

# Postgraduate Certificate Turbulence and Boundary Layer Modeling





## Postgraduate Certificate Turbulence and Boundary Layer Modeling

- » Modality: **online**
- » Duration: **6 weeks**
- » Certificate: **TECH Technological University**
- » Dedication: **16h/week**
- » Schedule: **at your own pace**
- » Exams: **online**

Website: [www.techtute.com/in/engineering/postgraduate-certificate/turbulence-boundary-layer-modeling](http://www.techtute.com/in/engineering/postgraduate-certificate/turbulence-boundary-layer-modeling)

# Index

01

Introduction

---

*p. 4*

02

Objectives

---

*p. 8*

03

Course Management

---

*p. 12*

04

Structure and Content

---

*p. 16*

05

Methodology

---

*p. 20*

06

Certificate

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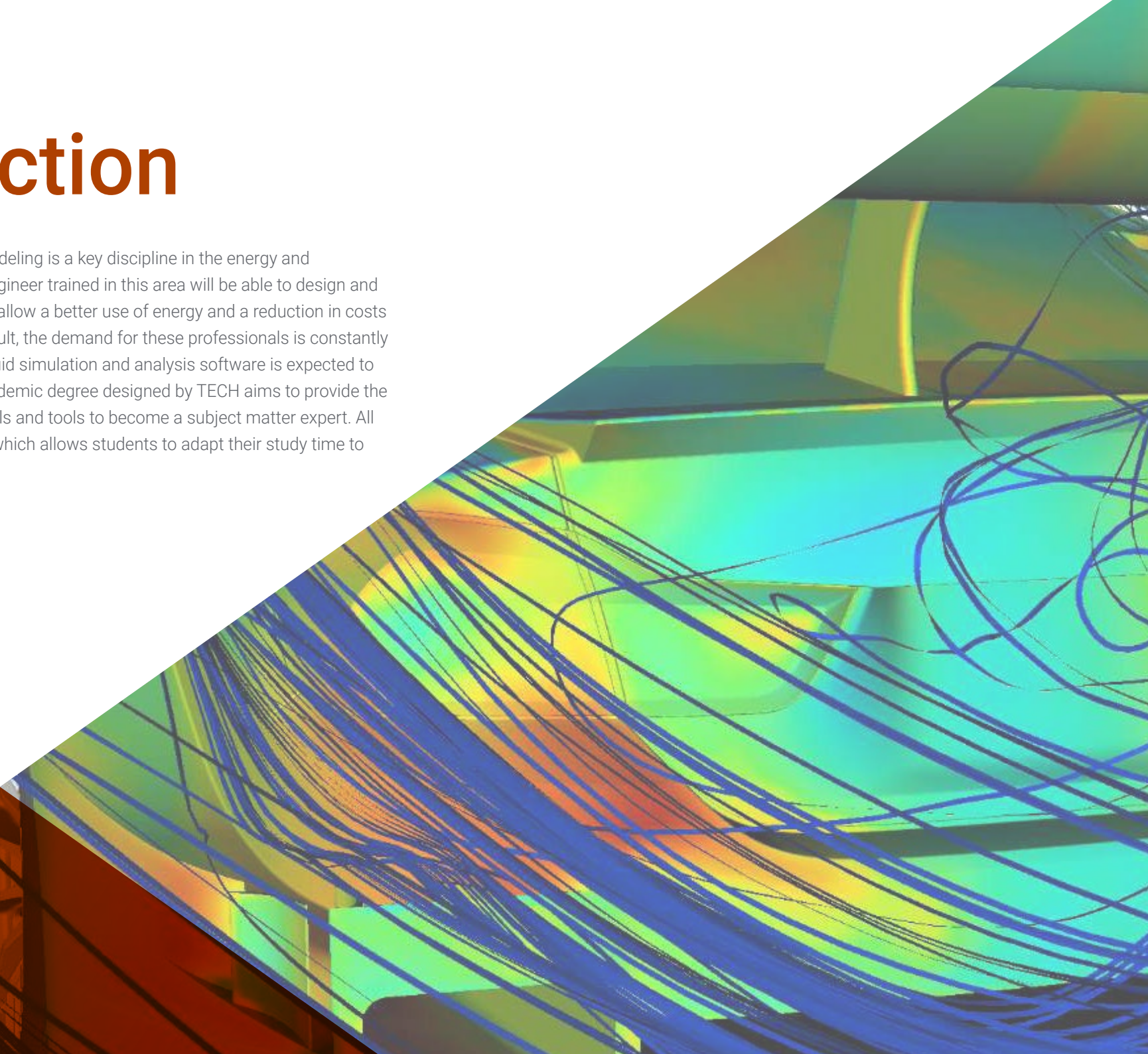
*p. 28*



