Postgraduate Diploma
Fluid Modeling

Postgraduate Diploma
Fluid Modeling

» Modality: **online**
» Duration: **6 months**
» Certificate: **TECH Global University**
» Credits: **18 ECTS**
» Schedule: **at your own pace**
» Exams: **online**

Website: **www.techtitute.com/us/engineering/postgraduate-diploma/postgraduate-diploma-fluid-modeling**

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01
Introduction

Fluid Modeling has turned out to be a great solution in the study of Turbulence, given the impossibility for companies to spend so much money, time and effort on other methods. As a result, professionals with precise and advanced knowledge in this area are increasingly in demand. This is the reason why TECH has created a program that seeks to provide students with updated competencies and skills in topics such as Energy Cascade, Compressible Fluids, Multiphase Flow or Advanced CFD Modeling, among others.

Become an expert in Fluid Modeling in only 6 months"

One of the keys to the study of turbulence is that it cannot be calculated but rather modeled. Even in the case of research, it is done in very simplified domains, using the largest computers in the world for several months. This time and these resources are unattainable for the vast majority of companies, but one of the great advantages of modeling is that it avoids these problems. As a result, the demand for professionals with specialized knowledge in this area continues to increase.

This is the reason why TECH has designed a Postgraduate Diploma in Fluid Modeling, to provide students with advanced skills and knowledge in this area, which can guarantee them a successful future as engineers in this field. Thus, this study plan offers a complete and accurate deepening in topics such as RANS Methods, LES Evolution, the Riemann Problem, Multiphase Flow or Bidirectional Cosimulation, among many other aspects of great relevance.

All this, through a convenient 100% online modality that allows students to combine their studies with their other main obligations, without the need to travel or fixed schedules. In addition, with the possibility of accessing all the theoretical and practical material from the first day, with total freedom and from any device with internet connection, whether mobile, computer or tablet.

This **Postgraduate Diploma in Fluid 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 Fluid Modeling
- 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

"Acquire updated knowledge in Fluid Modeling and stand out in a booming sector"

Deepen your knowledge and acquire new skills in Convective Heat Transfer or Bidirectional Cosimulation"

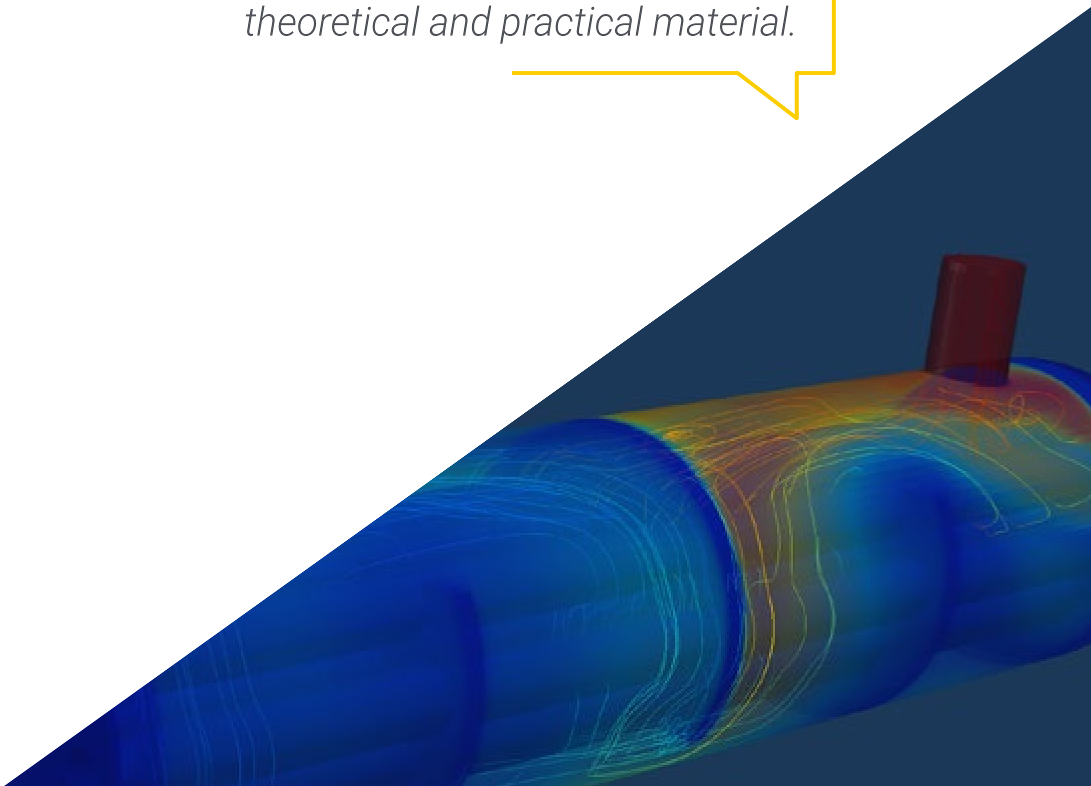
Enroll now and access all the content in Fluid Modeling, with no time limits or need to travel.

Learn all about Solid-Fluid Thermal Coupling, 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 programmed to learn in real situations.

