# Postgraduate Diploma
## Unconventional CFD Techniques


tech technological university

# Postgraduate Diploma
## Unconventional CFD Techniques

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

Website: **www.techtitute.com/in/engineering/postgraduate-diploma/postgraduate-diploma-unconventional-cfd-techniques**

# Index

01
# Introduction

Computational Fluid Mechanics consists of Advanced Methods and Unconventional Techniques that enhance its applications and virtues, multiplying the chances of success and allowing more efficient work. For this reason, TECH has created a program that seeks to satisfy the labor market demand for professionals trained in this area, as well as to provide students with the most complete and up-to-date knowledge. All this in a program with a 100% online modality, which delves into aspects such as the Finite Element Method, Smoothed Particle Hydrodynamics, Convective Heat Transfer or Advantages and Disadvantages of Simulation Methods.

*Become an expert in all kinds of CFD Techniques and learn to get the most out of them"*

The Finite Volume Method (FVM) is the most widely used method in Computational Fluid Mechanics. But there are alternative techniques that are also very suitable and have more specific applications. To know this series of methods, specific and highly advanced knowledge in this matter is necessary, which has caused companies to increasingly demand expert professionals in this area.

This is the reason why TECH has created a Postgraduate Diploma in Unconventional CFD Techniques, with the aim of providing its students with the most complete and up-to-date knowledge, as well as the best skills, so that they can face a professional future in this field, with total guarantee of success. Thus, throughout the agenda, calculation techniques such as Smoothed Particle Hydrodynamics, Monte Carlo Direct Simulation, the Lattice-Boltzmann Method or the aforementioned Finite Element Method are analyzed and addressed, among other topics, such as the Multiphysics Simulations or Numerical Methods and Fundamentals of Fluid Physics.

All this in a comfortable 100% online modality that allows students to combine their studies with their other day-to-day activities, without having to adapt to new schedules or travel. In addition, throughout this degree, the most complete, dynamic and practical content possible is offered, accessible from any device with an Internet connection, be it a tablet, mobile phone or computer.

This **Postgraduate Diploma in Unconventional CFD Techniques** contains the most complete and up-to-date program on the market. The most important features include:

- The development of practical cases presented by experts in Unconventional CFD Techniques
- 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 for 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

*"Strengthen your professional profile with new knowledge in FEM, SPH or DSMC"*

*Enroll now and access all the content on the Lattice - Boltzmann Method"*

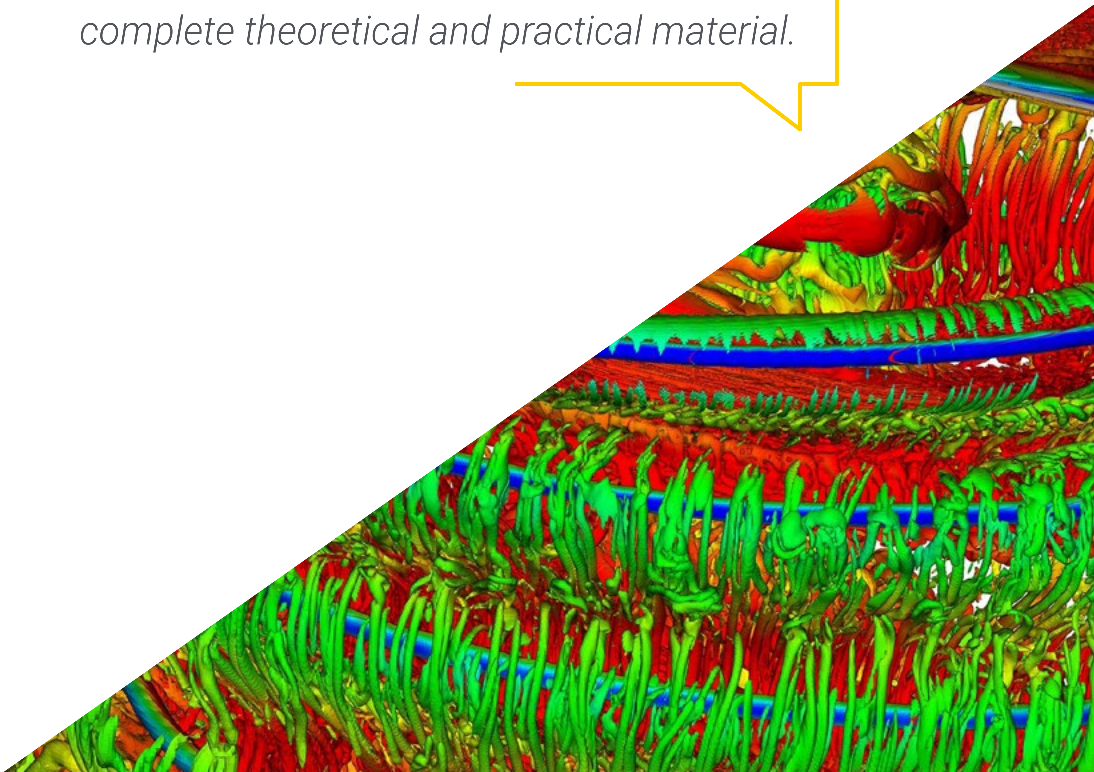
*Acquire new skills in the field of Multiphysics Simulations, in a few months and without leaving home.*

