Postgraduate Diploma
CFD Techniques

tech technological university

technological university

Postgraduate Diploma
CFD Techniques

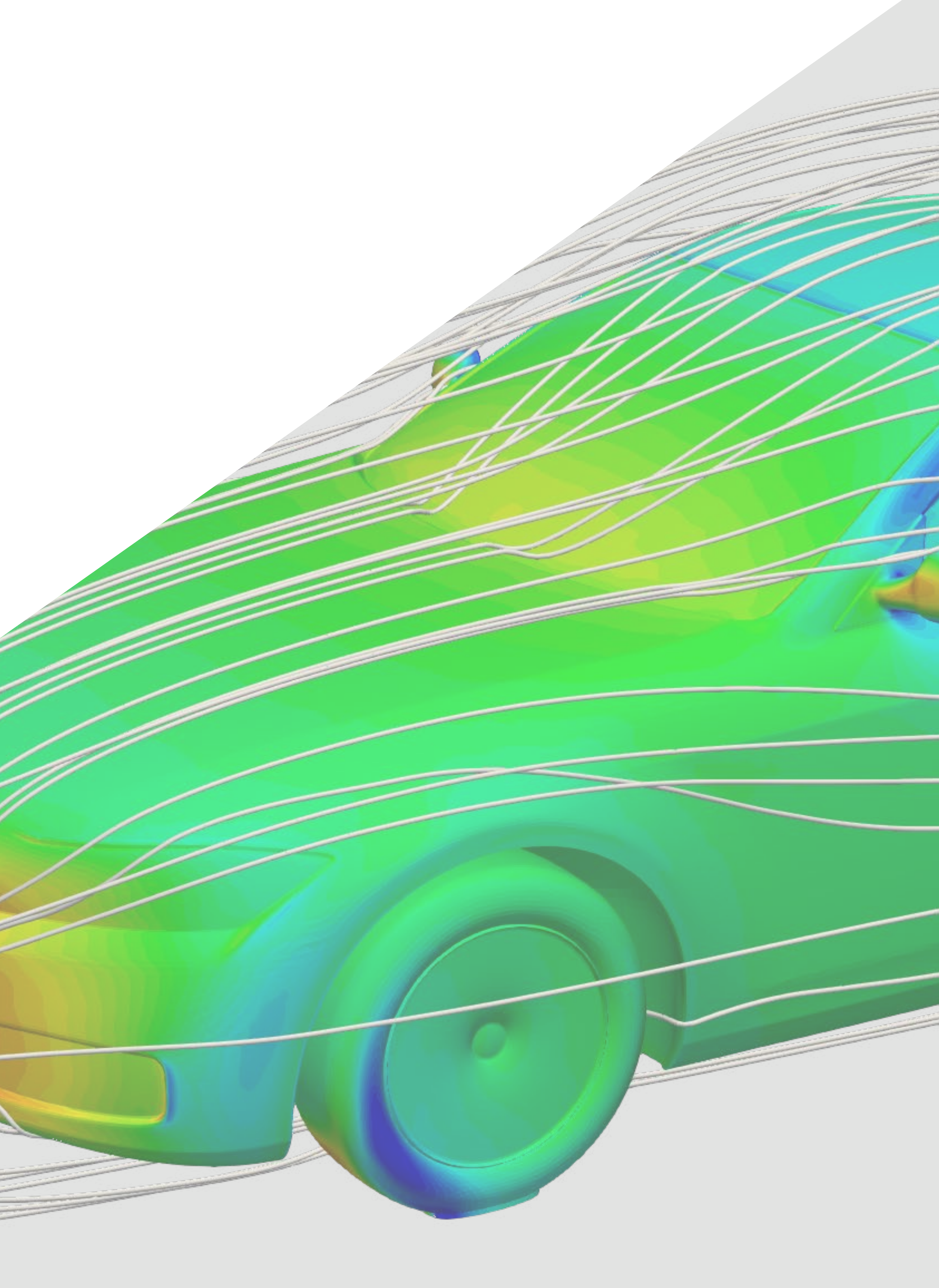
- Modality: **online**
- Duration: **6 months**
- Certificate: **TECH Technological University**
- Dedication: **16h/week**
- Schedule: **at your own pace**
- Exams: **online**

