Postgraduate Diploma
CFD Simulation in Industrial Environments

tech technological university

Postgraduate Diploma
CFD Simulation in Industrial Environments

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

Website: **www.techtitute.com/pk/engineering/postgraduate-diploma/postgraduate-diploma-cfd-simulation-industrial-environments**

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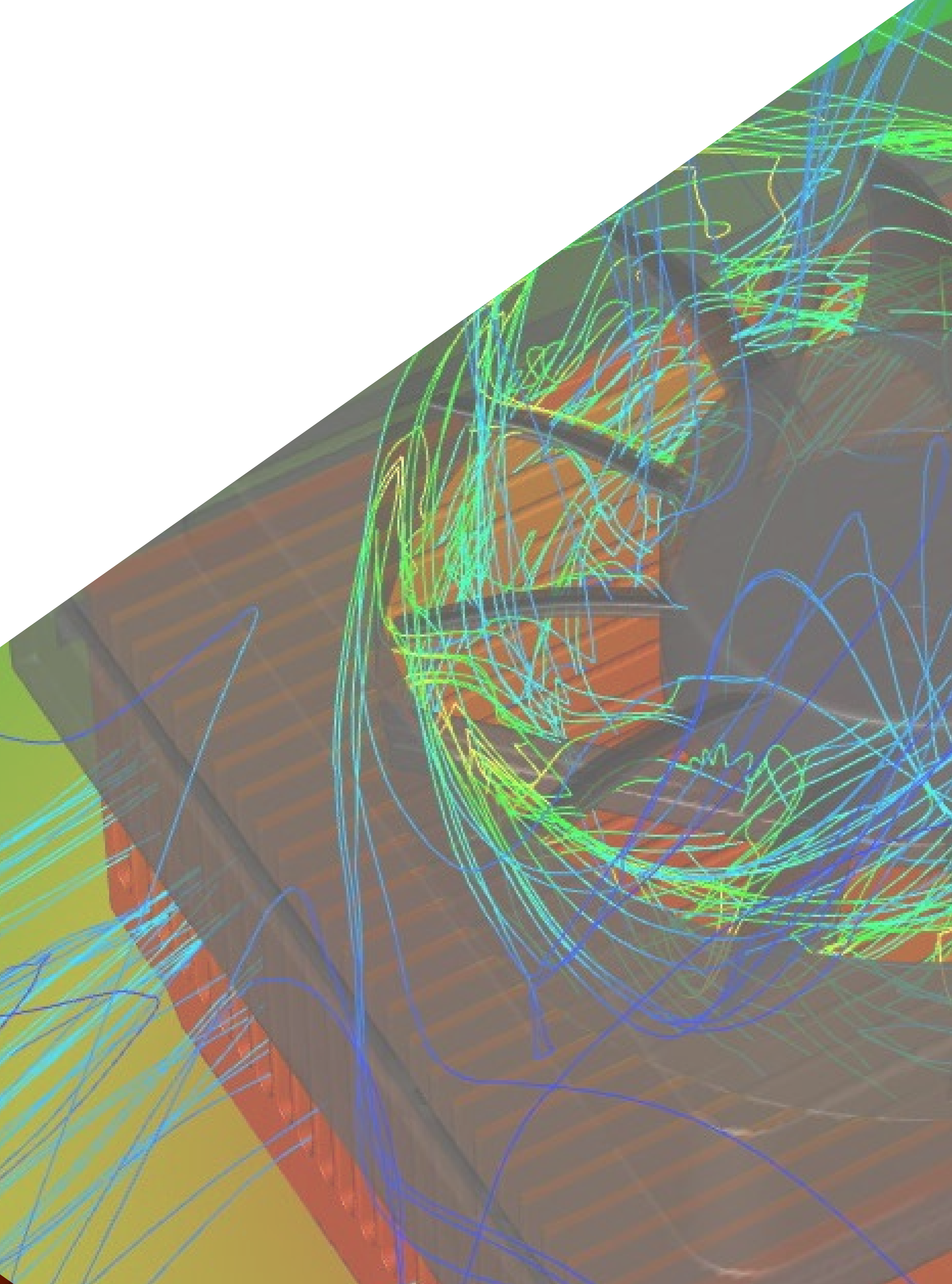
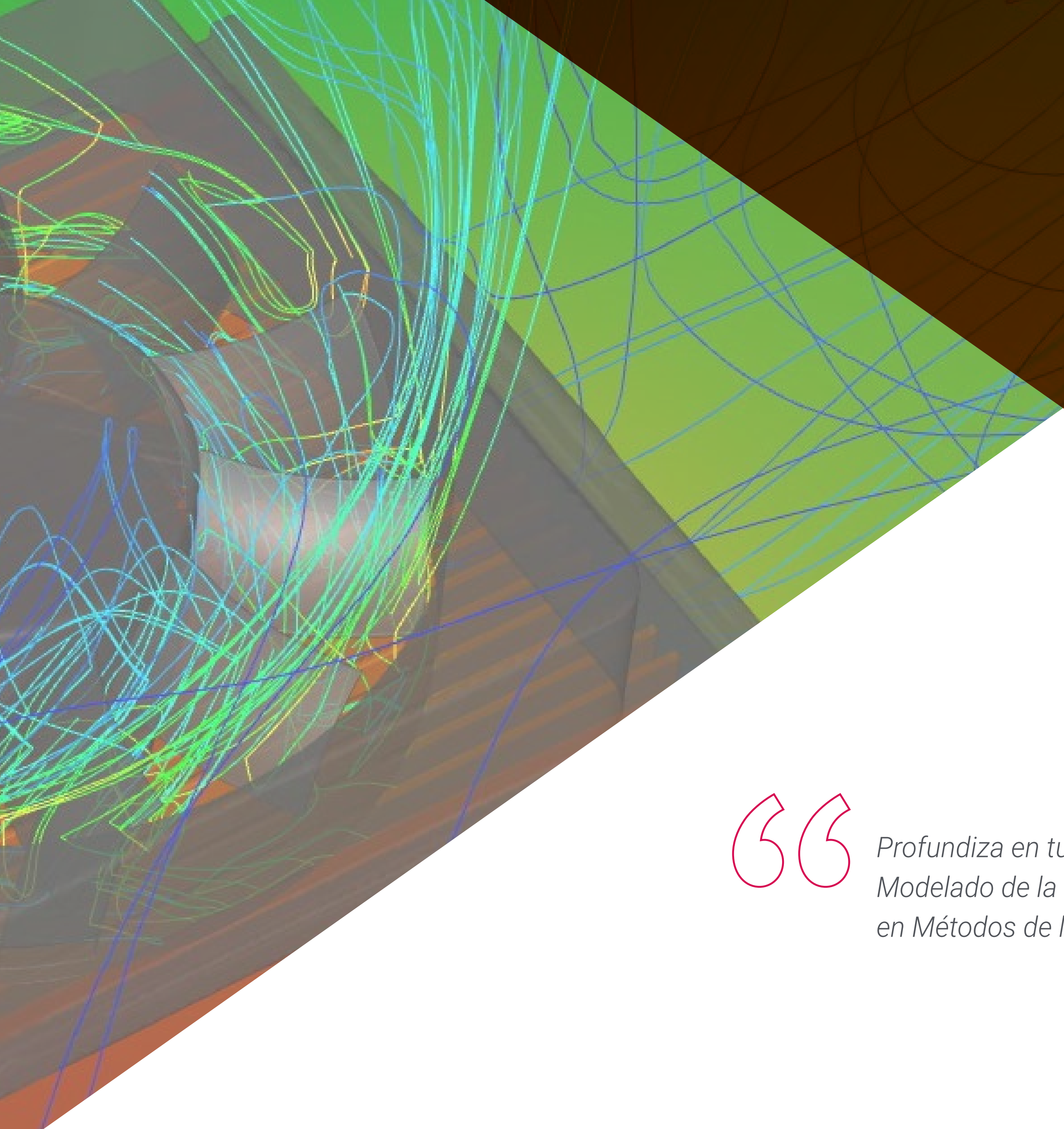
01