*You will be able to enhance your profile in CFD Techniques, thanks to the most complete theoretical and practical material.*

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 professional with situated and contextual learning, i.e., a simulated environment that will provide an immersive education designed 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 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.



02

# Objectives

The objective of this Postgraduate Diploma in Unconventional CFD Techniques is to delve into alternative techniques within Computational Fluid Mechanics, to provide students with advanced skills and knowledge in other methods that enable them to enhance their profile and get the most out of it. performance of these techniques. All this, through the most complete and updated contents of the current academic market.

*Give your career a boost and specialize in one of the fields with the greatest future in engineering"*

## General Objectives

- Establish the bases of the study of turbulence
- Develop statistical concepts of CFD
- Determine the main calculation techniques in turbulence research
- Generate specialized knowledge in the method of Finite Volumes
- Acquire specialized knowledge in techniques for calculating fluid mechanics
- Examine the wall units and the various regions of a turbulent wall flow
- Determine the characteristics of compressible flows
- Browse multiple models and multiphase methods
- Develop specialized knowledge about the multiple models and methods in multiphysics and in thermal analysis
- Interpret the results obtained through a correct post-processing

## Specific Objectives

### Module 1. Advanced Methods for CFD

- Develop the Finite Element Method and the Hydrodynamics Method Smoothed Particle
- Analyze the advantages of the Lagrangian methods compared to the Eulerian ones, in particular, SPH vs FVM
- Analyze the Monte-Carlo Direct Simulation method and the Method Lattice-Boltzmann
- Evaluate and interpret simulations of space aerodynamics and microfluidic dynamics
- Establish the advantages and disadvantages of LBM compared to the traditional FVM method

### Module 2. Advanced CFD Models

- Distinguish what type of physical interactions are going to be simulated: fluid-structure, such as a wing subjected to aerodynamic forces, fluid coupled with rigid body dynamics, such as simulating the movement of a buoy floating in the sea, or thermofluid, such as simulating the distribution of temperatures in a solid subject to currents of air
- Distinguish the most common data exchange schemes between different simulation software and when one can or is better to apply one or the other
- Examine the various patterns of heat transfer and how they can affect to a fluid
- Model convection, radiation and diffusion phenomena from a fluid point of view, model the creation of sound by a fluid, model simulations with advection-diffusion terms to simulate continuums or particles and model reactive flows

### Module 3. 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
- Analyze the convergence of a CFD simulation
- Establish the need to carry out a CFD validation and know basic examples of it
- Browse the various tools available on the market
- Substantiate the current context of CFD simulation