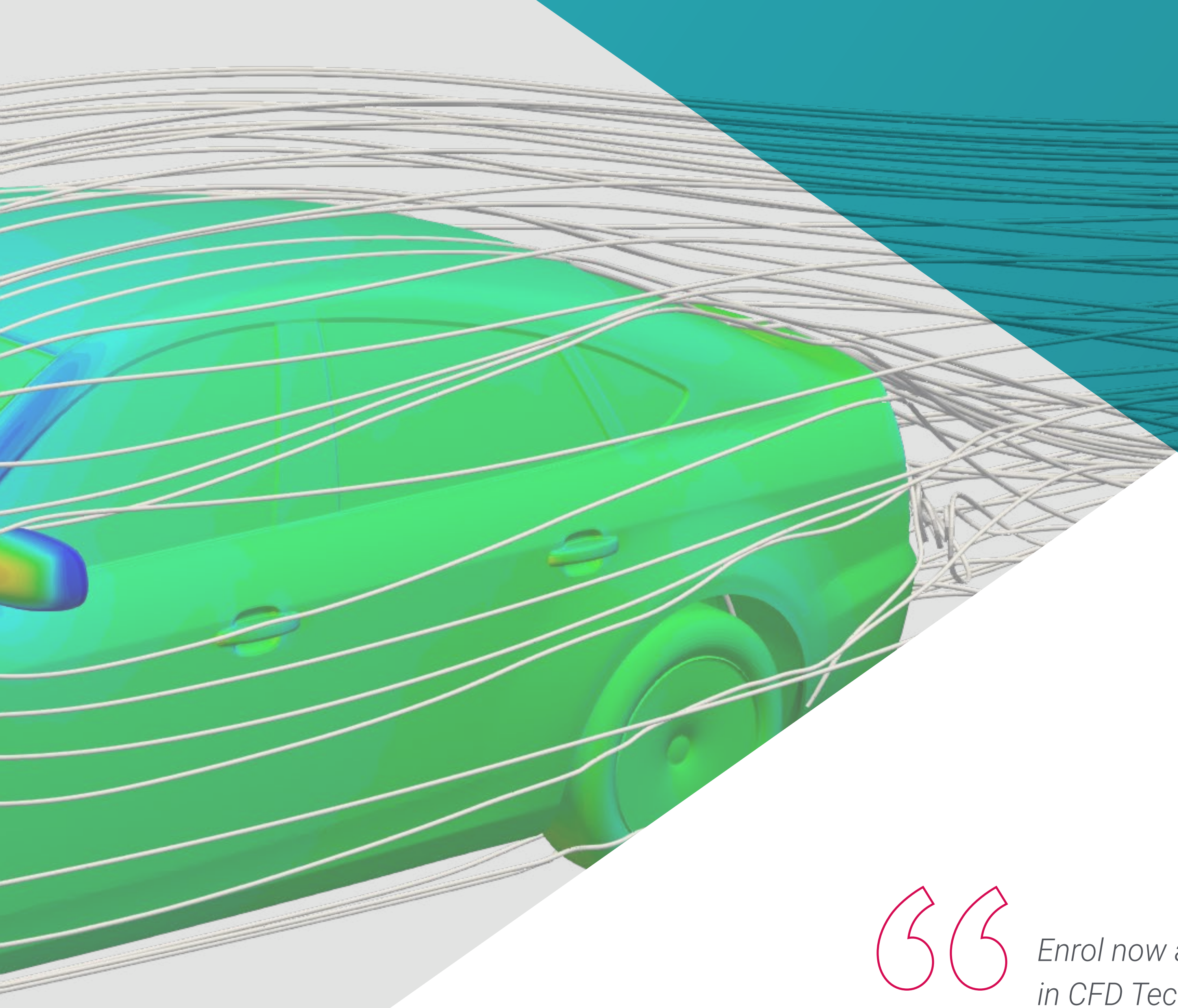
Website: www.techtitute.com/in/information-technology/postgraduate-diploma/postgraduate-diploma-cfd-techniques

Index

01
Introduction

Its reliability in proving or invalidating theories, as well as the possibility of replacing much more expensive experiments, have made simulation one of the cornerstones of science. Because of this, techniques such as Computational Fluid Dynamics have become so relevant and engineers with advanced knowledge and skills in the field are increasingly in demand by companies. For this reason, TECH Technological University has designed a degree that seeks to expand the training of students in areas such as Fluid Mechanics, High Performance Computing or Advanced Mathematics for CFD, so that they can face their profession with the highest quality in their work. All of this in a 100% online mode and with the most complete content on the subject.





Enrol now and become an expert in CFD Techniques"

Computational Fluid Dynamics (CFD) techniques are used to simulate the motion of fluids, so their applications in the field of research are multiple and very valuable. Among its many advantages are cost savings, time savings and its quality in simulating or analyzing conditions that would be much more complicated with other methods. Understanding these techniques and getting the most out of them requires advanced knowledge and skills.

For this reason, TECH Technological University has designed a Postgraduate Diploma in CFD Techniques, to provide students with the necessary skills to be able to undertake professional work of the highest quality and efficiency in this field. And this, through the study of topics such as Supercomputing Environments, 1D and 2D applications, input and physical model uncertainties or the Finite Element Method (FEM), among many other relevant aspects.