# 01

# Introduction

Turbulence and Boundary Layer Modeling is a key discipline in the energy and aerodynamics industry. Thus, an engineer trained in this area will be able to design and optimize systems and devices that allow a better use of energy and a reduction in costs and environmental impact. As a result, the demand for these professionals is constantly growing, as the global market for fluid simulation and analysis software is expected to continue to increase. Thus, this academic degree designed by TECH aims to provide the professional with the necessary skills and tools to become a subject matter expert. All this under a 100% online modality, which allows students to adapt their study time to their personal and work schedule.







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*Thanks to this Postgraduate Certificate, you will be able to establish hypotheses on turbulent viscosity”*

Turbulence and Boundary Layer Modeling is a discipline of great importance in sectors such as aerospace engineering, automotive, marine and energy industries. Thus, engineers trained in this area can design and analyze systems and devices to reduce flow resistance, improve energy efficiency, minimize environmental impacts and improve process safety.

For this reason, the demand for engineers trained in this sector is growing steadily and more and more organizations are hiring these professionals. In this sense, there is a growing need for professionals trained in this area to meet the demands of the industry. Thus, the graduate will be able to access numerous job opportunities in a variety of industries, where he/she will be able to contribute significantly to the development of technology and improve efficiency and sustainability in processes and devices.

For all these reasons, TECH has created an academic degree in which the graduate will delve into the problem of chaos and the energy cascade, as well as the turbulence cycle. All this under a comfortable 100% online modality, which allows you to adapt your study time and combine it with your personal and professional work. In addition, the program's methodology focuses on providing the student with a complete, practical and efficient education under the most effective methodology, Relearning.

This **Postgraduate Certificate in Turbulence and Boundary Layer Modeling** contains the most complete and up-to-date program on the market. The most important features include:

- ◆ The development of case studies presented by experts in Textile Engineering
- ◆ The graphic, schematic, and practical contents with which they are created, provide 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



*A curriculum in which the contents are presented in an attractive and dynamic way to turn you into a first level engineer”*

“

*The teaching system offered by TECH will allow you to organize your time and pace of learning, adapting it to your schedule”*

*You will be able to access the contents from any device with an internet connection 24 hours a day.*

*This is your opportunity to access the best theoretical and practical contents of the academic panorama, only in the TECH library.*

The program's teaching staff includes professionals from 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 professional 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 professional must try to solve the different professional practice situations that are presented throughout the academic course. This will be done with the help of an innovative system of interactive videos made by renowned experts.