*Enroll now and enjoy the most innovative educational tools in CFD Techniques”*

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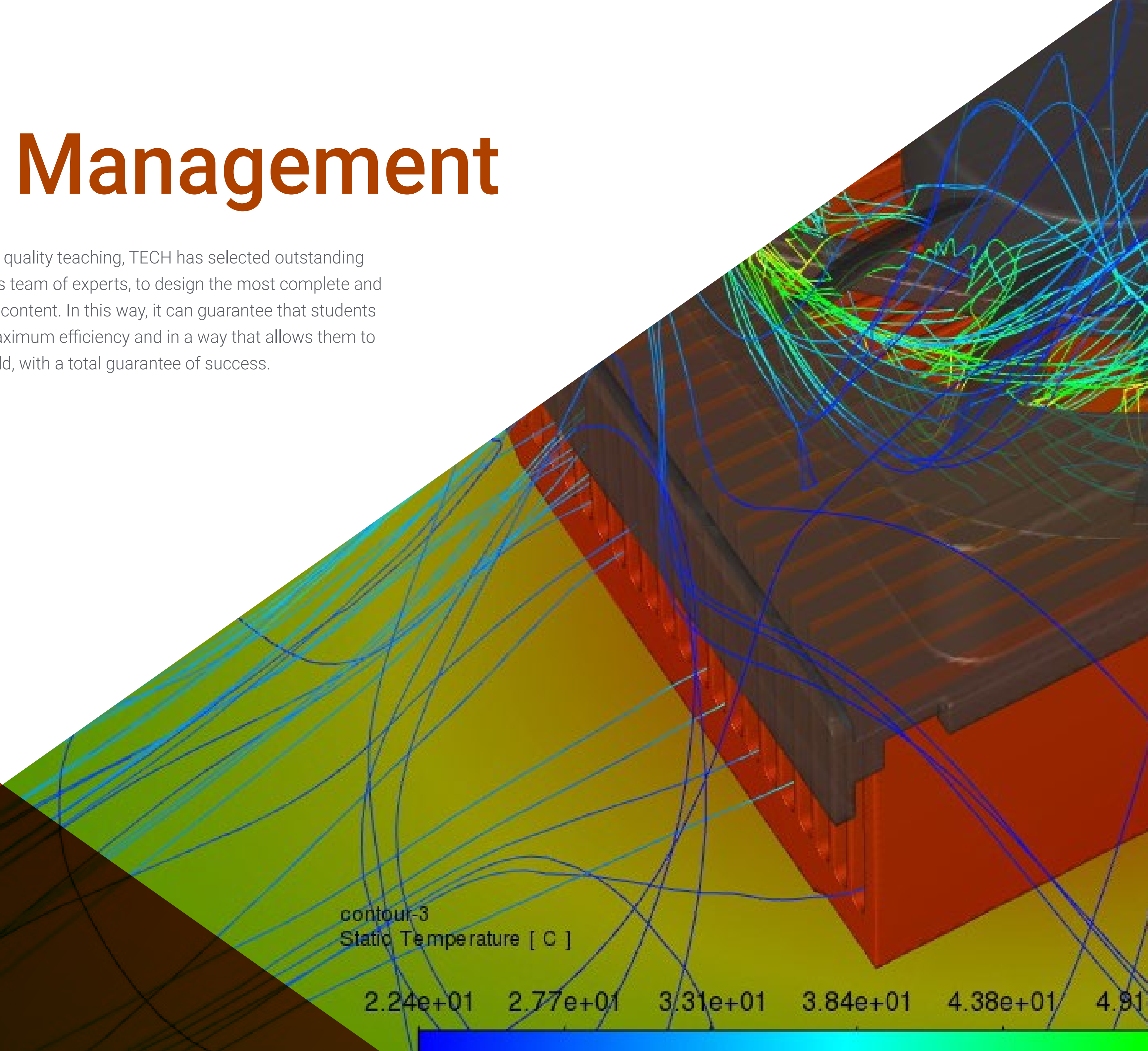
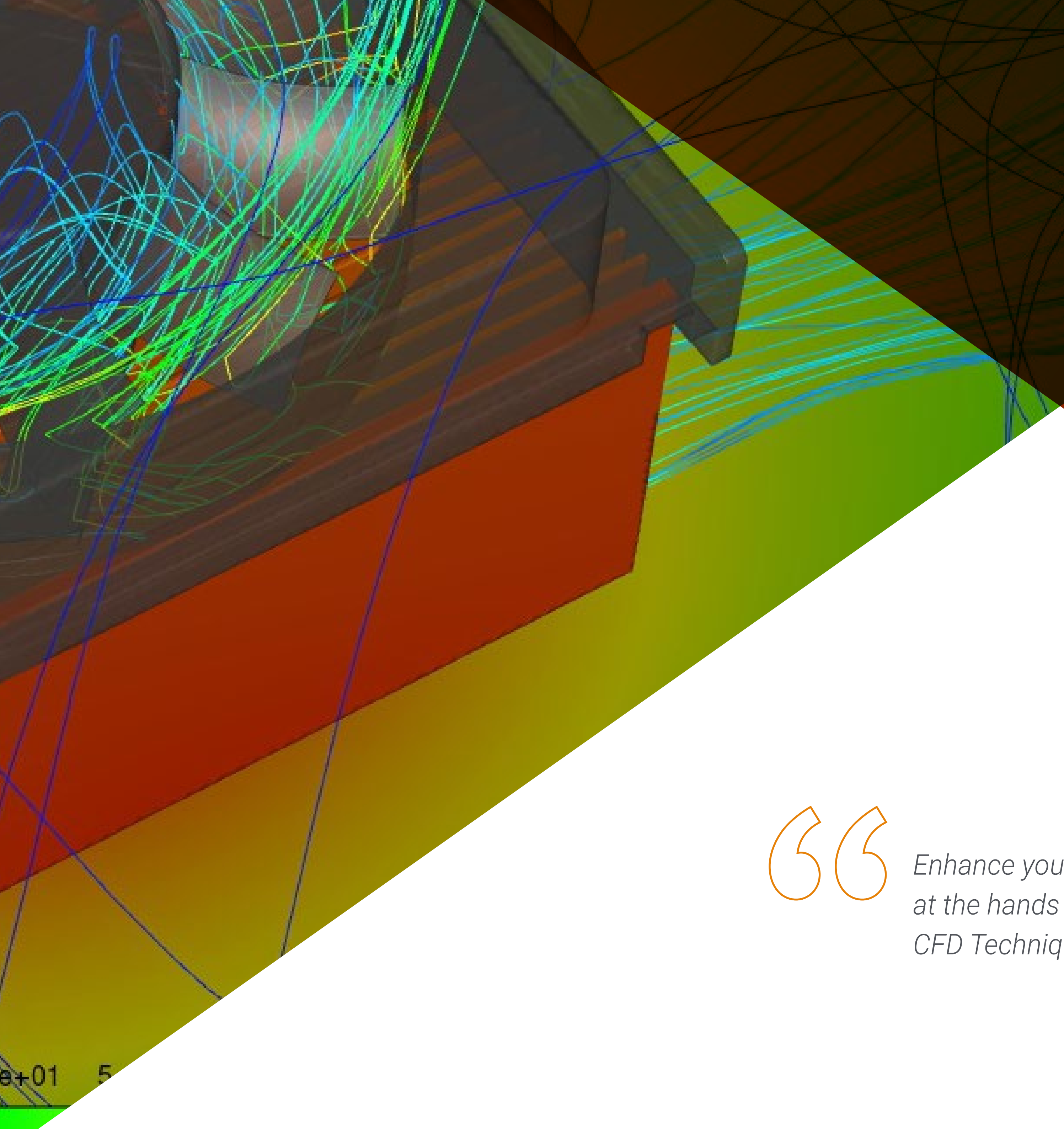
# Course Management