All of this, with total freedom for the student so that they can organize their study timetables and combine them with their other day-to-day activities, thanks to a convenient 100% online mode. In addition, with the most complete content, the most up-to-date information and the most innovative multimedia teaching materials, which have been designed by TECH Technological University outstanding team of CFD experts.

This **Postgraduate Diploma in CFD Techniques** 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 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 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

"Stand out in a booming sector and achieve your most demanding goals in the field of Computational Fluid Dynamics"

Access all the content in Advanced Methods for CFD, from day one and with total freedom"

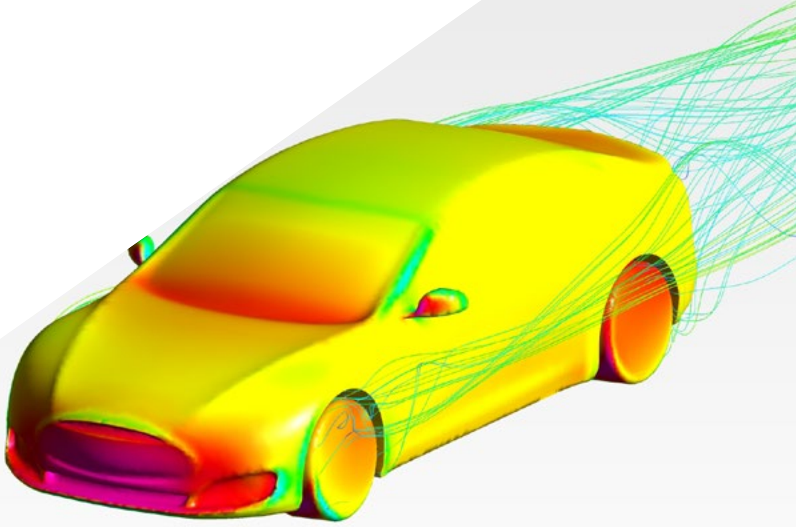
Acquire new skills through experimentation with collision operators or turbulence models.

Thanks to the most complete theoretical and practical material, you will be able to test your new competences in Supercomputing Environments.

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

Its multimedia content, developed with the latest educational technology, will allow the professional a situated and contextual learning, that is, a simulated environment that will provide an immersive training programmed to train in real situations.

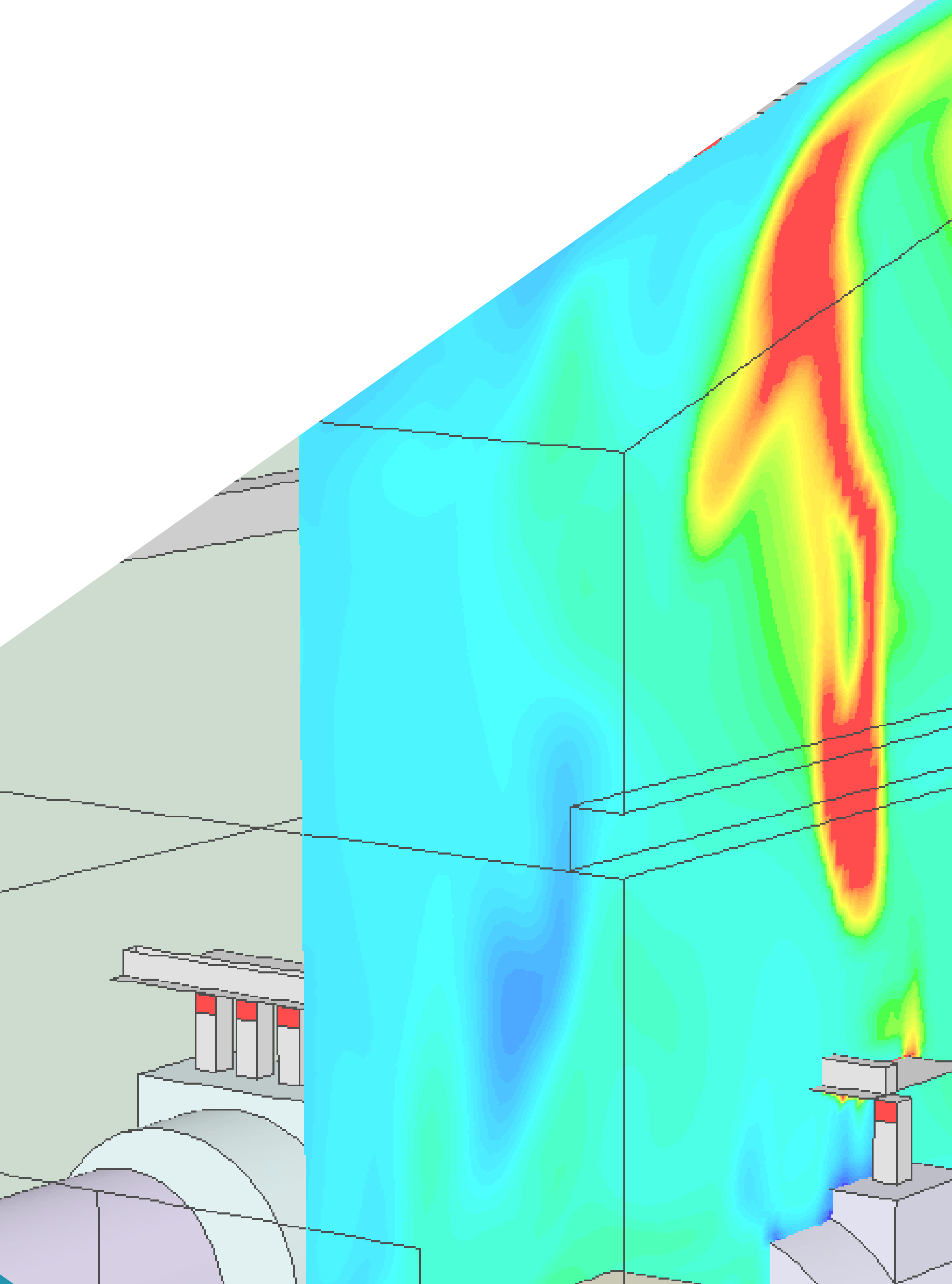
The design of this program focuses on Problem-Based Learning, in which the professional will have to try to solve the different professional practice situations that will arise throughout the academic course. For this purpose, the student will be assisted by an innovative interactive video system created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