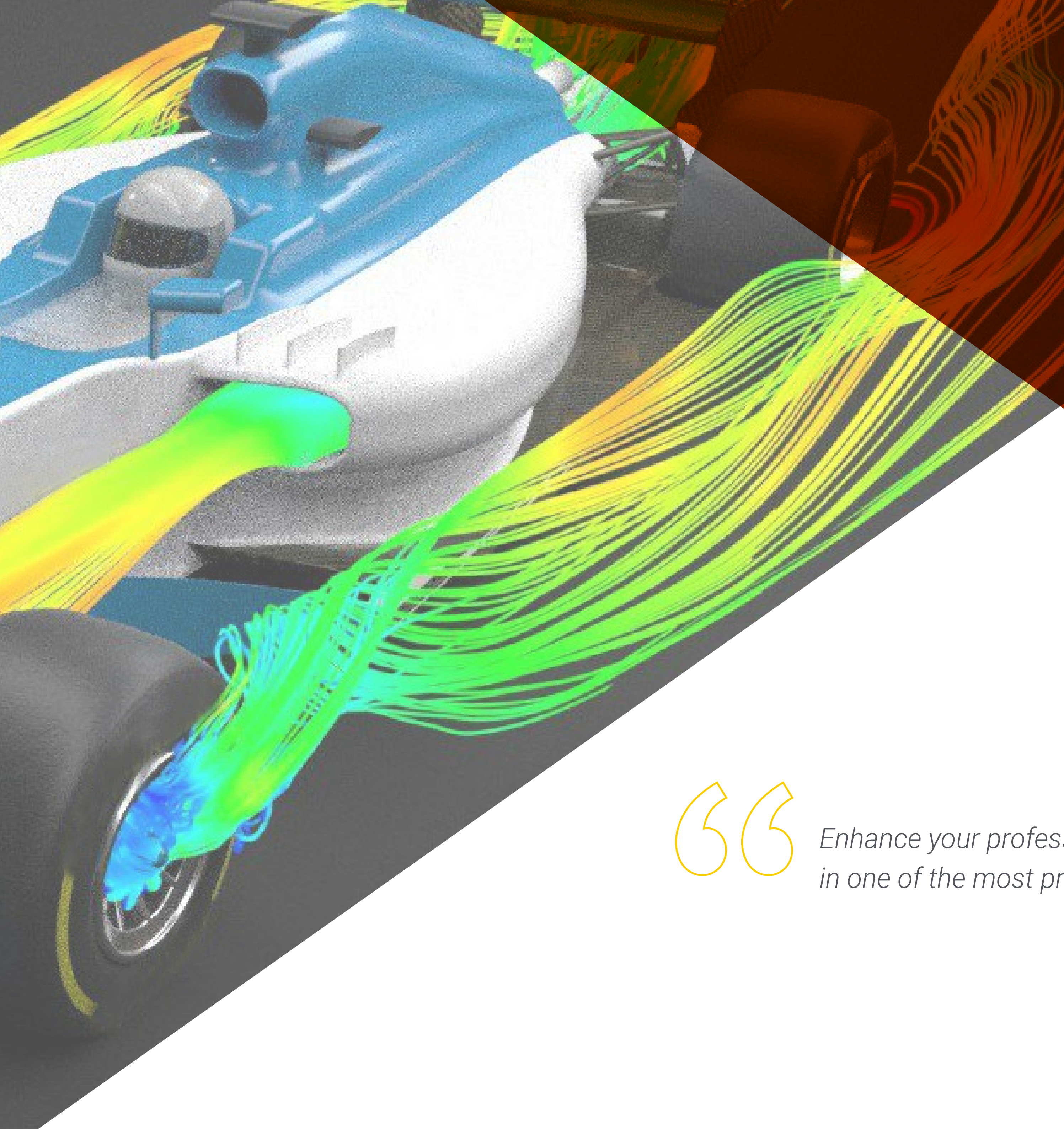
The design of this program focuses on Problem-Based Learning, by means of which the professional must try to solve the different professional practice situations that are presented throughout the academic course. For this purpose, the student will be assisted by an innovative interactive video system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



02

Objectives

The objective of this Postgraduate Diploma in Fluid Modeling is to provide students with specialized knowledge in this subject, so that they can face their work as engineers in this area with total guarantee of success and being able to solve any inconvenience they may have to face. All this, thanks to the most complete, accurate and updated contents in the academic market.



Enhance your professional profile and get a position in one of the most promising areas of engineering"

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

Reach your most demanding goals, thanks to a unique opportunity to expand your knowledge in Fluid Modeling"

Specific Objectives

Module 1. Modeling of turbulence in Fluid

- 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

Module 2. Compressible Fluids

- Develop the main differences between compressible and incompressible flow
- Examine typical examples of the occurrence of compressible fluids
- Identify the peculiarities in the solution of hyperbolic differential equations
- Establish the basic methodology for solving the Riemann problem
- Compile different resolution strategies
- Analyze the pros and cons of the different methods
- Present the applicability of these methodologies to the Euler / Navier-Stokes equations, showing classical examples

Module 3. Multiphase flow

- Distinguish what type of multiphase flow is to be simulated: continuous phases, such as simulating a ship at sea, a continuous medium; discrete phases, such as simulating specific droplet trajectories; or use statistical populations when the number of particles, droplets or bubbles is too large to be simulated
- Establish the difference between Lagrangian, Eulerian and mixed methods
- Determine the tools best suited to the type of flow to be simulated
- Modeling the effects of surface tension and phase changes such as evaporation, condensation or capitation
- Develop boundary conditions for wave simulation, learn about the different wave models and apply the so-called numerical beach, a region of the domain located at the exit whose objective is to avoid wave reflection

Module 4. Advanced CFD Models

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

03

Course Management

To fulfill its purpose, TECH has selected a teaching staff that meets the highest expectations, with which to offer a curriculum of the highest quality, updated and accurate. In this way, it has chosen outstanding professionals who have poured their experience and knowledge into all the content. All this has resulted in the most complete and innovative program possible.