Introduction

Computational Fluid Dynamics is a very active field in research and in environments in different fields, such as industry. Industrial companies are the main users of CFD Simulation, so they are also the main demanding factors of professionals with advanced knowledge in the field. For this reason, TECH has created a degree that seeks to provide students with the necessary skills and the deepest knowledge in CFD, with which they can face their professional work with the highest quality. For this purpose, a syllabus has been created covering the Future of AI in Turbulence, the FEM or MVF Environment, Turbulence Modeling in Fluid or Post-processing, among others. All this in a convenient 100% online mode that gives students total freedom to organize their studies and schedules.





Profundiza en tus conocimientos en el Modelado de la Turbulencia en Fluido o en Métodos de los Volúmenes Finitos"

Computational Fluid Dynamics is one of the most relevant computer simulation techniques. Its multiple advantages are used in a large number of sectors, among which the industrial sector stands out, since companies in this field are the main users of CFD Simulation. As a result, the demand for expert engineers with knowledge in this sector and advanced skills in this technique is increasing steadily.

For this reason, TECH has designed a University Expert in CFD Simulation in Industrial Environments, with the aim of providing students with specialized knowledge on Finite Volume Methods, Temporal Integration, Turbulent Structures, the Energy Equation, Postprocessing in CFD or Simulation Methods, among many other essential aspects. Thus, they will obtain the necessary skills to face their future in this area, with the maximum possible efficiency and the ability to solve any inconvenience.

All this, through a convenient 100% online modality that gives students total freedom to organize their studies and schedules, without the need to travel. In addition, being able to combine the completion of this program with their other obligations and with the possibility of accessing all the content from any device with internet connection, whether computer, tablet or cell phone.

This **Postgraduate Diploma in CFD Simulation in Industrial Environments** 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 CFD Simulation in Industrial Environments
- 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 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

"Learn how to get the most out of CFD Simulation in Industrial Environments"

Acquire new knowledge about Good Practices and the different Errors that can occur in CFD Simulation"

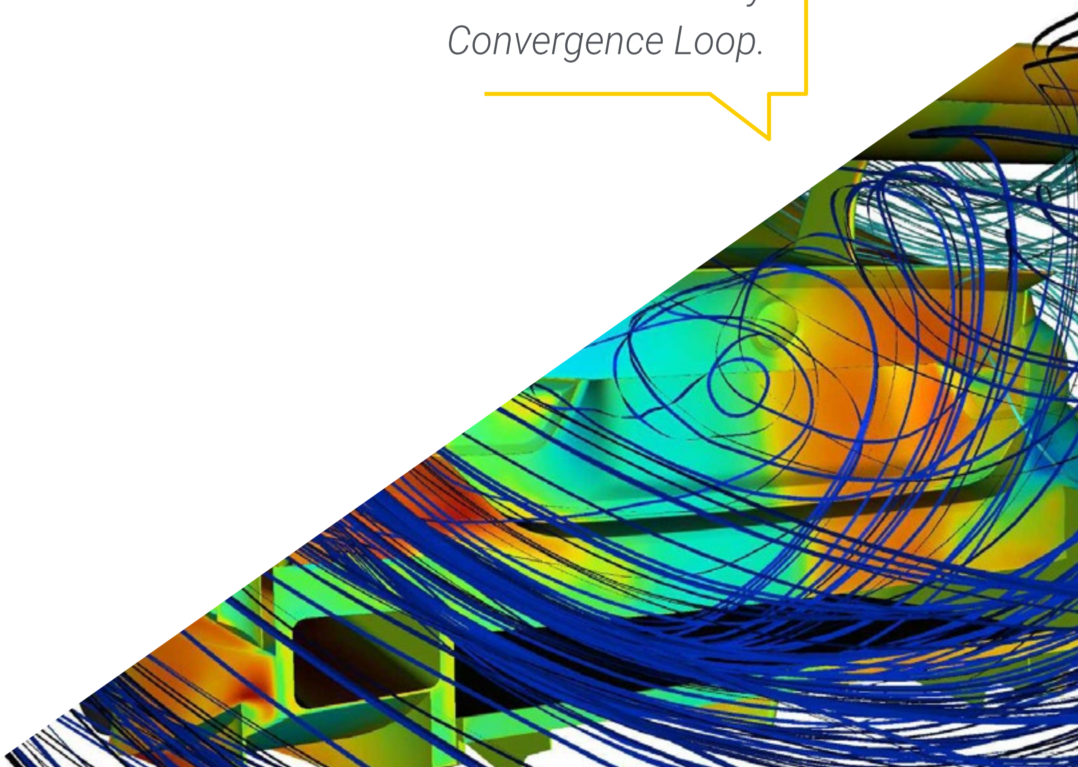
The program's teaching staff includes professionals from sector who contribute their work experience to this educational program, as well as renowned specialists from leading societies and prestigious universities.