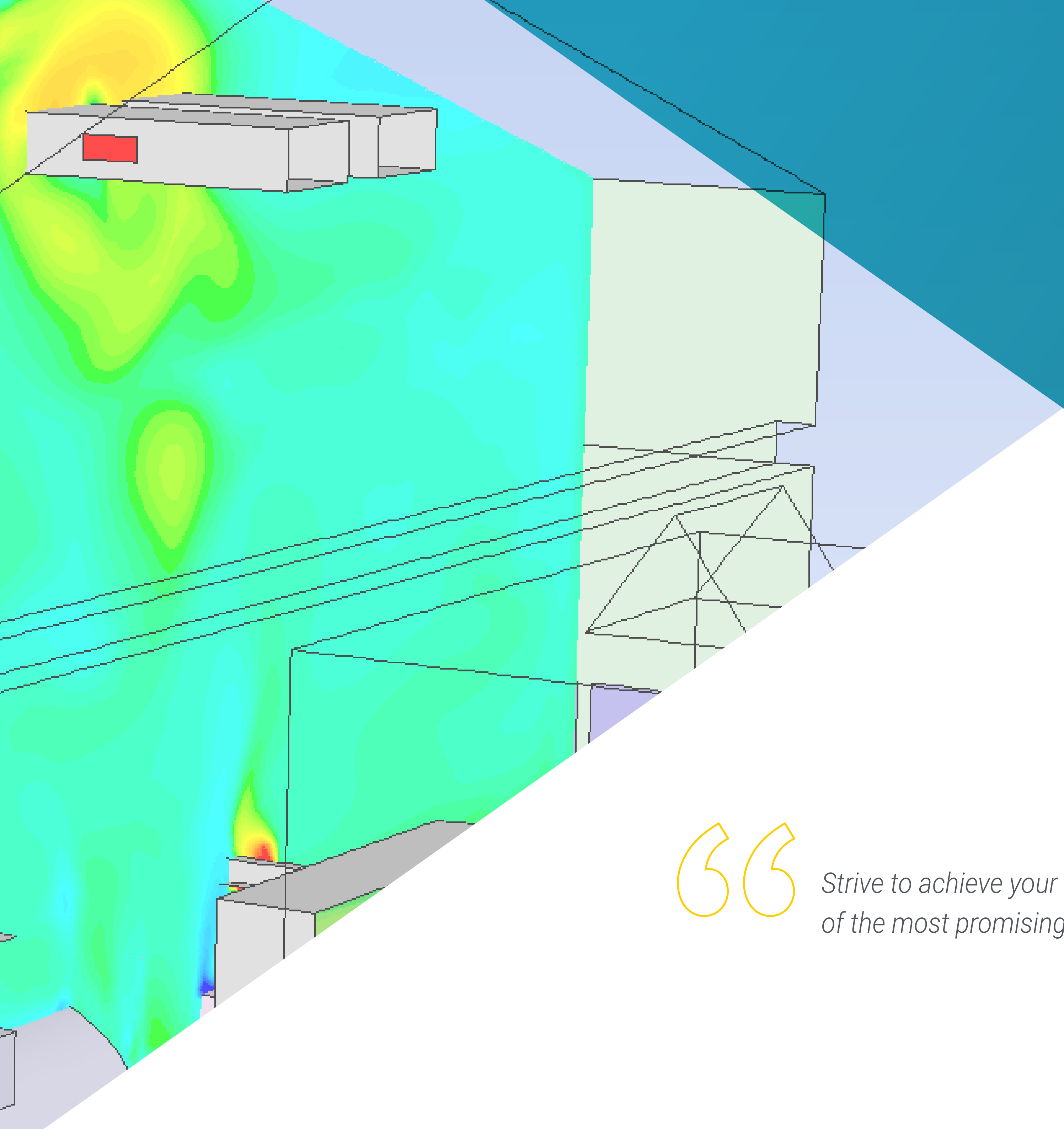


02

Objectives

The objective of this Postgraduate Diploma in CFD Techniques is to provide students with the most advanced and practical skills and knowledge, so that they can carry out their work in the field of Computational Fluid Dynamics with the