3. Adjoint Operator
  - 1.4.4. Self-Adjoint Operator
  - 1.4.5. Positive Definite Operator
  - 1.4.6. Unitary Operator | Change of Basis
  - 1.4.7. Antiunitary Operator
  - 1.4.8. Projector
- 1.5. Sturm-Liouville Theory
  - 1.5.1. Eigenvalue Theorem
  - 1.5.2. Eigenvector Theorem
  - 1.5.3. Sturm-Liouville Problem
  - 1.5.4. Important Theorems for Sturm-Liouville Theory
- 1.6. Introduction to Group Theory
  - 1.6.1. Definition of Group and Characteristics
  - 1.6.2. Symmetries
  - 1.6.3. Study of  $SO(3)$ ,  $SU(2)$  and  $SU(N)$  Groups
  - 1.6.4. Lie Algebra
  - 1.6.5. Groups of Quantum Physics
- 1.7. Introduction to Representations
  - 1.7.1. Definitions
  - 1.7.2. Fundamental Representation
  - 1.7.3. Adjoint Representation
  - 1.7.4. Unitary Representation
  - 1.7.5. Product of Representation
  - 1.7.6. Young Tables
  - 1.7.7. Okubo Theorems
  - 1.7.8. Applications to Particle Physics
- 1.8. Introduction to Tensors
  - 1.8.1. Definition of Covariant and Contravariant Tensors
  - 1.8.2. Kronecker Delta
  - 1.8.3. Levi-Civita Tensor
  - 1.8.4. Study of  $SO(N)$  i  $SO(3)$
  - 1.8.5. Study of  $SO(N)$
  - 1.8.6. Relation between Tensors and Representations

- 1.9. Group Theory Applied to Physics
  - 1.9.1. Translation Group
  - 1.9.2. Lorentz Group
  - 1.9.3. Discrete Groups
  - 1.9.4. Continuous Groups
- 1.10. Representations and Particle Physics
  - 1.10.1. Representations of  $SU(N)$  Groups
  - 1.10.2. Fundamental Representations
  - 1.10.3. Multiplication of Representations
  - 1.10.4. Okubo Theorem and Eightfold Ways

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*With this 100% online program  
you can easily master particle  
physics and representations”*



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.*

### A learning method that is different and innovative

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.

“*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.





**Case Studies**

Students will complete a selection of the best case studies chosen specifically for this program. Cases that are presented, analyzed, and supervised by the best specialists in the world.



**Interactive Summaries**

The TECH team presents the contents attractively and dynamically in multimedia lessons that include audio, videos, images, diagrams, and concept maps in order to reinforce knowledge.

This exclusive educational system for presenting multimedia content was awarded by Microsoft as a "European Success Story".



**Testing & Retesting**

We periodically evaluate and re-evaluate students' knowledge throughout the program, through assessment and self-assessment activities and exercises, so that they can see how they are achieving their goals.



05

# Certificate

The Postgraduate Certificate in Mathematical Methods in Physics guarantees students, in addition to the most rigorous and up-to-date education, access to a Postgraduate Certificate issued by TECH Global University.



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

This program will allow you to obtain your **Postgraduate Certificate in Mathematical Methods in Physics** endorsed by **TECH Global University**, the world's largest online university.

**TECH Global University** is an official European University publicly recognized by the Government of Andorra ([official bulletin](#)). Andorra is part of the European Higher Education Area (EHEA) since 2003. The EHEA is an initiative promoted by the European Union that aims to organize the international training framework and harmonize the higher education systems of the member countries of this space. The project promotes common values, the implementation of collaborative tools and strengthening its quality assurance mechanisms to enhance collaboration and mobility among students, researchers and academics.

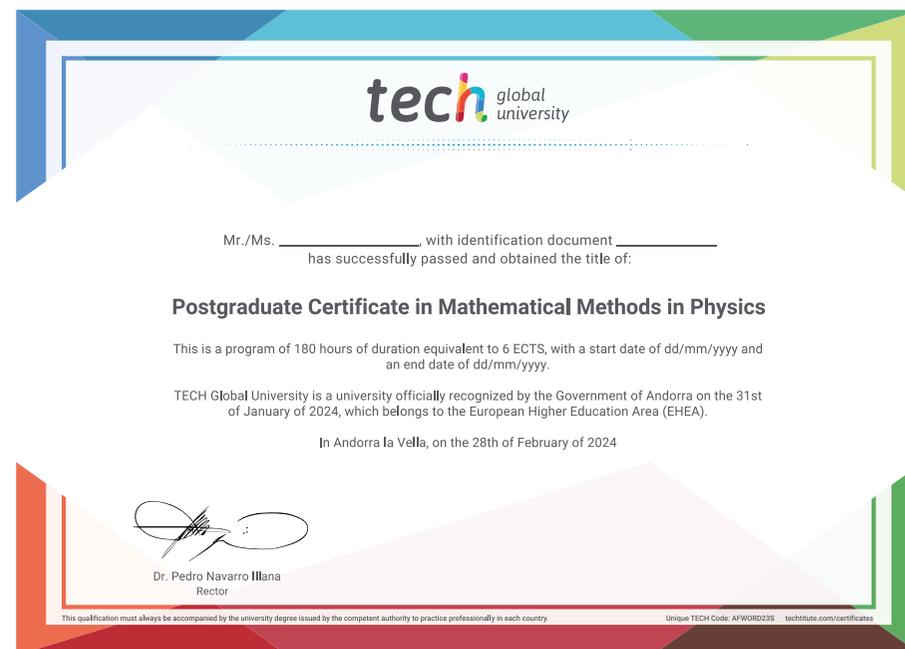
This **TECH Global University** title is a European program of continuing education and professional updating that guarantees the acquisition of competencies in its area of knowledge, providing a high curricular value to the student who completes the program.

Title: **Postgraduate Certificate in Mathematical Methods in Physics**

Modality: **online**

Duration: **6 weeks**

Accreditation: **6 ECTS**



future  
health confidence people  
education information tutors  
guarantee accreditation teaching  
institutions technology learning  
community commitment  
personalized service innovation  
knowledge present  
development languages  
virtual classroom



**Postgraduate Certificate**  
Mathematical Methods  
in Physics

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