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. For this purpose, the student will be assisted by an innovative interactive video system created by renowned experts.

Get to know the future of CFD Simulation and adapt your profile to reach your most demanding professional goals in a short time.

With TECH, you will have access to the best theoretical and practical content on Pressure Velocity Convergence Loop.



02

Objectives

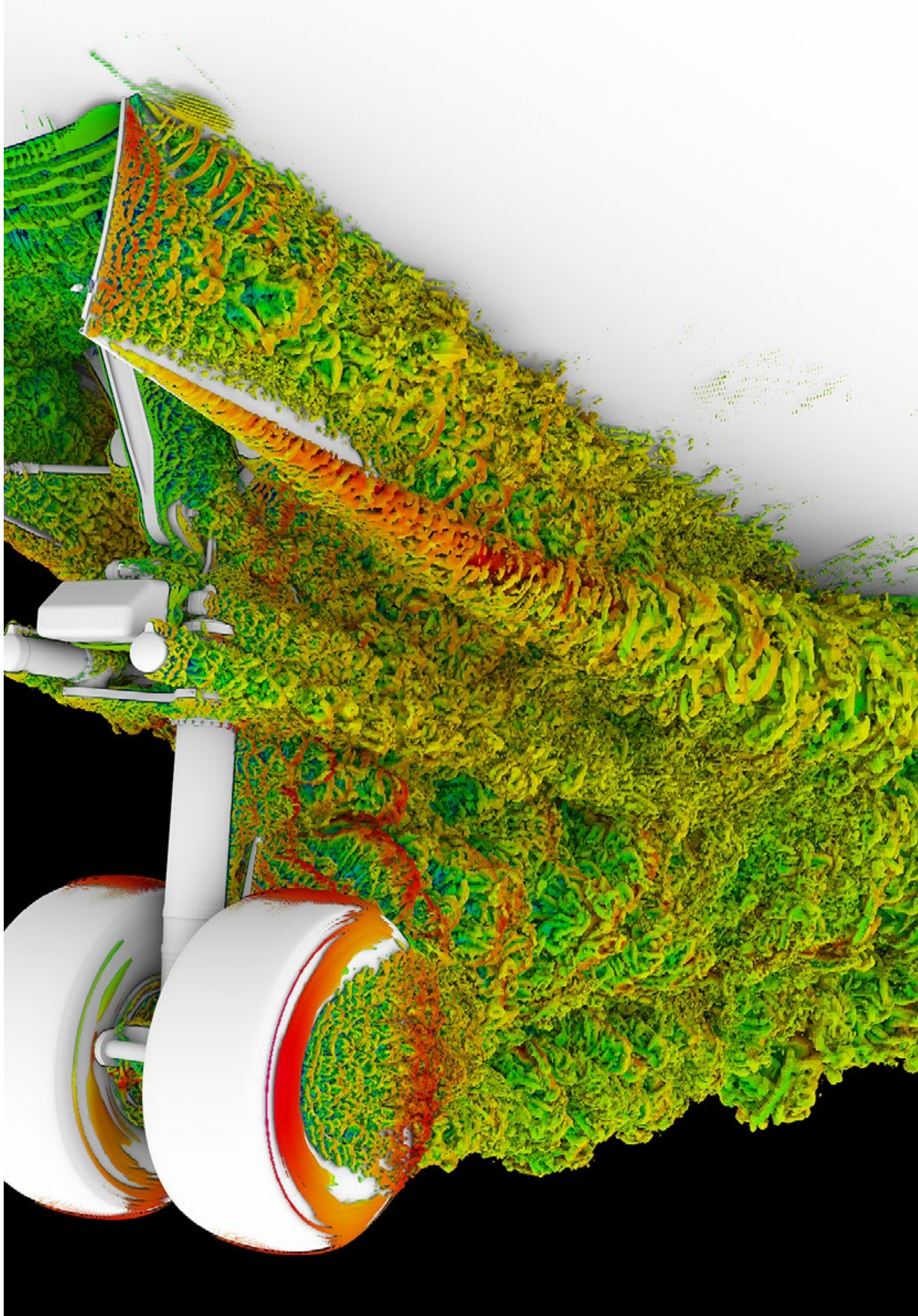
The objective of this Postgraduate Diploma in CFD Simulation in Industrial Environments is to train students with the skills and competencies necessary to face their work in one of the sectors with the greatest future in the area of CFD Simulation. All this, through the most updated, dynamic and accurate contents of the academic market.

In only 6 months you will be able to specialize in one of the most promising areas of engineering, thanks to TECH"

General Objectives

- 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

Get the most out of the most innovative CFD simulation tools"



Specific Objectives

Module 1. CFD in Research and Modeling Environments

- Analyzing the future of artificial intelligence in turbulence
- Apply classical discretization methods to fluid mechanics problems
- Determine the different turbulent structures and their importance
- Show the method of characteristics
- To present the effect of the evolution of supercomputing on CFD problems
- Examine the main open problems in turbulence

Module 2. CFD in Application Environments: Finite Volume Methods

- Analyze the FEM or MVF environment
- Specify what, where and how the boundary conditions can be defined
- Determine possible time steps
- Concretizing and designing Upwind schemes
- Develop high order schemes
- Examine convergence loops and in which cases to use each one
- Expose the imperfections of CFD results

Module 3. Modeling of turbulence in Fluid

- Applying the concept of orders of magnitude
- To present the problem of closure of the Navier-Stokes equations
- Examining energy budget equations
- Developing the concept of turbulent viscosity
- To substantiate the different types of RANS and LES
- To present the regions of a turbulent flow
- Modeling the energy equation