With the aim of offering the highest quality teaching, TECH has selected outstanding professionals with whom to form its team of experts, to design the most complete and up-to-date theoretical and practical content. In this way, it can guarantee that students assimilate the contents with the maximum efficiency and in a way that allows them to face a professional future in this field, with a total guarantee of success.





*Enhance your skills and succeed at the hands of the best experts in CFD Techniques"*

## Management

### Dr. García Galache, José Pedro

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

## Professors

### Dr. Espinoza Vásquez, Daniel

- Consultant Aeronautical Engineer at Alten SAU
- Freelance Consultant in CFD and Programming
- CFD Specialist at Particle Analytics Ltd.
- Research Assistant at the University of Strathclyde
- Teaching Assistant in Fluid Mechanics, University of Strathclyde
- PhD in Aeronautical Engineering from the University of Strathclyde
- Master in Computational Fluid Mechanics from Cranfield University
- Degree in Aeronautical Engineering from the Polytechnic University of Madrid

### Mr. Mata Bueso, Enrique

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



**Ms. Pérez Tainta, Maider**

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

# 04
# Structure and Content

The structure and content of this program have been designed by the renowned professionals that make up TECH's team of experts in CFD Techniques. They have created a study plan that exceeds all expectations, based on the most efficient pedagogical methodology, Relearning, which guarantees optimal assimilation of the main contents of the syllabus, in a natural, precise way and dynamic.

*A quality content, designed by CFD experts and under the most efficient pedagogical methodology, Relearning"*

## Module 1. Advanced Methods for CFD

1.1. Finite Element Method (FEM)
  1.1.1. Domain Discretization. Finite Element
  1.1.2. Shape functions. Reconstruction of the Continuum FieldFinite Elements
  1.1.3. Assembly of the Matrix of Coefficients and Boundary Conditions
  1.1.4. Solving Systems of Equations
1.2. FEM Case Studies Development of a FEM Simulator
  1.2.1. Shape functions
  1.2.2. Assembly of the Matrix of Coefficients and Boundary application of Conditions
  1.2.3. Solving Systems of Equations
  1.2.4. Post-Process
1.3. Smoothed Particle Hydrodynamics (SPH)
  1.3.1. Fluid Field Mapping from Particle Values
  1.3.2. Evaluation of Derivatives and Interaction between Particles
  1.3.3. Production Function The Smoothing Function.
  1.3.4. Boundary Conditions
1.4. SPH: Development of a simulator based on SPH
  1.4.1. The Kernel
  1.4.2. Storage and Ordering of Particles in Voxels
  1.4.3. Development Contouring Conditions
  1.4.4. Post-Process
1.5. Direct Monte Carlo Simulation (DSMC)
  1.5.1. Kinetic-molecular Theory
  1.5.2. Statistical Mechanics
  1.5.3. Molecular Balance
1.6. DSMC: Methodology
  1.6.1. Applicability of the DSMC Method
  1.6.2. Modeling
  1.6.3. Considerations for Method Implementation
1.7. DSMC: Applications
  1.7.1. Example in 0-D: Thermal Relaxation
  1.7.2. Example in 1-D: Normal Shock Wave
  1.7.3. Example in 2-D: Supersonic Cilinder
  1.7.4. Example in 3-D: Supersonic Corner
  1.7.5. Complex example: Space Shuttle
1.8. Lattice-Boltzmann Method (LBM)
  1.8.1. Ecuación de Boltzmann y distribución de equilibro
  1.8.2. From Boltzmann to Navier-Stokes. Chapman–Enskog expansion
  1.8.3. From Probability Distribution to Physical Quantity
  1.8.4. Unit Conversion. From Physical Magnitudes to Lattice Magnitudes
1.9. LBM: Numerical Approximation
  1.9.1. The LBM Algorithm. Transfer Step and Collision Step
  1.9.2. Collision Operators and Normalization of Moments
  1.9.3. Boundary Conditions
1.10. LBM: Case Study
  1.10.1. Development of a Simulator Based on LBM
  1.10.2. Experimentation with Various Collision Operators
  1.10.3. Experimentation with Various Turbulence Models