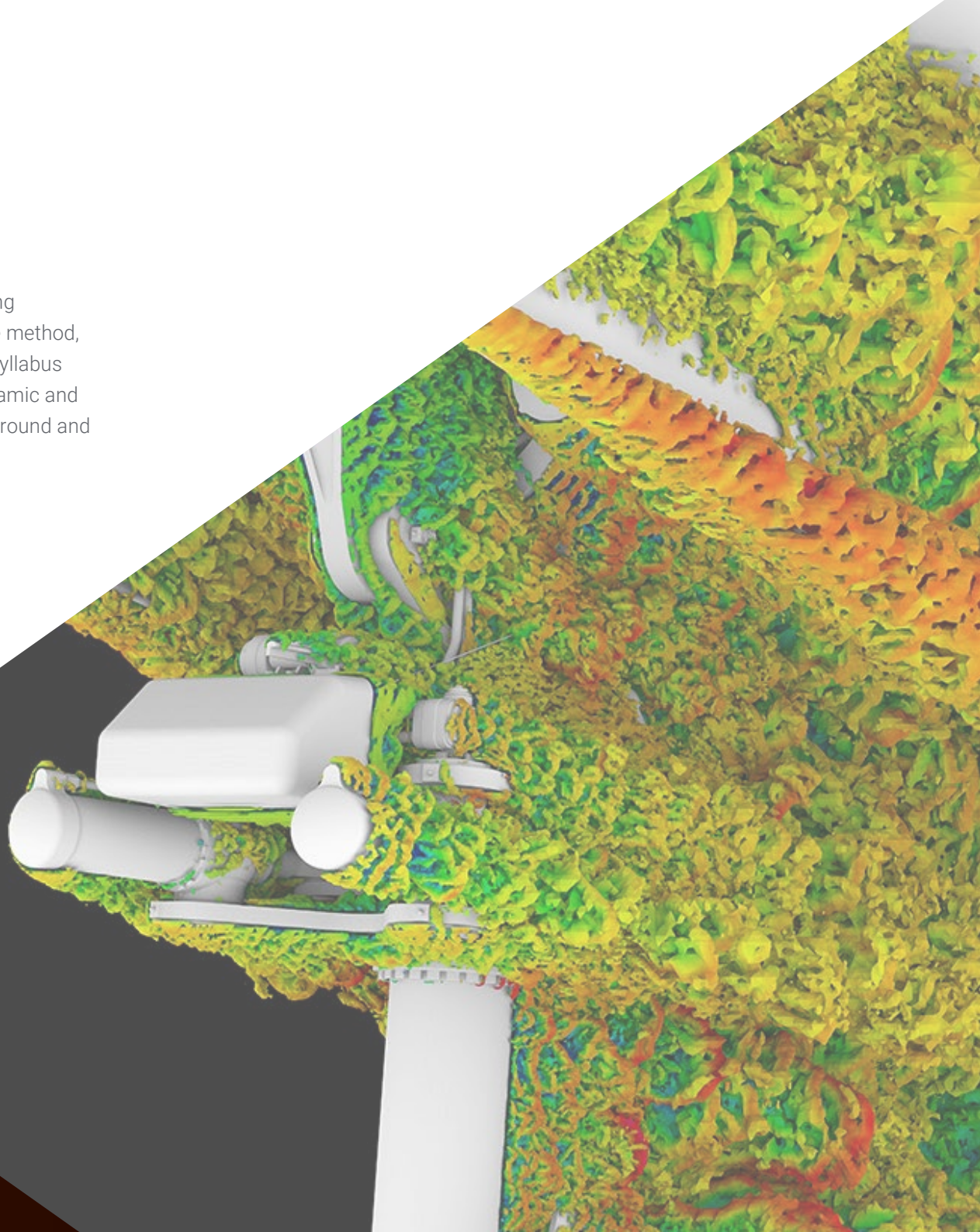




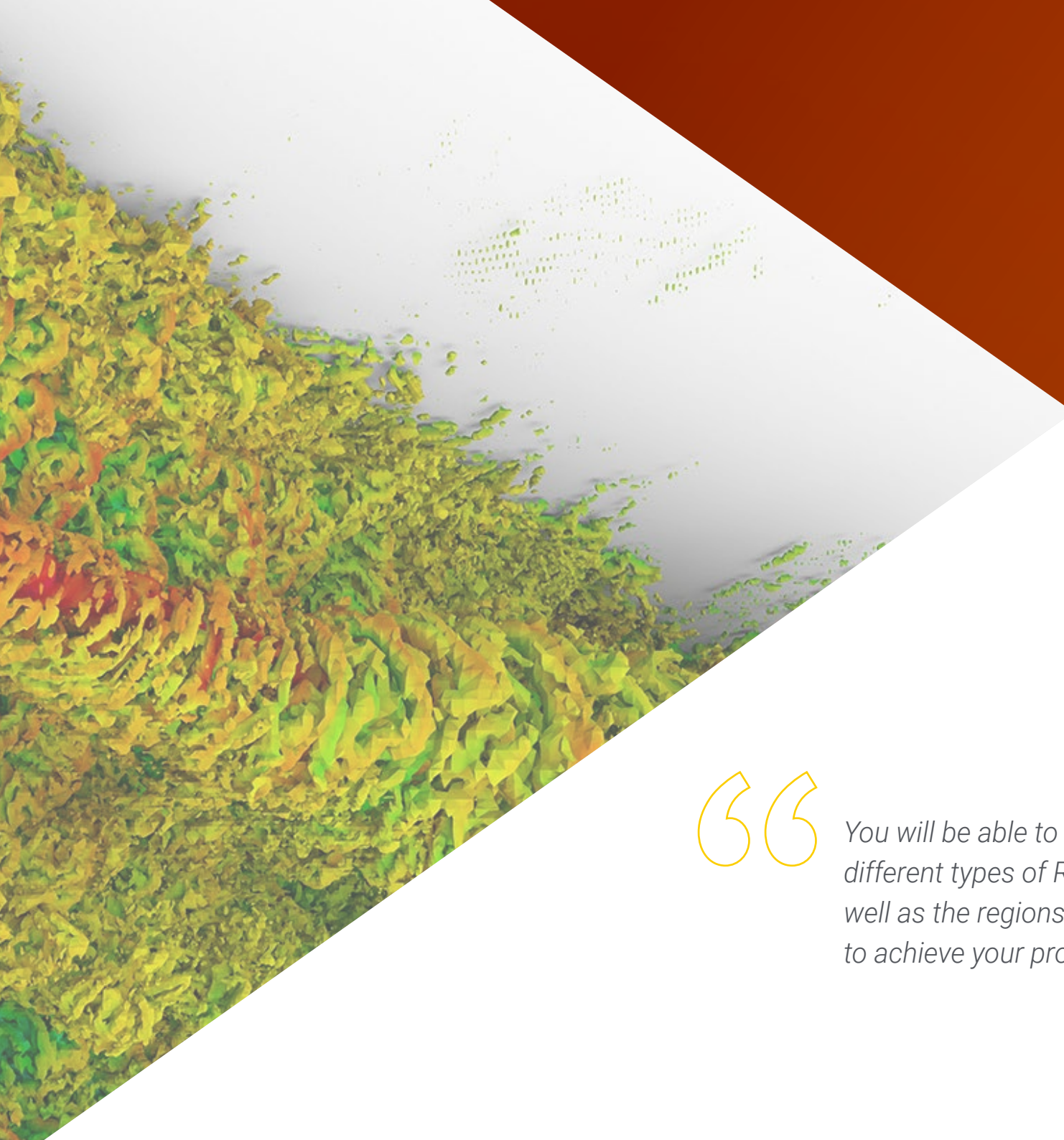
# 02

# Objectives

Throughout the 150 hours of instruction of this university course, engineering professionals will be able to acquire in-depth knowledge of the finite volume method, as well as develop the concept of turbulent viscosity. For this purpose, the syllabus has been designed by a specialized teaching team that