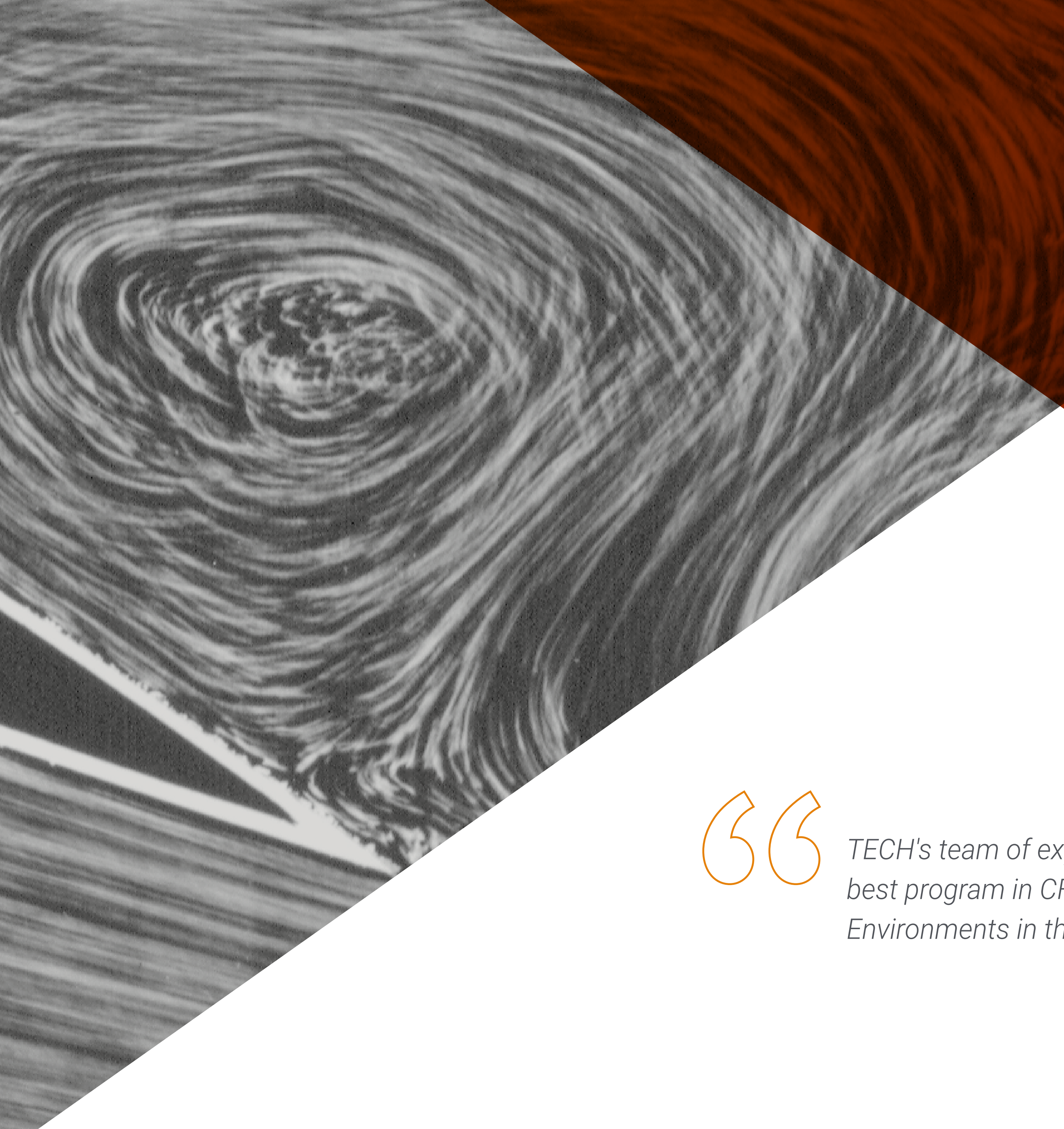
Module 4. Post-processing, validation and application in CFD

- Determine the types of post-processing according to the results to be analyzed: purely numerical, visual or a mixture of both
- Analyzing the convergence of a CFD simulation
- Establish the need for CFD validation and know basic examples of CFD validation
- Examine the different tools available on the market
- To provide a foundation for the current context of CFD simulation

03

Course Management

In its quest to offer the most efficient teaching materials with the best quality in the academic market, TECH has selected an excellent group of experts, composed of the best professionals in the field of CFD Simulation, who are specialized in Industrial Environments. In this way, multimedia contents and the latest and most innovative information are offered, as well as the most useful practical activities, so that students can test their new skills.



TECH's team of experts has designed the best program in CFD Simulation in Industrial Environments in the academic market"

Management

Dr. José Pedro García Galache

- XFlow Development Engineer at Dassault Systèmes
- D. in Aeronautical Engineering from the Polytechnic University of Valencia
- Degree in Aeronautical Engineering from the Polytechnic University of Valencia
- Professional 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

Professors

Dr. Enrique Mata Bueso

- Senior Thermal Conditioning and Aerodynamics Engineer at Siemens Gamesa
- Application Engineer and CFD R&D Manager at Dassault Systèmes
- Thermal Conditioning and Aerodynamics Engineer in Gamesa-Altran
- Fatigue and Damage Tolerance Engineer at Airbus-Atos
- R&D CFD Engineer at UPM
- Aeronautical Technical Engineer with specialization in Aircraft by UPM
- Master's Degree in Aerospace Engineering from the Royal Institute of Technology in Stockholm