Succeed in the most promising engineering career field, with the best experts and thanks to TECH"

Management

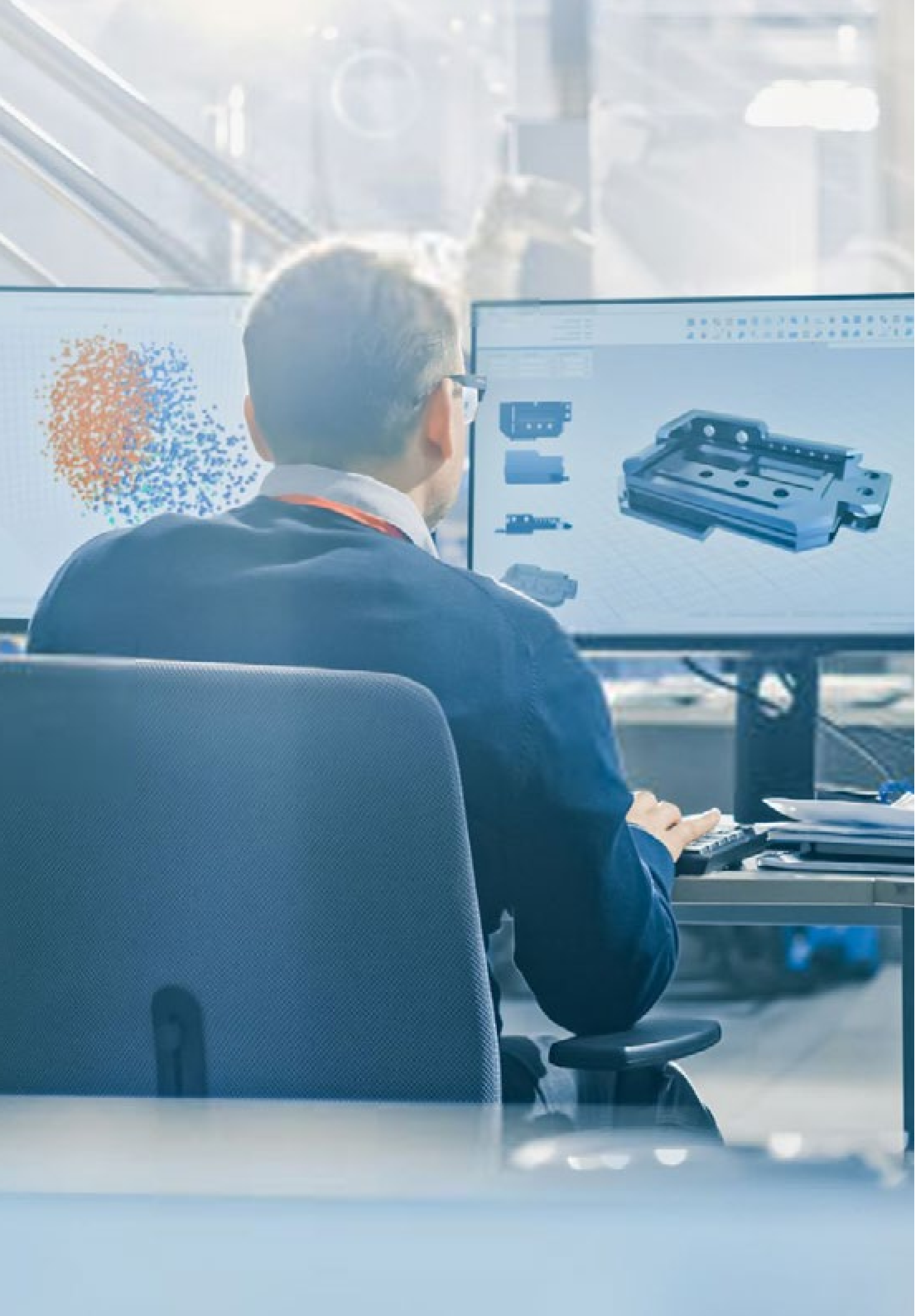
Dr. García Galache, José Pedro

- XFlow Development Engineer at Dassault Systèmes
- Dr. 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 Program en el Von Kármán Institute for Fluid Dynamics