will present in a dynamic and efficient manner the revised closure problem, as well as the historical background and parallels in the orders of magnitude.







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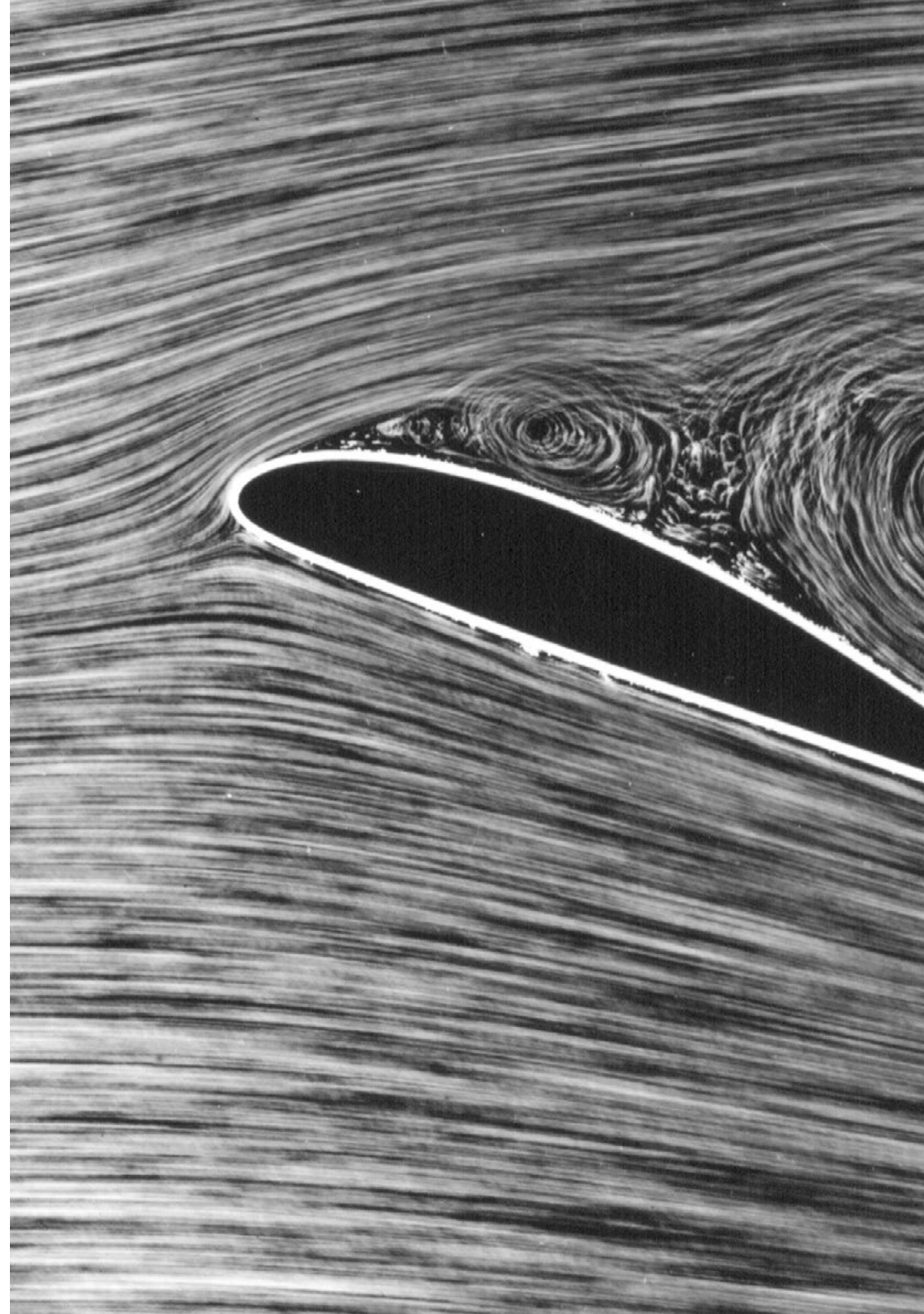
*You will be able to understand the different types of RANS and LES, as well as the regions of a turbulent flow to achieve your professional goals”*