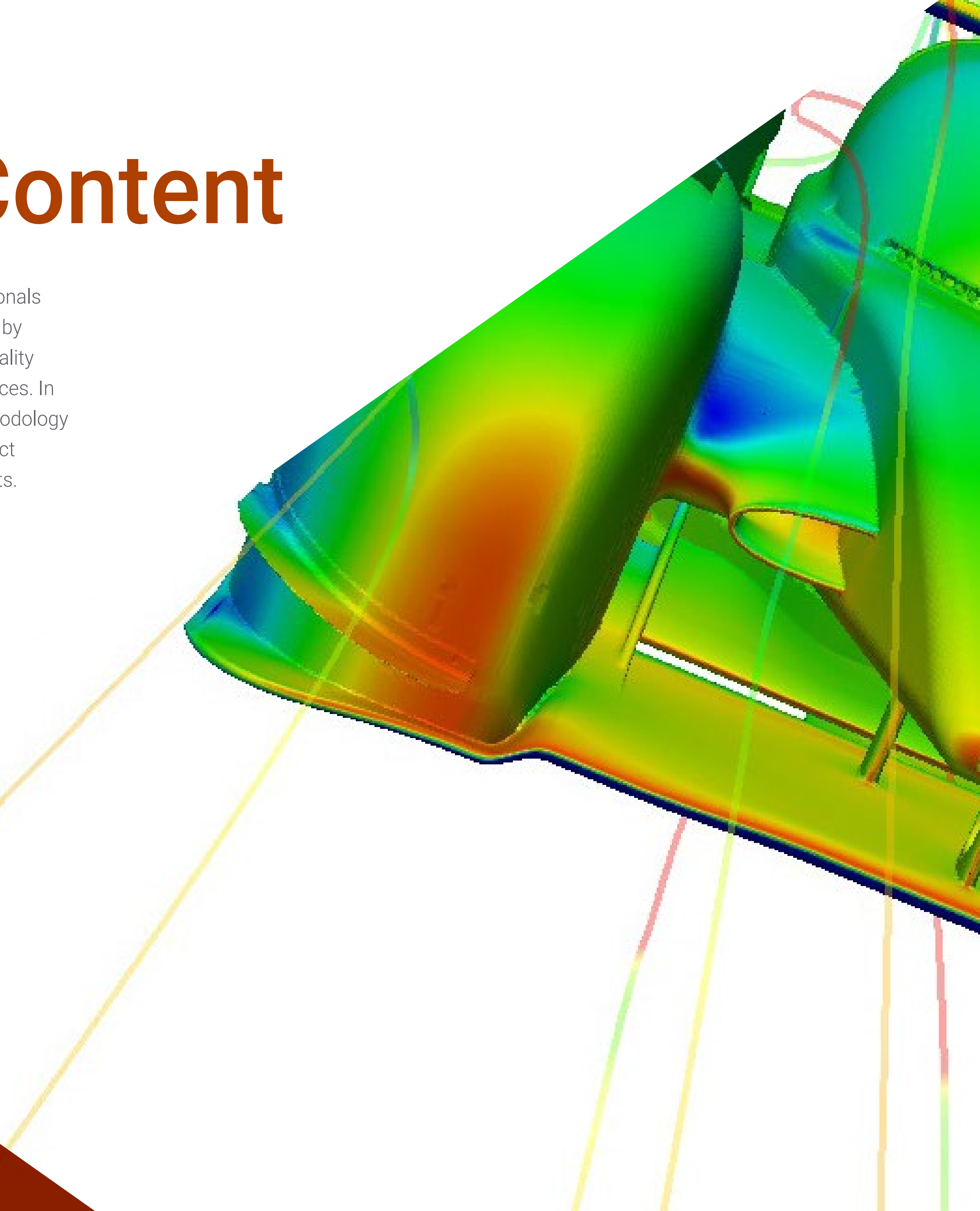
Ms. Maider Pérez Tainta

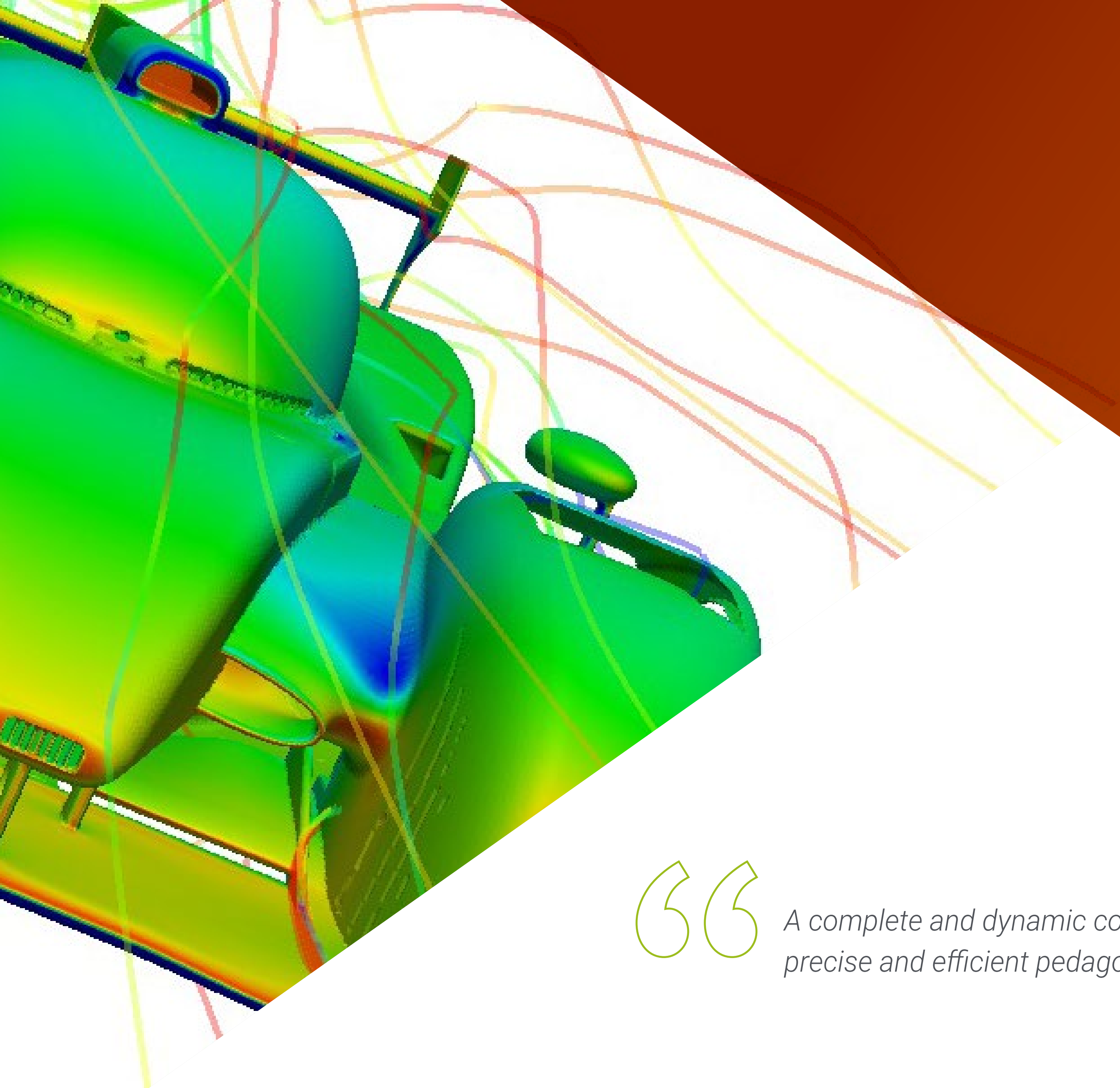
- Cement fluidization engineer at Kemex Ingesoa
- Process Engineer at J.M. Jauregui
- Researcher in hydrogen combustion at Ikerlan
- Mechanical engineer at Idom
- Graduate in Mechanical Engineering from the University of the Basque Country (UPV)
- Master's Degree in Mechanical Engineering
- Interuniversity Professional Master's Degree in Fluid Mechanics
- Python programming program program program