Professors

Dr. Espinoza Vásquez, Daniel

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



Mr. Mata Bueso, Enrique

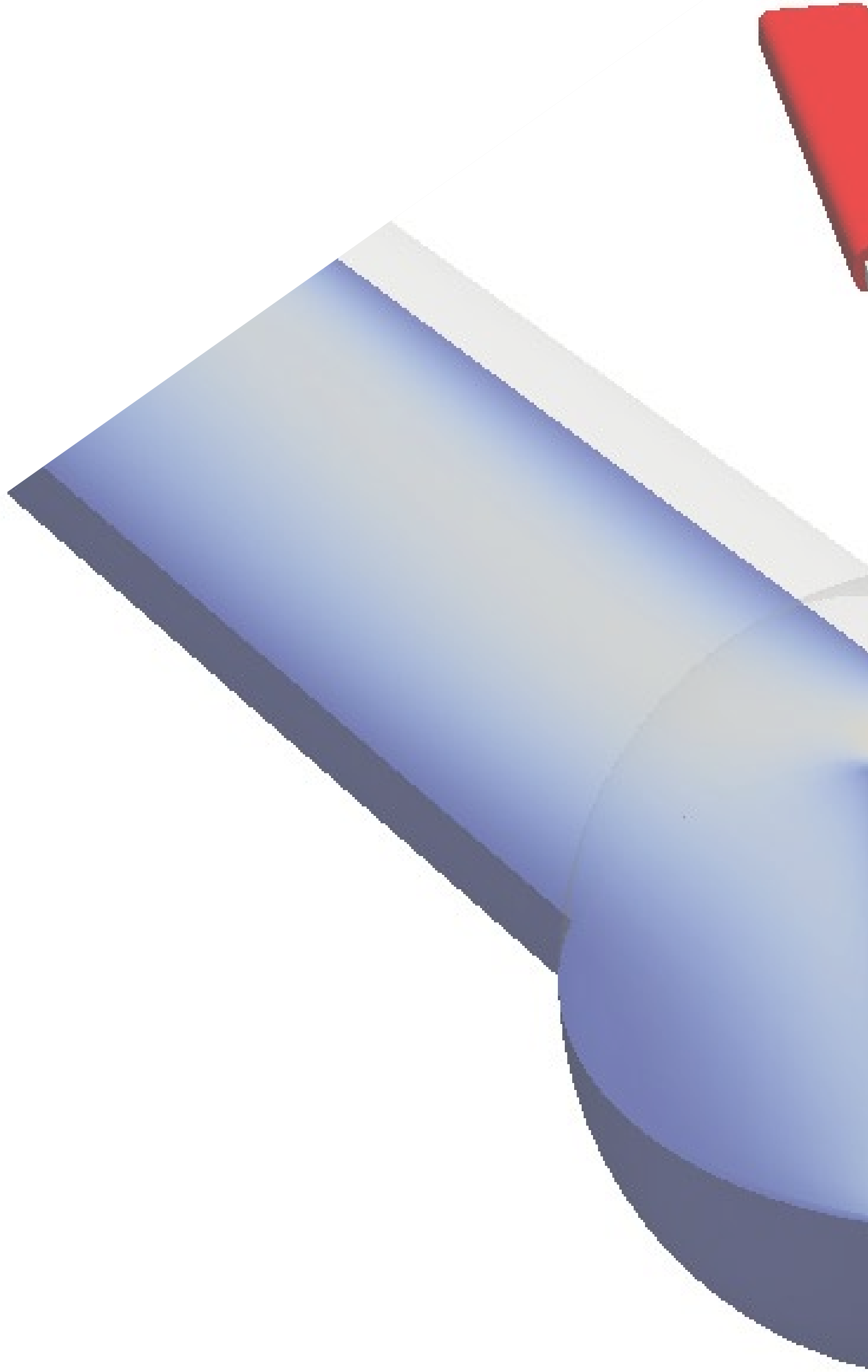
- Senior Engineer of Thermal Conditioning and Aerodynamics at Siemens Gamesa
- Application Engineer and CFD R&D Manager in Dassault Systèmes
- Thermal Conditioning & Aerodynamics Engineer at Gamesa-Altran
- Fatigue and Damage Tolerance Engineer at Airbus-Atos
- R&D CFD Engineer at UPM
- Aeronautical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

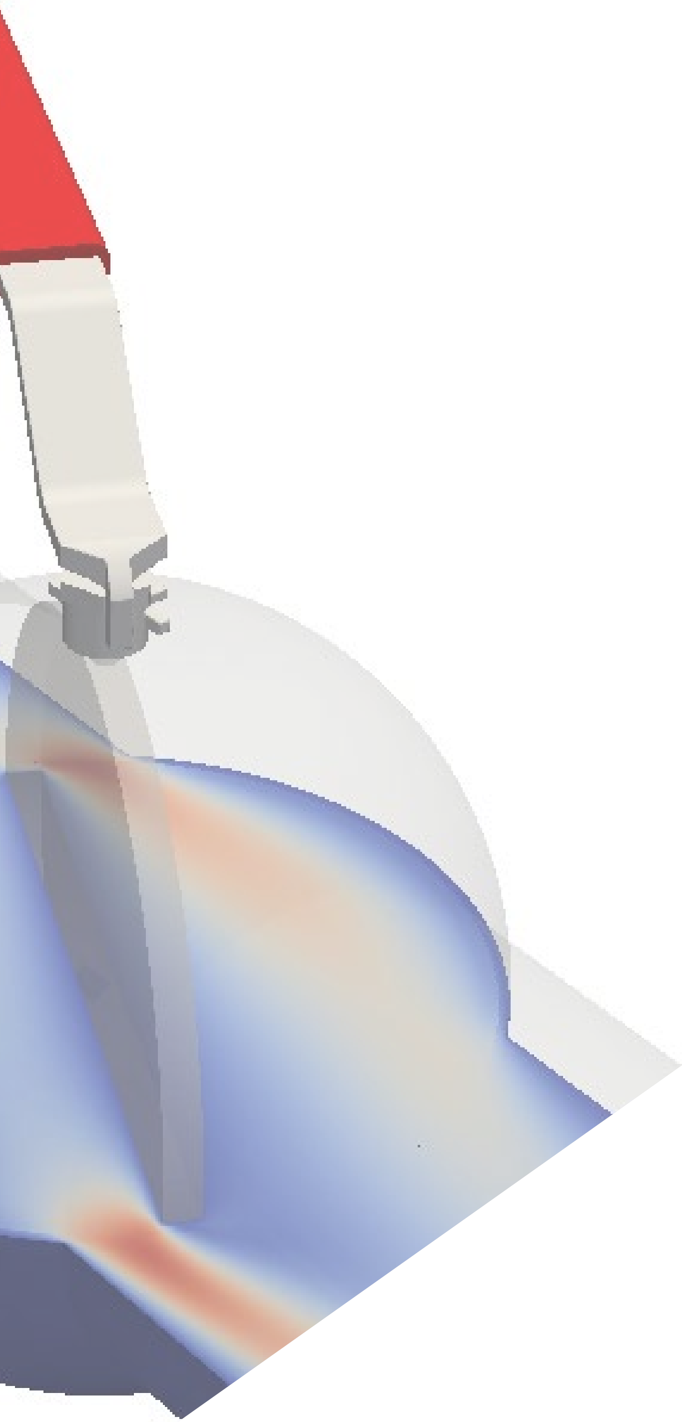
A unique, key, and decisive educational experience to boost your professional development”

04

Structure and Content

This Postgraduate Diploma in Fluid Modeling has been designed by the outstanding professionals that make up TECH's team of experts. They have been based on the most efficient pedagogical methodology, Relearning, as well as on the most rigorous and updated sources, to create theoretical and practical contents that are easy to assimilate, which will prevent the student from having to dedicate excessive time to study.