## Module 2. Advanced CFD Models

2.1. Multiphysics
  2.1.1. Multiphysics Simulations
  2.1.2. System Types
  2.1.3. Application Examples
2.2. Unidirectional Cosimulation
  2.2.1. Unidirectional Cosimulation Advanced Aspects
  2.2.2. Information Exchange Schemes
  2.2.3. Applications

2.3. Bidirectional Cosimulation
- 2.3.1. Bidirectional Cosimulation Advanced Aspects
- 2.3.2. Information Exchange Schemes
- 2.3.3. Applications

2.4. Convection Heat Transfer
- 2.4.1. Convection Heat Transfer. Advanced Aspects
- 2.4.2. Convective Heat Transfer Equations
- 2.4.3. Convection Troubleshooting Methods

2.5. Conduction Heat Transfer
- 2.5.1. Conduction Heat Transfer. Advanced Aspects
- 2.5.2. Behavior Heat Transfer Equations
- 2.5.3. Conduction Troubleshooting Methods

2.6. Radiation Heat Transfer
- 2.6.1. Radiation Heat Transfer. Advanced Aspects
- 2.6.2. Due to Radiation Heat Transfer Equations
- 2.6.3. Radiation Troubleshooting Methods

2.7. Solid-fluid Coupling Heat
- 2.7.1. Solid-fluid Coupling Heat
- 2.7.2. Solid-fluid Thermal Coupling
- 2.7.3. CFD and FEM

2.8. Aeroacoustics
- 2.8.1. Computational Aeroacoustics
- 2.8.2. Acoustic Analogies
- 2.8.3. Resolution Methods

2.9. Advection-diffusion Problems
- 2.9.1. Advection-diffusion Problems
- 2.9.2. Scalar Fields
- 2.9.3. Particle Methods

2.10. Reactive Flow Coupling Models
- 2.10.1. Reactive Flow Coupling Models. Applications
- 2.10.2. System of Differential Equations. Solving the Chemical Reaction
- 2.10.3. CHEMKINs
- 2.10.4. Combustion: Flame, Spark, Wobee
- 2.10.5. Reactive Flows in Non-steady Regime: Quasi-steady System Hypothesis
- 2.10.6. Reactive Flows in Turbulent Flows
- 2.10.7. Catalizers

## Module 3. Post-processing, Validation and Application in CFD

3.1. Post-processing in CFD I
- 3.1.1. Postprocessing on Plane and Surfaces
  - 3.1.1.1. Post-Process in the Plane
  - 3.1.1.2. Post-Process in Surfaces

3.2. Post-processing in CFD II
- 3.2.1. Volumetric Post Processing
  - 3.2.1.1. Post- Volumetric I
  - 3.2.1.2. Post- Volumetric II

3.3. Free Post Processing Software in CFD
- 3.3.1. Free Post Processing Software
- 3.3.2. Paraview
- 3.3.3. Paraview Examples of Use