04

Structure and Content

The structure and content of this curriculum have been created by professionals who are experts in the field and have been carefully and rigorously selected by TECH. In this way, we can guarantee that the contents are of the highest quality and that all information is based on the most complete and up-to-date sources. In addition, throughout the creation process, the Relearning pedagogical methodology has been applied, which ensures the best possible assimilation of the subject matter, thanks to the natural and precise reiteration of the essential concepts.





A complete and dynamic content, designed under the most precise and efficient pedagogical methodology, Relearning"

Module 1. CFD in Research and Modeling Environments

1.1. Research in Computational Fluid Dynamics (CFD)
    1.1.1. Challenges in turbulence
    1.1.2. Advances in Chronic Obstructive Pulmonary Disease
    1.1.3. Artificial Intelligence
1.2. Finite differences
    1.2.1. Presentation and application to a 1D problem. Taylor's Theorem
    1.2.2. 2D Applications
    1.2.3. Boundary Conditions
1.3. Compact finite differences
    1.3.1. Objective SK Lele's article
    1.3.2. Obtaining coefficients
    1.3.3. Application to a 1D problem
1.4. The Fourier transform
    1.4.1. The Fourier transform. From Fourier to the present day
    1.4.2. The FFTW package
    1.4.3. Cosine transform: Tchebycheff
1.5. Spectral methods
    1.5.1. Application to a fluid problem
    1.5.2. Pseudo-spectral methods: Fourier + CFD
    1.5.3. Placement methods
1.6. Advanced time discretization methods
    1.6.1. The Adams-Bamsford method
    1.6.2. The Crack-Nicholson method
    1.6.3. Runge-Kutta
1.7. Structures in turbulence
    1.7.1. The Vortex
    1.7.2. The life cycle of a turbulent structure
    1.7.3. Visualization Techniques
1.8. The Characteristics Method
    1.8.1. Compressible Fluids
    1.8.2. Application A breaking wave
    1.8.3. Application: Burguers equation
1.9. CFD and supercomputing
    1.9.1. The memory problem and the evolution of computers
    1.9.2. Parallelization techniques
    1.9.3. Domain decomposition
1.10. Open problems in turbulence
    1.10.1. Modeling and the Von-Karma constant
    1.10.2. Aerodynamics: boundary layers
    1.10.3. Noise in CFD problems

Module 2. CFD in Application Environments: Finite Volume Methods

2.1. Finite Volume Methods
    2.1.1. Definitions in FVM
    2.1.2. Historical Background
    2.1.3. MVF in Structures
2.2. Source Terms
    2.2.1. External volumetric forces
        2.2.1.1. Gravity, centrifugal force
    2.2.2. Volumetric (mass) and pressure source term (evaporation, cavitation, chemical)
    2.2.3. Scalar source term
        2.2.3.1. Temperature, species
2.3. Applications of boundary conditions
    2.3.1. Input and Output
    2.3.2. Symmetry condition
    2.3.3. Wall condition
        2.3.3.1. Tax values
        2.3.3.2. Values to be solved by parallel calculation
        2.3.3.3. Wall models

2.4. Boundary Conditions
- 2.4.1. Known boundary conditions: Dirichlet
  - 2.4.1.1. Scalars
  - 2.4.1.2. Diseases
- 2.4.2. Boundary conditions with known derivative: Neumann
  - 2.4.2.1. Zero gradient
  - 2.4.2.2. Finite gradient
- 2.4.3. Cyclic boundary conditions: Born-von Karman
- 2.4.4. Other boundary conditions: Robin

2.5. Temporary integration
- 2.5.1. Explicit and implicit Euler
- 2.5.2. Lax-Wendroff time step and variants (Richtmyer and MacCormack)
- 2.5.3. Runge-Kutta multi-stage time step

2.6. Upwind Schematics
- 2.6.1. Riemman's Problem
- 2.6.2. Main upwind schemes: MUSCL, Van Leer, Roe, AUSM
- 2.6.3. Design of an upwind spatial scheme

2.7. High order schemes
- 2.7.1. High-order discontinuous Galerkin
- 2.7.2. ENO and WENO
- 2.7.3. High Order Schemes. Advantages and Disadvantages

2.8. Pressure-velocity convergence loop
- 2.8.1. PISO
- 2.8.2. SIMPLE, SIMPLER and SIMPLEC
- 2.8.3. PIMPLE
- 2.8.4. Transient loops

2.9. Moving contours
- 2.9.1. Overlocking techniques
- 2.9.2. Mapping: mobile reference system
- 2.9.3. *Método de los límites sumergidos*
- 2.9.4. Overlapping meshes

2.10. Errors and uncertainties in CFD modeling
- 2.10.1. Precision and accuracy
- 2.10.2. Numerical errors
- 2.10.3. Input and physical model uncertainties

Module 3. Modeling of turbulence in Fluid

3.1. Turbulence. Key features
- 3.1.1. Dissipation and diffusivity
- 3.1.2. Characteristic scales. Orders of magnitude
- 3.1.3. Reynolds Numbers

3.2. Definitions of Turbulence. From Reynolds to the present day
- 3.2.1. The Reynolds problem. The boundary layer
- 3.2.2. Meteorology, Richardson and Smagorinsky
- 3.2.3. The problem of chaos