## General Objectives

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- ◆ Establish the basis for the study of turbulence
- ◆ Develop CFD statistical concepts
- ◆ Determine the main computational techniques in turbulence research
- ◆ Generate specialized knowledge in the method of Finite Volumes
- ◆ Acquire specialized knowledge in fluid mechanics calculation techniques
- ◆ Examine the wall units and the different regions of a turbulent wall flow
- ◆ Determine the characteristics of compressible flows
- ◆ Examine multiple models and multiphase methods
- ◆ Develop expertise on multiple models and methods in multiphysics and thermal analysis
- ◆ Interpret the results obtained by correct post-processing







## Specific Objectives

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- ◆ Applying the concept of orders of magnitude
- ◆ Present the problem of closure of the Navier-Stokes equations
- ◆ Examine energy budget equations
- ◆ Develop the concept of turbulent viscosity
- ◆ Substantiate the different types of RANS and LES
- ◆ Present the regions of a turbulent flow
- ◆ Model the energy equation



*Enroll now and get access to the most innovative pedagogical tools in the turbulent kinetic energy equation”*



03

# Course Management

To ensure that the student has the proper guidance, TECH has been careful to select a team of experienced professionals in the field to create this program. Thus, these well-versed professionals bring years of experience to your specialization in the field of Computational Fluid Mechanics, ensuring that engineers will have access to the most innovative and relevant content in the industry. In addition, the teaching methodology used, Relearning, is highly efficient and effective.





“

*TECH, together with a team of experts in this field have designed the best program in Turbulence and Boundary Layer Modeling in the academic landscape today”*

## Management



### **Dr. José Pedro García Galache**

- ♦ XFlow Development Engineer at Dassault Systèmes
- ♦ PhD in Aeronautical Engineering from the Polytechnic University of Valencia
- ♦ Degree in Aeronautical Engineering from the Polytechnic University of Valencia
- ♦ Master's Degree in Research in Fluid Mechanics from the Von Kármán Institute for Fluid Dynamics
- ♦ Short Training Programme en el Von Kármán Institute for Fluid Dynamics