Dynamic and practical content on Fluid Modeling that you can access at any time and from 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

Module 2. Compressible Fluids

2.1. Compressible Fluids
- 2.1.1. Compressible and incompressible fluids. Differences
- 2.1.2. Equation of State
- 2.1.3. Differential equations of compressible fluids

2.2. Practical examples of the compressible regime
- 2.2.1. Shock Waves
- 2.2.2. Prandtl-Meyer Expansion
- 2.2.3. Nozzles

2.3. Riemann's Problem
- 2.3.1. Riemann's problem
- 2.3.2. Solution of the Riemann problem by characteristics
- 2.3.3. Non-linear systems: Shock Waves Rankine-Hugoniot condition
- 2.3.4. Non-linear systems: Waves and expansion fans. Entropy condition
- 2.3.5. Riemannian Invariants

2.4. Euler Equations
- 2.4.1. Invariants of the Euler equations
- 2.4.2. Conservative vs. primitive variables
- 2.4.3. Solution Strategies

2.5. Solutions to the Riemann problem
- 2.5.1. Exact solution
- 2.5.2. Conservative numerical methods
- 2.5.3. Godunov's method
- 2.5.4. Flux Vector Splitting

2.6. Approximate Riemann solvers
- 2.6.1. HLLC
- 2.6.2. Roe
- 2.6.3. AUSM

2.7. Higher order methods
- 2.7.1. Problems of higher order methods
- 2.7.2. Limiters and TVD methods
- 2.7.3. Practical Examples

2.8. Additional aspects of the Riemann Problem
- 2.8.1. Non-homogeneous equations
- 2.8.2. Splitting dimensional
- 2.8.3. Applications to the Navier-Stokes equations

2.9. Regions with high gradients and discontinuities
- 2.9.1. Importance of meshing
- 2.9.2. Automatic mesh adaptation (AMR)
- 2.9.3. Shock Fitting Methods

2.10. Compressible flow applications
- 2.10.1. Sod problem
- 2.10.2. Supersonic wedge
- 2.10.3. Convergent-divergent nozzle

Module 3. Multiphase flow

3.1. Flow regimes
- 3.1.1. Continuous phase
- 3.1.2. Discrete phase
- 3.1.3. Discrete phase populations

3.2. Continuous phases
- 3.2.1. Properties of the liquid-gas interface
- 3.2.2. Each phase a domain
- 3.2.3. Phase resolution independently
- 3.2.4. Coupled solution
- 3.2.5. Fluid fraction as a descriptive phase scalar
- 3.2.6. Reconstruction of the gas-liquid interface

3.3. Marine simulation
- 3.3.1. Wave regimes. Wave height vs. depth
- 3.3.2. Input boundary condition. Wave simulation
- 3.3.3. Non-reflective output boundary condition. Numerical beach
- 3.3.4. Lateral boundary conditions. Lateral wind and drift

3.4. Surface Tension
- 3.4.1. Physical Phenomenon of the Surface Tension
- 3.4.2. Modeling
- 3.4.3. Interaction with surfaces. Angle of wetting

3.5. Phase shift
- 3.5.1. Source and sink terms associated with phase change
- 3.5.2. Evaporation models
- 3.5.3. Condensation and precipitation models. Nucleation of droplets
- 3.5.4. Cavitation

3.6. Discrete phase: particles, droplets and bubbles
- 3.6.1. Resistance strength
- 3.6.2. The buoyancy force
- 3.6.3. Inertia
- 3.6.4. Brownian motion and turbulence effects
- 3.6.5. Other forces

3.7. Interaction with the surrounding fluid
- 3.7.1. Generation from continuous phase
- 3.7.2. Aerodynamic drag
- 3.7.3. Interaction with other entities, coalescence and rupture
- 3.7.4. Boundary Conditions

3.8. Statistical description of particle populations. Packages
- 3.8.1. Transportation of stocks
- 3.8.2. Stock boundary conditions
- 3.8.3. Stock interactions
- 3.8.4. Extending the discrete phase to populations

3.9. Water film
- 3.9.1. Water Sheet Hypothesis
- 3.9.2. Equations and modeling
- 3.9.3. Source term from particles

3.10. Example of an application with OpenFOAM
- 3.10.1. Description of an industrial problem
- 3.10.2. Setup and simulation
- 3.10.3. Visualization and interpretation of results

Module 4. Advanced CFD Models

4.1. Multiphysics
- 4.1.1. Multiphysics Simulations
- 4.1.2. System Types
- 4.1.3. Application Examples

4.2. Unidirectional Cosimulation
- 4.2.1. Unidirectional Cosimulation. Advanced Aspects
- 4.2.2. Information exchange schemes
- 4.2.3. Applications

4.3. Bidirectional Cosimulation
- 4.3.1. Bidirectional Cosimulation. Advanced Aspects
- 4.3.2. Information exchange schemes
- 4.3.3. Applications

4.4. Convection Heat Transfer
- 4.4.1. Heat Transfer by Convection. Advanced Aspects
- 4.4.2. Convective heat transfer equations
- 4.4.3. Methods for solving convection problems

4.5. Conduction Heat Transfer
- 4.5.1. Conduction Heat Transfer. Advanced Aspects
- 4.5.2. Conductive heat transfer equations
- 4.5.3. Methods of solving driving problems