highest quality and manage to stand out as professionals in the sector. All of this, through the most dynamic and complete content on the academic market.

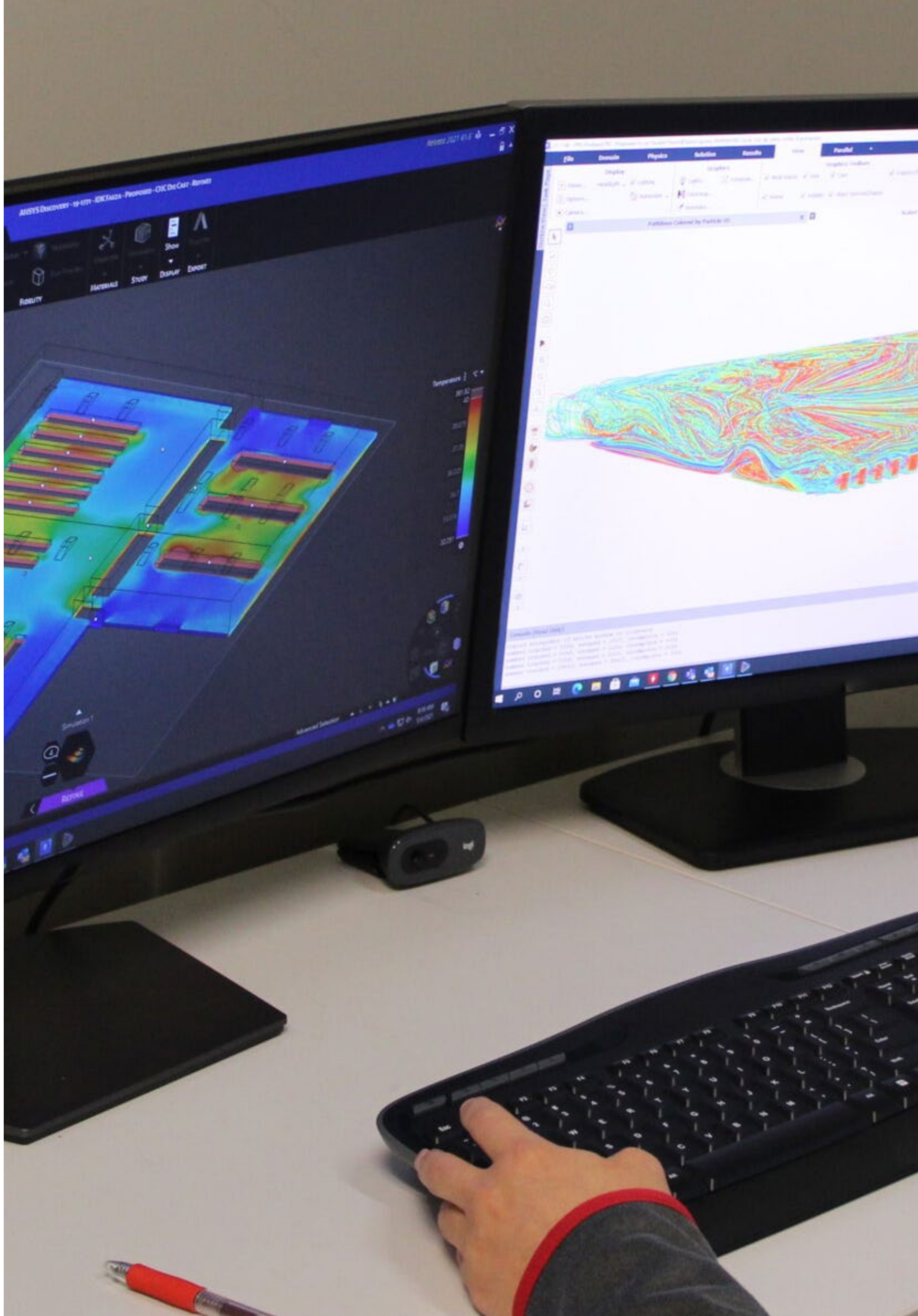




Strive to achieve your goals and specialise in one of the most promising fields of engineering"