3.4. Simulation Convergence
- 3.4.1. Convergence
- 3.4.2. Mesh Convergence
- 3.4.3. Numerical Convergence

3.5. Method Classification
- 3.5.1. Applications
- 3.5.2. Types of Fluid
- 3.5.3. Scales
- 3.5.4. Calcuation Machines

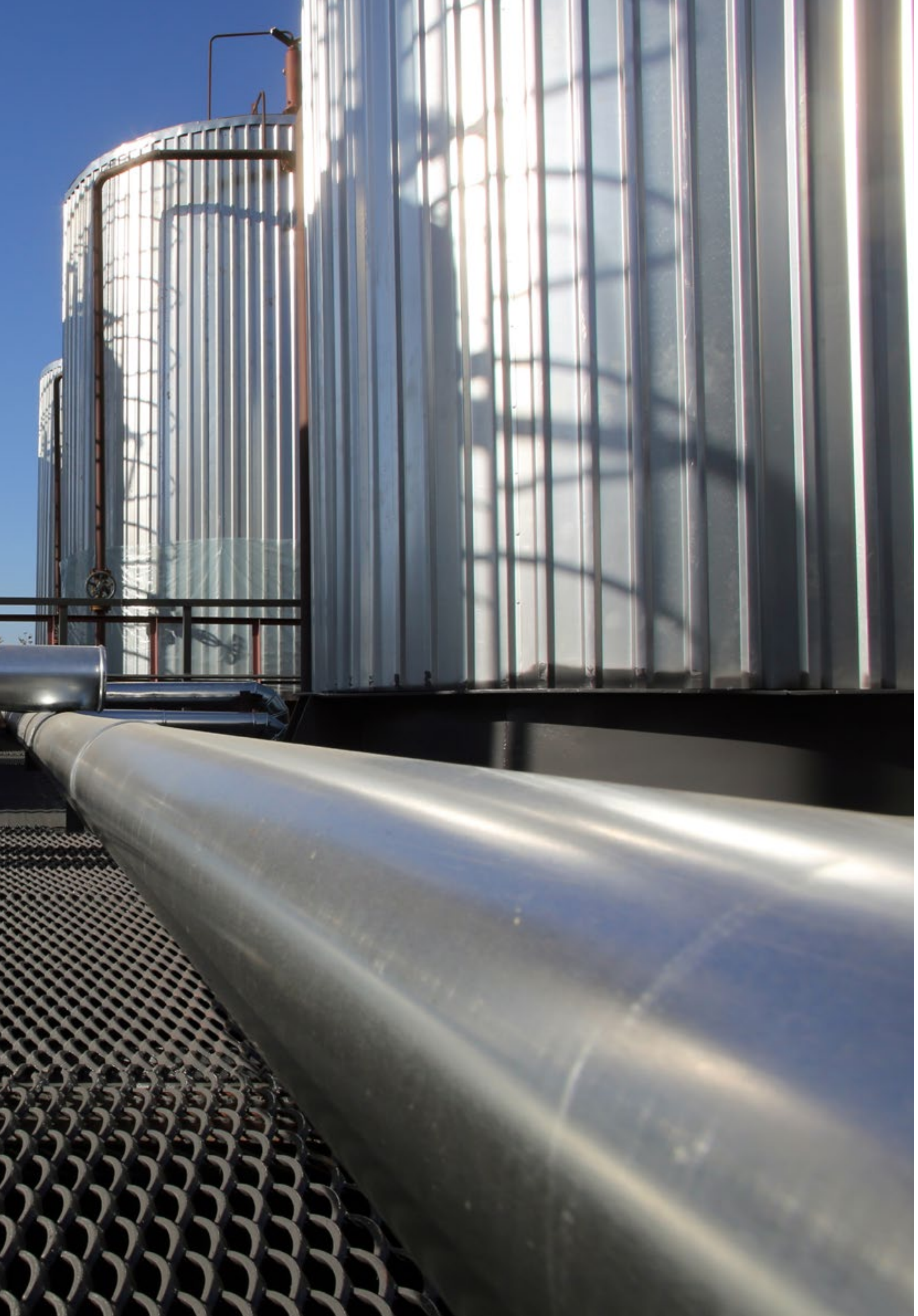
3.6. Validity Models
- 3.6.1. Validity Needs
- 3.6.2. Simulation vs Experiment
- 3.6.3. Validation Examples

3.7. Simulation Methods Advantages and Disadvantages
- 3.7.1. RANS
- 3.7.2. LES, DES, DNS
- 3.7.3. Other Methods
- 3.7.4. Advantages and Disadvantages

3.8. Examples of Methods and Applications
- 3.8.1. Case of a Body Subjected to Aerodynamic Forces
- 3.8.2. Thermal Case
- 3.8.3. Multiphase Case

3.9. Good Simulation Practices (GMP)
- 3.9.1. Importance of Good Practices
- 3.9.2. Best Practices
- 3.9.3. Simulation Errors

3.10. Commercial and Free Software
- 3.10.1. FVM Software
- 3.10.2. Software of Other Methods
- 3.10.3. Advantages and Disadvantages
- 3.10.4. CFD Simulation Future



> *A Postgraduate Diploma in Unconventional CFD Techniques, designed so that you assimilate the contents in a precise and dynamic way”*