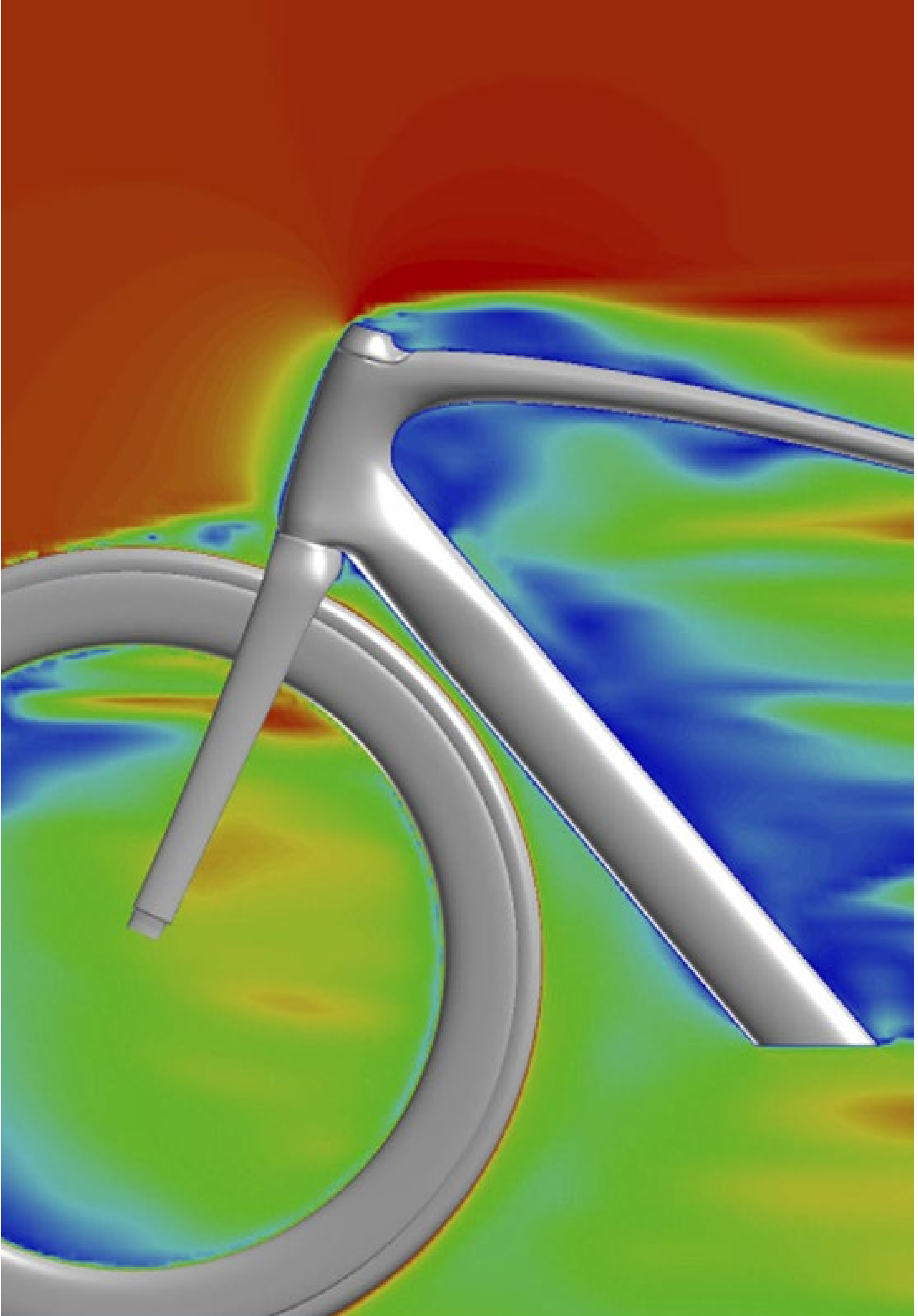
4.6. Radiative Heat Transfer
- 4.6.1. Radiative Heat Transfer. Advanced Aspects
- 4.6.2. Radiation heat transfer equations
- 4.6.3. Radiation troubleshooting methods

4.7. Solid-fluid-heat coupling
- 4.7.1. Solid-fluid-heat coupling
- 4.7.2. Solid-fluid thermal coupling
- 4.7.3. CFD and FEM

4.8. Aeroacoustics
- 4.8.1. Computational aeroacoustics
- 4.8.2. Acoustic analogies
- 4.8.3. Resolution methods

4.9. Advection-diffusion problems
- 4.9.1. Diffusion-advection problems
- 4.9.2. Scalar Fields
- 4.9.3. Particle methods

4.10. Coupling models with reactive flow
- 4.10.1. Reactive Flow Coupling Models. Applications
- 4.10.2. System of differential equations. Solving the chemical reaction
- 4.10.3. CHEMKINs
- 4.10.4. Combustion: flame, spark, Wobee
- 4.10.5. Reactive flows in a non-stationary regime: quasi-stationary system hypothesis
- 4.10.6. Reactive flows in turbulent flows
- 4.10.7. Catalysts



A curriculum created to guarantee your success as a Fluid Modeling expert"