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 multi-physicsand thermal analysis
- Interpret the results obtained by correct post-processing



Specific Objectives

Module 1. Fluid Mechanics and High Performance Computing

- Identify the equations of turbulent flows
- Examining the closure problem
- Establish the dimensionless numbers needed for modelling
- Analyze the main CFD techniques
- Examine the main experimental techniques
- Developing the different types of supercomputers
- Show the future: GPU

Module 2. Advanced Mathematics for CFD

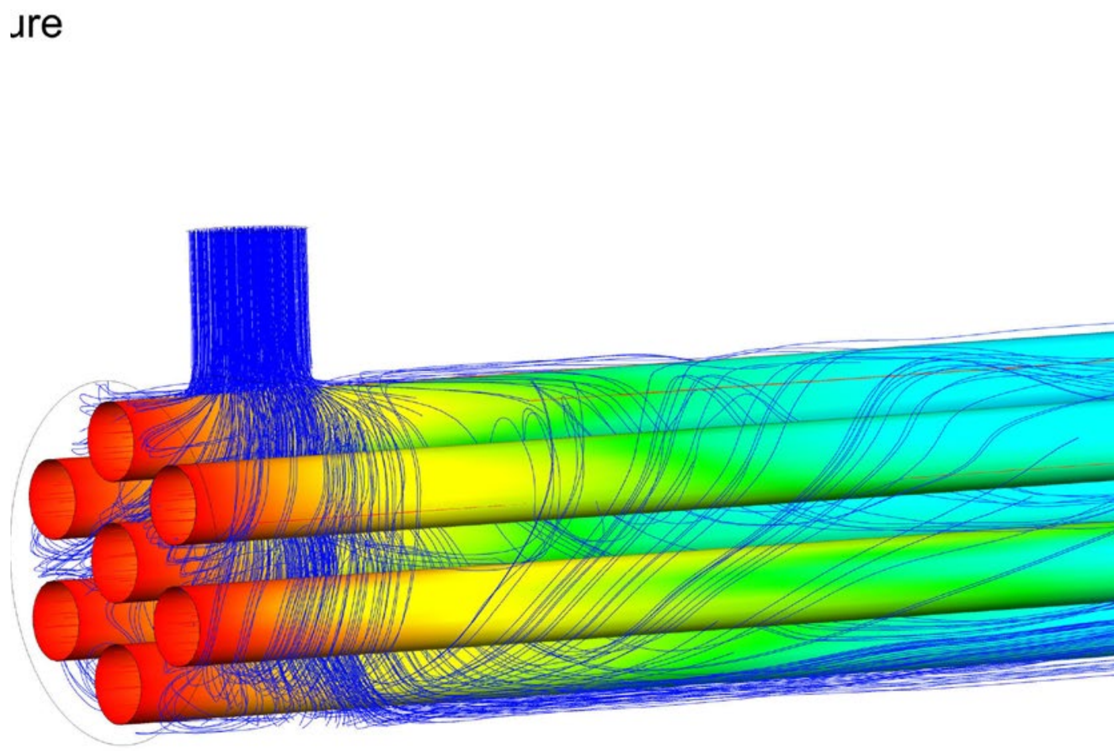
- Develop the mathematical concepts of turbulence.
- Generate expertise on the application of statistics to turbulent flows.
- Fundamentals of the method of solving CFD equations
- Show the methods of solving algebraic problems.
- Analyzing the multi-grid method
- Examine the use of eigenvalues and eigenvectors in CFD problems
- Determine methods for solving nolinear problems