3.3. The energy cascade
- 3.3.1. Smaller scales of turbulence
- 3.3.2. Kolmogorov's hypothesis
- 3.3.3. The cascade exponent

3.4. The closure problem revisited
- 3.4.1. 10 unknowns and 4 equations
- 3.4.2. The turbulent kinetic energy equation
- 3.4.3. The turbulence cycle

3.5. Turbulent viscosity
- 3.5.1. Historical background and parallels
- 3.5.2. Initiation problem: jets
- 3.5.3. Turbulent viscosity in CFD problems

3.6. RANS methods
- 3.6.1. The turbulent viscosity hypothesis
- 3.6.2. The RANS equations
- 3.6.3. RANS methods. Examples of use

3.7. The evolution of SLE
- 3.7.1. Historical Background
- 3.7.2. Spectral filters
- 3.7.3. Spatial filters. The problem in the wall

3.8. Wall turbulence I
- 3.8.1. Characteristic scales
- 3.8.2. The momentum equations
- 3.8.3. The regions of a turbulent wall flow

3.9. Wall turbulence II
- 3.9.1. Boundary layers
- 3.9.2. Dimensionless numbers of a boundary layer
- 3.9.3. The Blasius solution

3.10. The energy equation
- 3.10.1. Passive scalars
- 3.10.2. Active scalars. The Bousinesq approach
- 3.10.3. Fanno and Rayleigh flows

Module 4. Post-processing, validation and application in CFD

4.1. Postprocessing in CFD I
- 4.1.1. Postprocessing on Plane and Surfaces
  - 4.1.1.1. Post-processing in the plane
  - 4.1.1.2. Post-processing on surfaces

4.2. Postprocessing in CFD II
- 4.2.1. Volumetric Postprocessing
  - 4.2.1.1. Volumetric post-processing I
  - 4.2.1.2. Volumetric post-processing II

4.3. Free CFD post-processing software
- 4.3.1. Free Postprocessing Software
- 4.3.2. *Paraview*
- 4.3.3. Paraview usage example

4.4. Convergence of simulations
- 4.4.1. Convergence
- 4.4.2. Mesh convergence
- 4.4.3. Numerical convergence

4.5. Classification of methods
- 4.5.1. Applications
- 4.5.2. Types of Fluid
- 4.5.3. Scales
- 4.5.4. Calculation machines

4.6. Model validation
- 4.6.1. Need for Validation
- 4.6.2. Simulation vs Experiment
- 4.6.3. Validation examples

4.7. Simulation methods. Advantages and Disadvantages
- 4.7.1. RANS
- 4.7.2. LES, DES, DNS
- 4.7.3. Other Methods
- 4.7.4. advantages and disadvantages

4.8. Examples of methods and applications
- 4.8.1. Case of a body subjected to aerodynamic forces
- 4.8.2. Thermal case
- 4.8.3. Multiphase case

4.9. Good Simulation Practices
- 4.9.1. Importance of Good Practices
- 4.9.2. Best Practices
- 4.9.3. Simulation errors

4.10. Free and commercial software
- 4.10.1. FVM Software
- 4.10.2. Software for other methods
- 4.10.3. Advantages and Disadvantages
- 4.10.4. CFD Simulation Futures

Access all content and a wide variety of additional information, from day one and with any device with an internet connection"

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

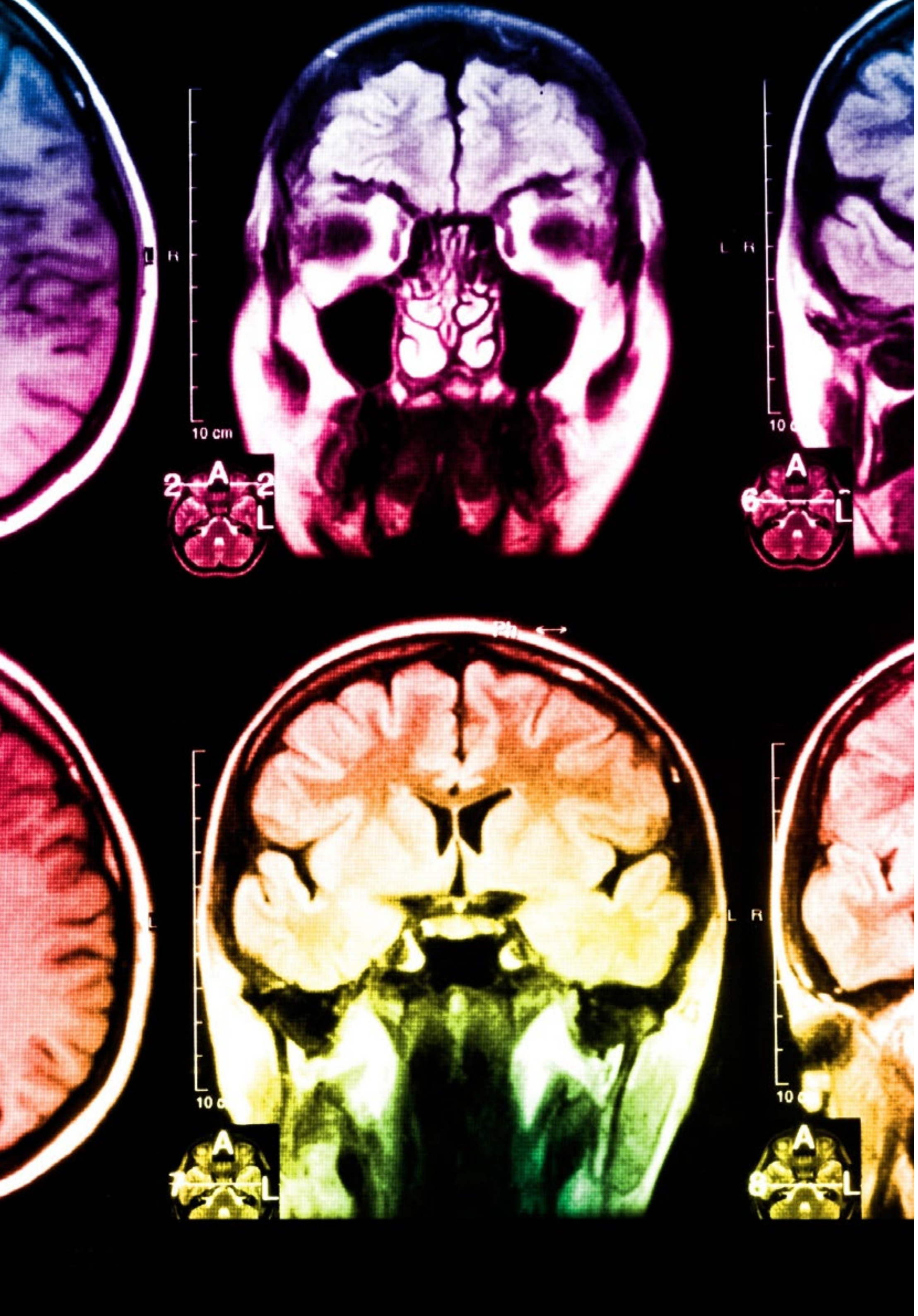
TECH effectively combines the Case Study methodology with a 100% online learning system based on repetition, which combines 8 different teaching elements in each lesson.