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

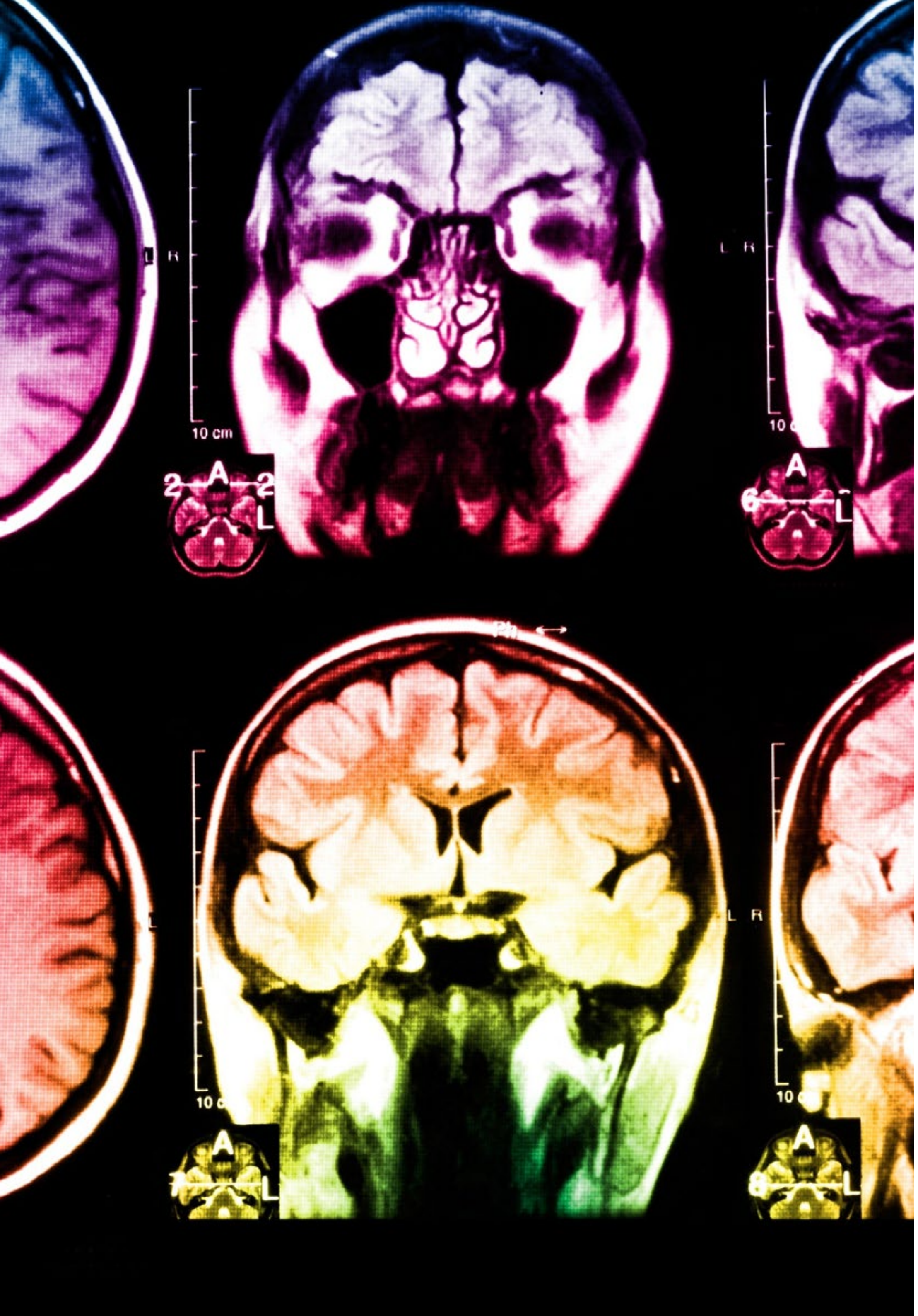
TECH effectively combines the Case Study methodology with a 100% online learning system based on repetition, which combines 8 different teaching elements in each lesson.

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.