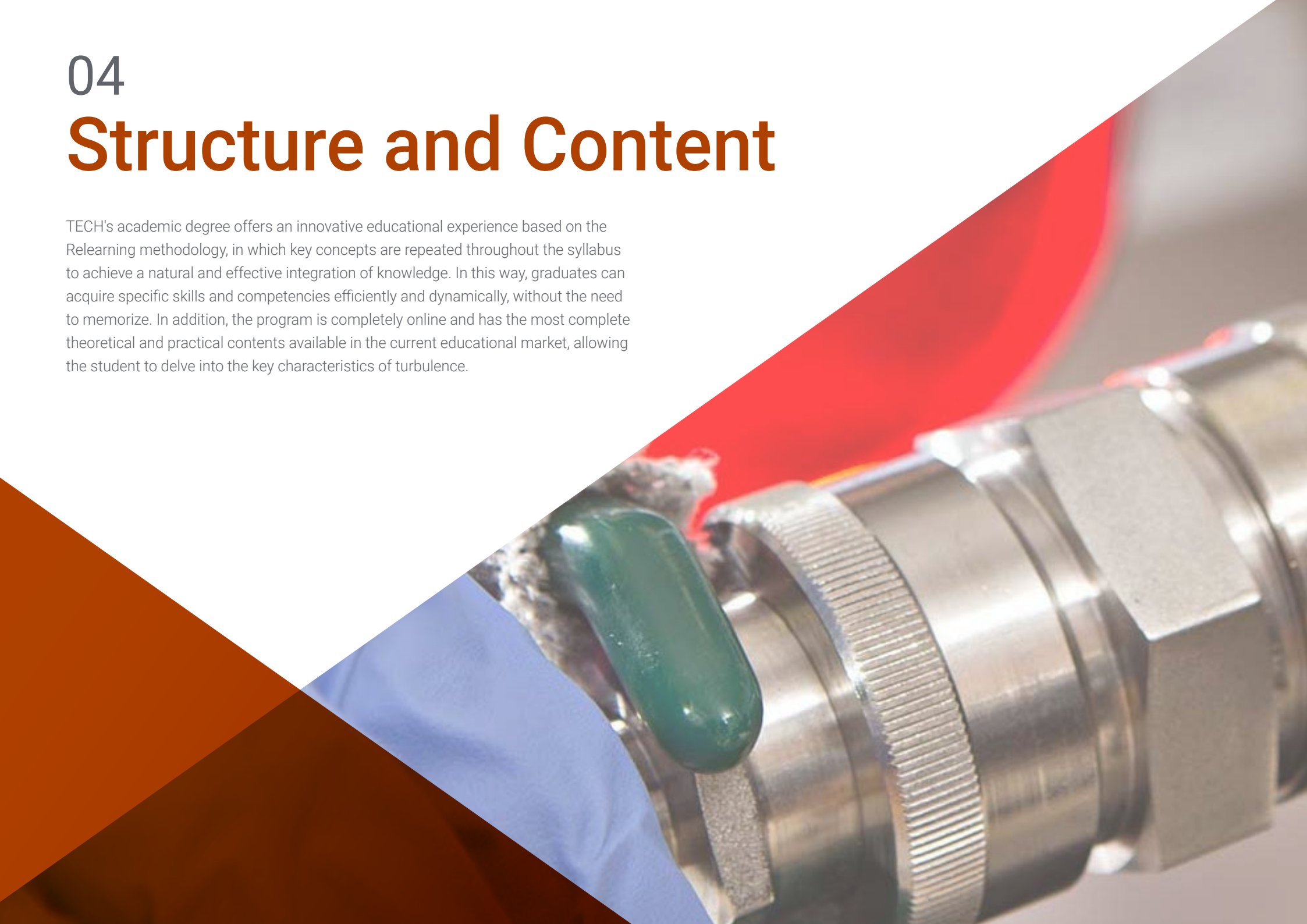




# 04

# Structure and Content

TECH's academic degree offers an innovative educational experience based on the Relearning methodology, in which key concepts are repeated throughout the syllabus to achieve a natural and effective integration of knowledge. In this way, graduates can acquire specific skills and competencies efficiently and dynamically, without the need to memorize. In addition, the program is completely online and has the most complete theoretical and practical contents available in the current educational market, allowing the student to delve into the key characteristics of turbulence.