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.

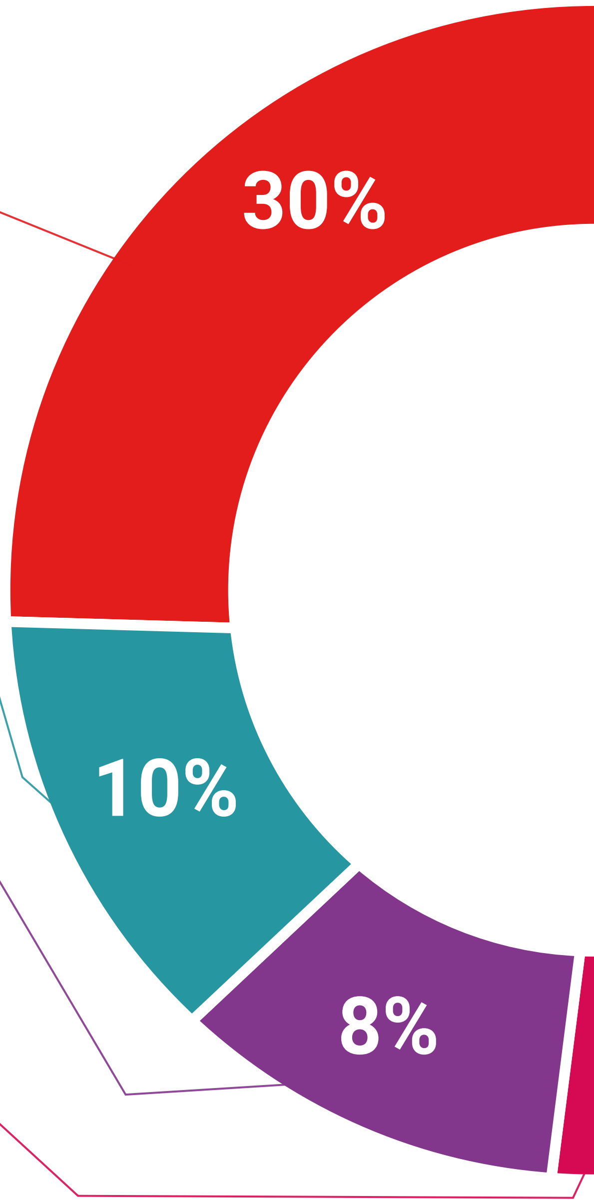
Learning from an Expert strengthens knowledge and memory, and generates confidence in future difficult decisions.

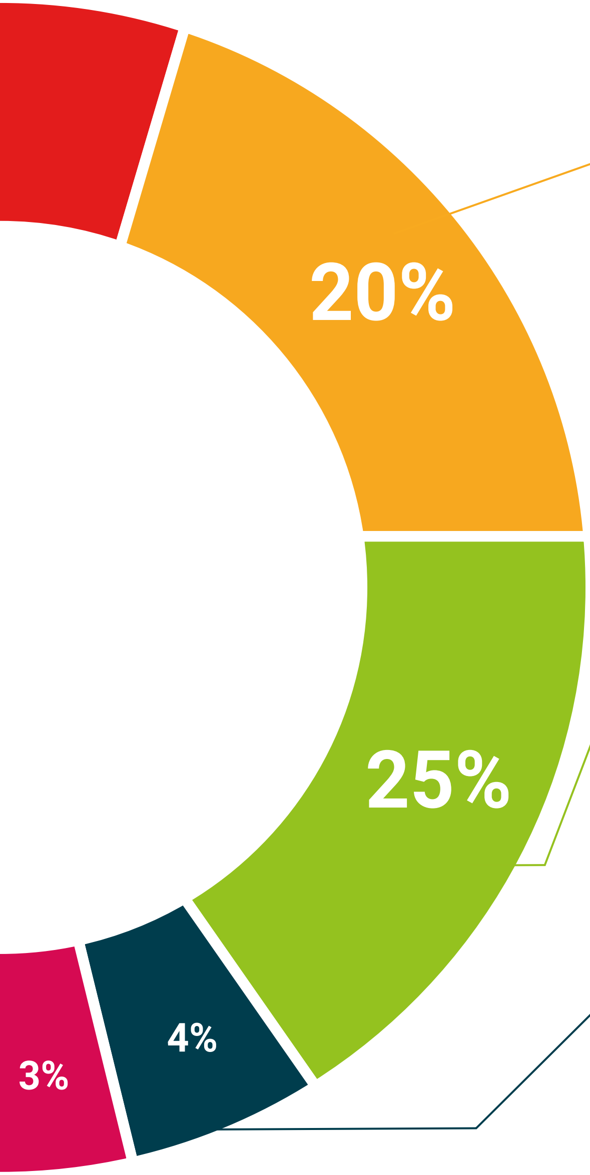
Practising Skills and Abilities

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 Diploma in CFD Simulation in Industrial Environments guarantees students, in addition to the most rigorous and up-to-date education, access to a Postgraduate Diploma issued by TECH Technological University.

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

This **Postgraduate Diploma in CFD Simulation in Industrial Environments** 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 Diploma**, issued by **TECH Technological University** via tracked delivery*.

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

Title: **Postgraduate Diploma in CFD Simulation in Industrial Environments**

Official Nº of Hours: **450 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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