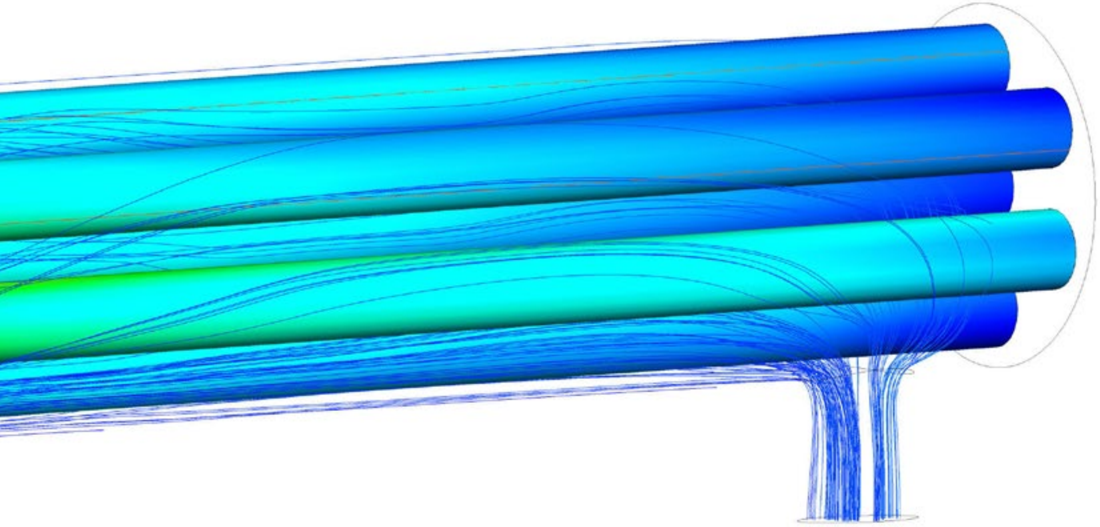
Module 3. CFD in Application Environments: Finite Volume Methods

- 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 4. Advanced Methods for CFD