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

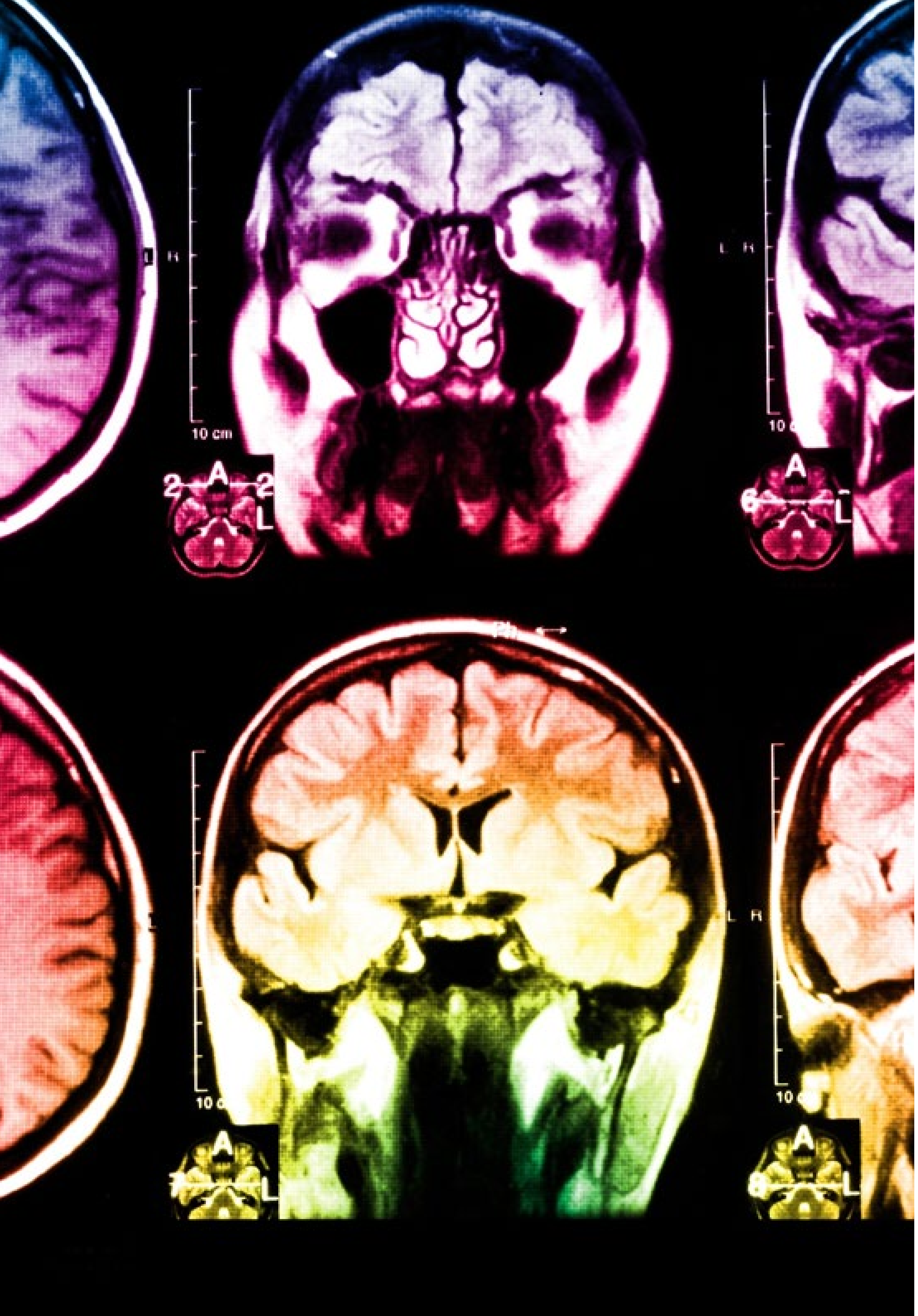
TECH effectively combines the Case Study methodology with a 100% online learning system based on repetition, which combines 8 different teaching elements in each lesson.

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.

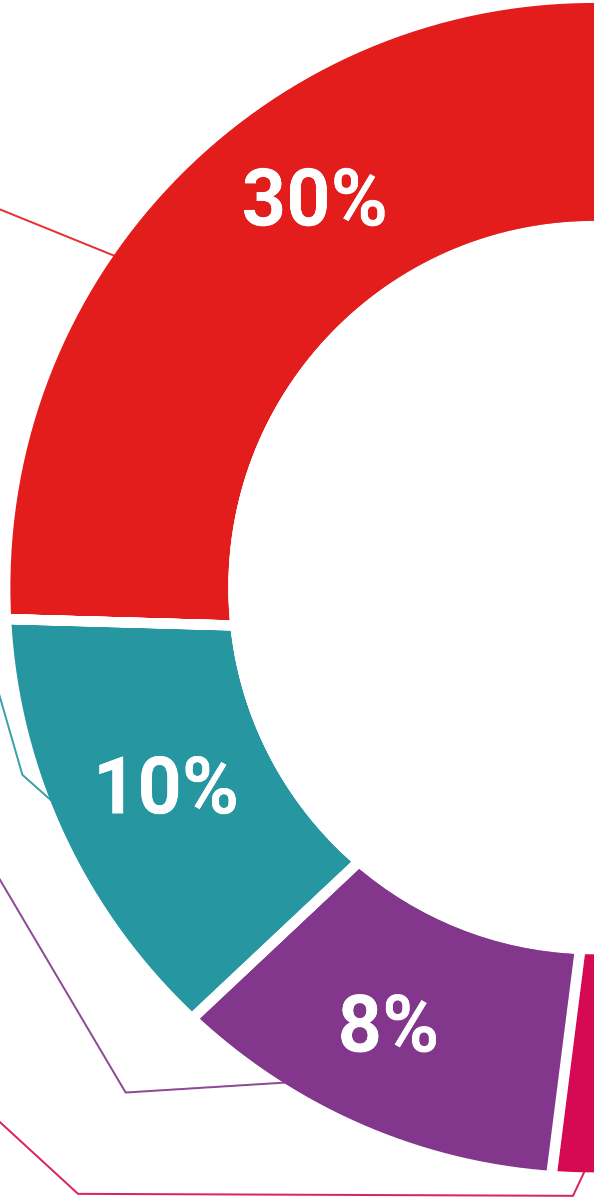
Learning from an Expert strengthens knowledge and memory, and generates confidence in future difficult decisions.