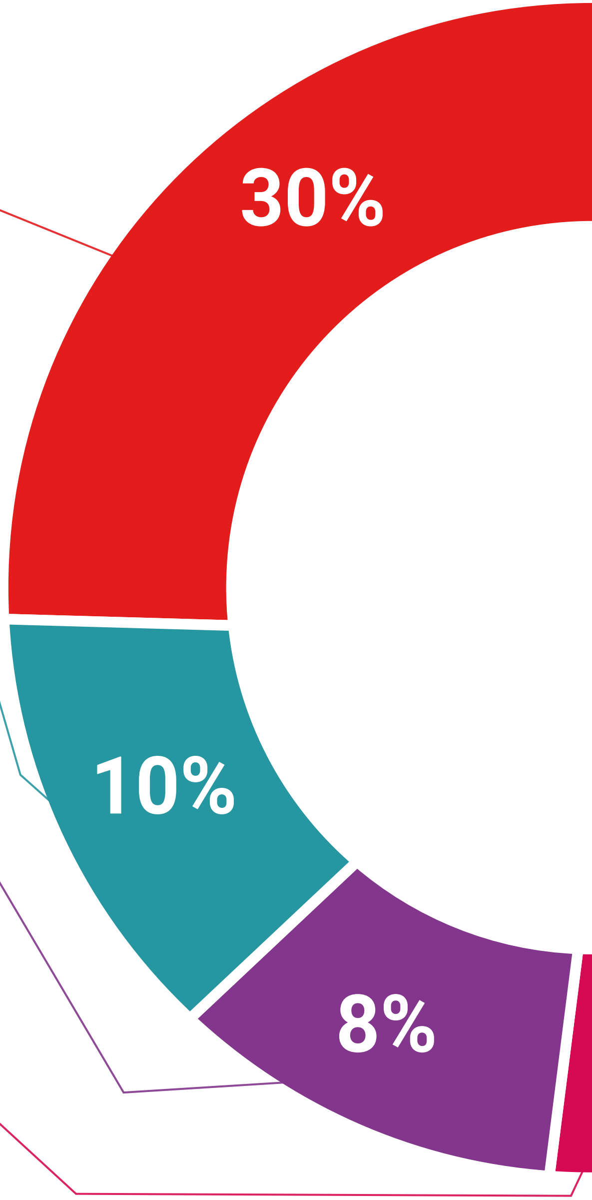
Learning from an Expert strengthens knowledge and memory, and generates confidence in future difficult decisions.

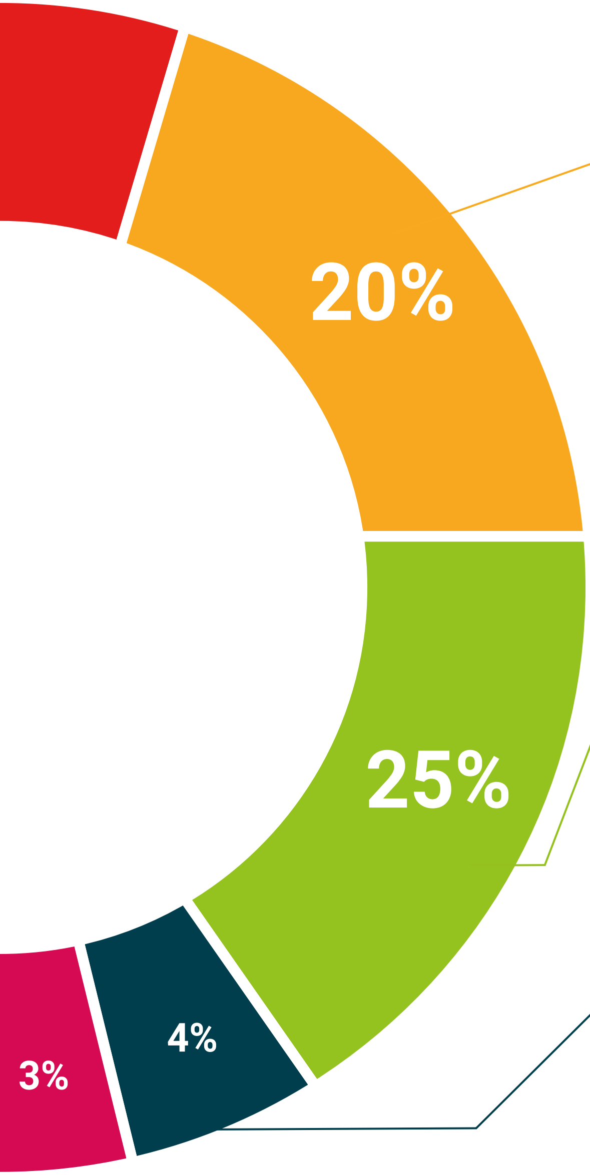
### Practising Skills and Abilities

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 Non-Conventional CFD Techniques 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 Unconventional CFD Techniques** 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 Unconventional CFD Techniques**

Official N° of Hours: **450 h.**


tech technological university

Awards the following

CERTIFICATE

to

Mr./Ms. _______________, with identification number ___________.

For having passed and accredited the following program

**POSTGRADUATE DIPLOMA**

in

Unconventional CFD Techniques

This is a qualification awarded by this University, equivalent to 450 hours, with a start date of dd/mm/yyyy and an end date of dd/mm/yyyy.

TECH is a Private Institution of Higher Education recognized by the Ministry of Public Education as of June 28, 2018.

June 17, 2020

Tere Guevara Navarro
Dean

This qualification must always be accompanied by the university degree issued by the competent authority to practice professionally in each country.

Unique TECH Code: AFWORD23S techtitute.com/certificates

*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.

technological university

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