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*Dynamic and practical content on  
Turbulence and Boundary Layer  
Modeling that you can access  
anytime, anywhere”*



## Module 1. Modeling of turbulence in Fluid

- 1.1. Turbulence. Key features
  - 1.1.1. Dissipation and diffusivity
  - 1.1.2. Characteristic scales. Orders of magnitude
  - 1.1.3. Reynolds Numbers
- 1.2. Definitions of Turbulence. From Reynolds to the present day
  - 1.2.1. The Reynolds problem. The boundary layer
  - 1.2.2. Meteorology, Richardson and Smagorinsky
  - 1.2.3. The problem of chaos
- 1.3. The energy cascade
  - 1.3.1. Smaller scales of turbulence
  - 1.3.2. Kolmogorov's hypothesis
  - 1.3.3. The cascade exponent
- 1.4. The closure problem revisited
  - 1.4.1. 10 unknowns and 4 equations
  - 1.4.2. The turbulent kinetic energy equation
  - 1.4.3. The turbulence cycle
- 1.5. Turbulent viscosity
  - 1.5.1. Historical background and parallels
  - 1.5.2. Initiation problem: jets
  - 1.5.3. Turbulent viscosity in CFD problems
- 1.6. RANS methods
  - 1.6.1. The turbulent viscosity hypothesis
  - 1.6.2. The RANS equations
  - 1.6.3. RANS methods. Examples of use
- 1.7. The evolution of SLE
  - 1.7.1. Historical Background
  - 1.7.2. Spectral filters
  - 1.7.3. Spatial filters. The problem in the wall





- 1.8. Wall turbulence I
  - 1.8.1. Characteristic scales
  - 1.8.2. The momentum equations
  - 1.8.3. The regions of a turbulent wall flow
- 1.9. Wall turbulence II
  - 1.9.1. Boundary layers
  - 1.9.2. Dimensionless numbers of a boundary layer
  - 1.9.3. The Blasius solution
- 1.10. The energy equation
  - 1.10.1. Passive scalars
  - 1.10.2. Active scalars. The Bousinesq approach
  - 1.10.3. Fanno and Rayleigh flows

“*Quality content designed under the most efficient pedagogical methodology, Relearning, in which TECH is a pioneer*”



05

# 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.







“

*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.

“

*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.



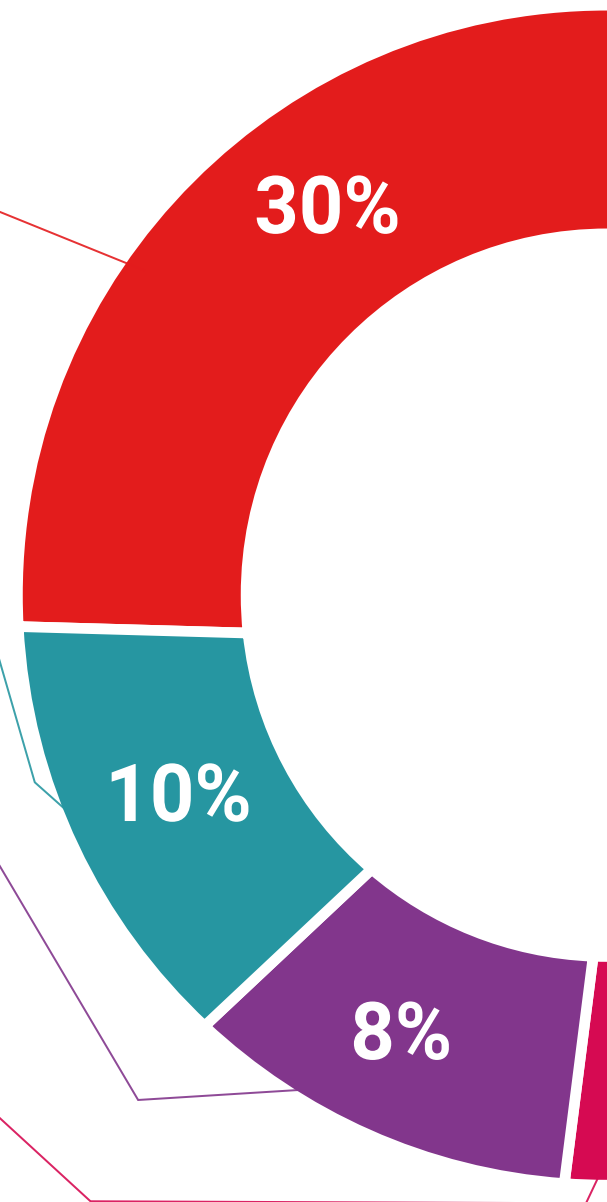
### Practising Skills and Abilities

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.





06

# Certificate

The Postgraduate Certificate in Turbulence and Boundary Layer Modeling 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 Turbulence and Boundary Layer Modeling** 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.

Program: **Postgraduate Certificate in Turbulence and Boundary Layer Modeling**

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.

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



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