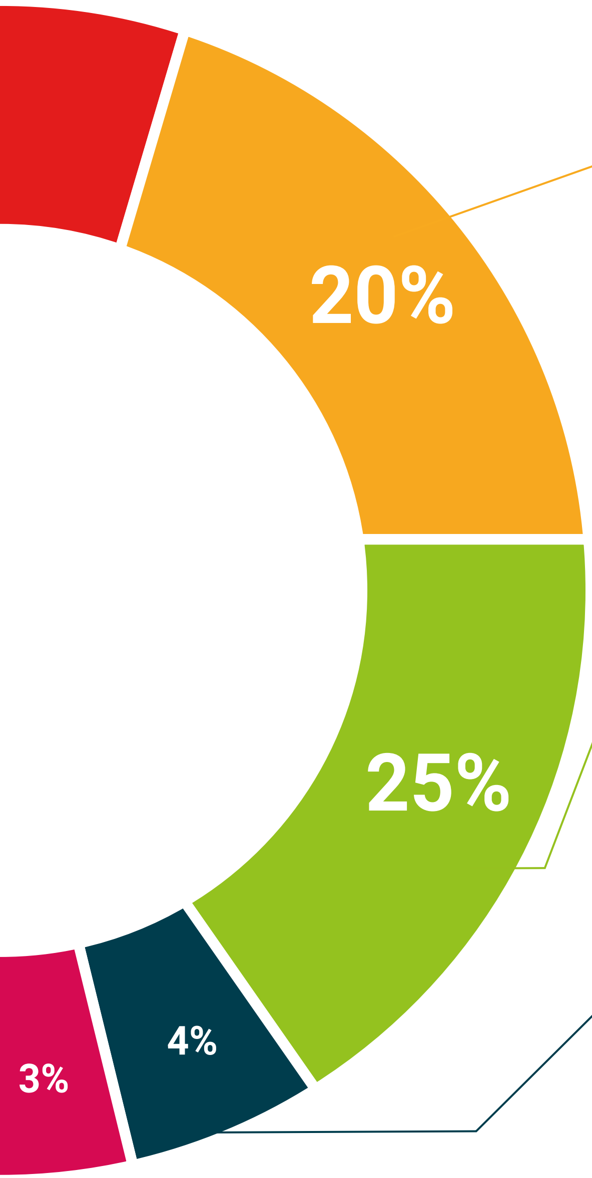
Practising Skills and Abilities

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 Fluid Modeling guarantees students, in addition to the most rigorous and up-to-date education, access to a Postgraduate Diploma issued by TECH Global University.

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 Diploma in Fluid Modeling** 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.

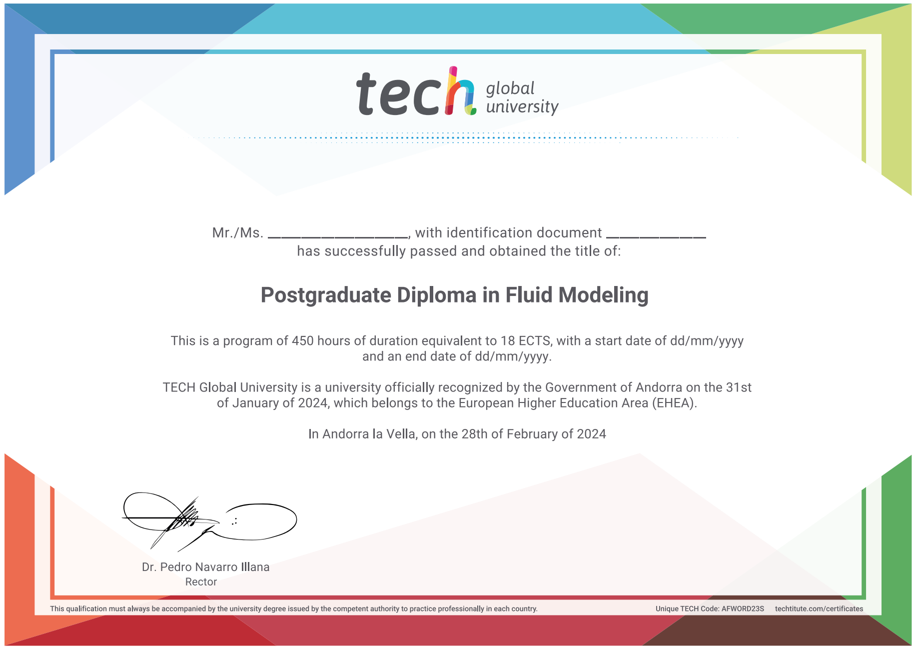
This **TECH Global University** title is a European program of continuing education and professional updating that guarantees the acquisition of competencies in its area of knowledge, providing a high curricular value to the student who completes the program.

Title: **Postgraduate Diploma in Fluid Modeling**

Modality: **online**

Duration: **6 months**

Accreditation: **18 ECTS**


tech global university

Mr./Ms. _______________, with identification document ___________
has successfully passed and obtained the title of:

Postgraduate Diploma in Fluid Modeling

This is a program of 450 hours of duration equivalent to 18 ECTS, with a start date of dd/mm/yyyy and an end date of dd/mm/yyyy.

TECH Global University is a university officially recognized by the Government of Andorra on the 31st of January of 2024, which belongs to the European Higher Education Area (EHEA).

In Andorra la Vella, on the 28th of February of 2024

Dr. Pedro Navarro Illana
Rector

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 diploma issued with an apostille, TECH Global University will make the necessary arrangements to obtain it, at an additional cost.

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