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

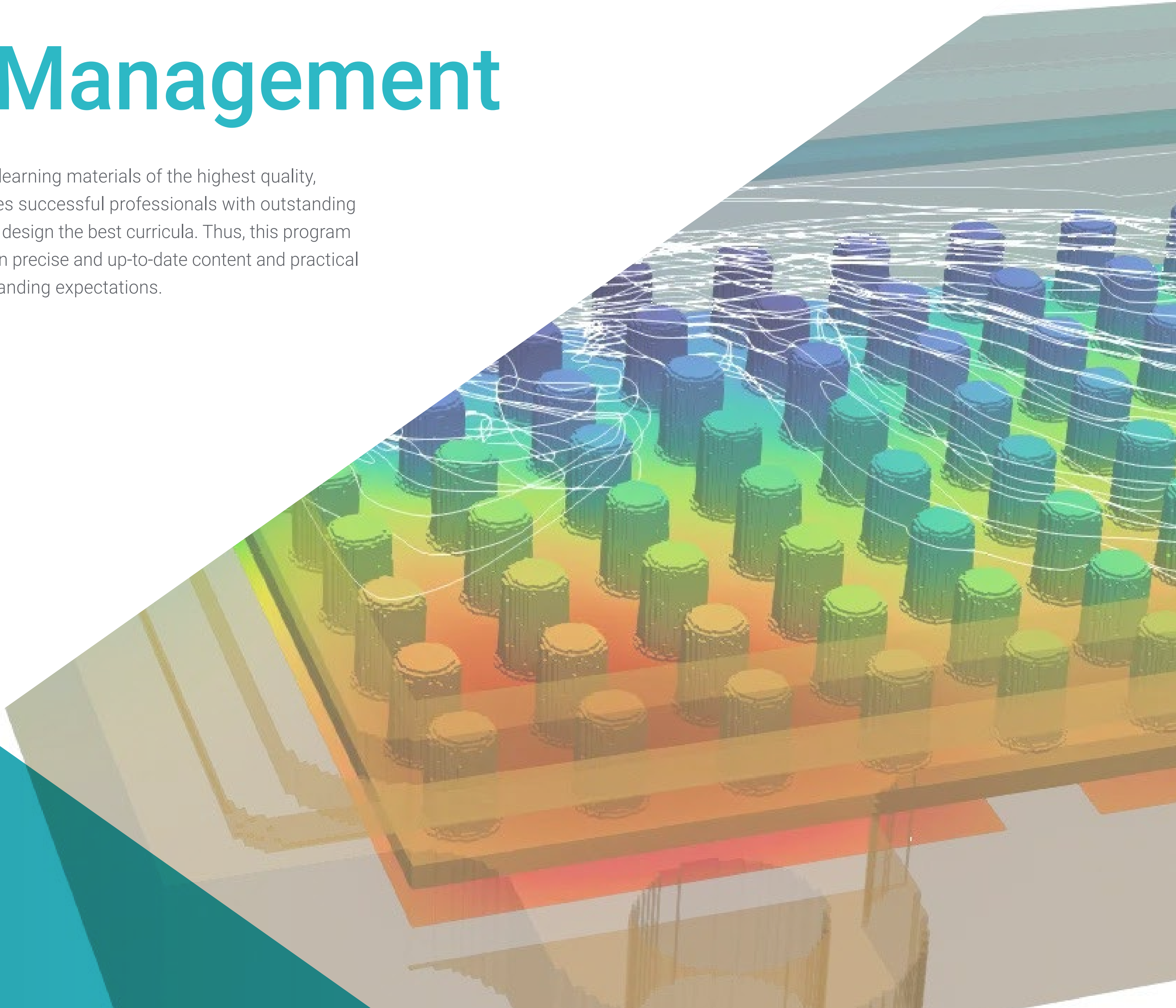


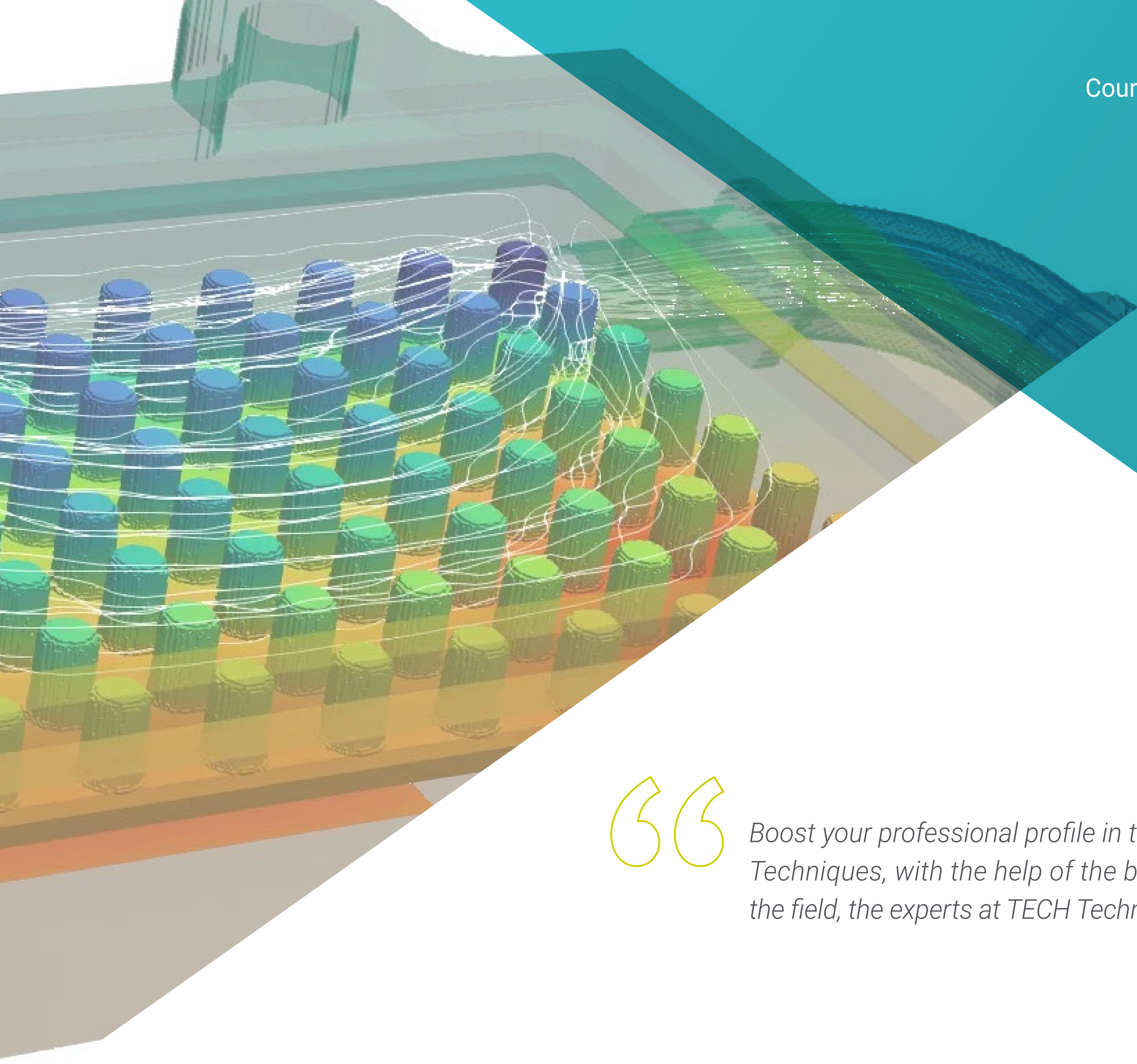


You will become a successful professional in just a few months, thanks to the most innovative CFD simulation tools"

03
Course Management

With the aim of offering teaching and learning materials of the highest quality, TECH Technological University chooses successful professionals with outstanding careers to join its group of experts and design the best curricula. Thus, this program has been carefully designed, resulting in precise and up-to-date content and practical activities that will meet the most demanding expectations.





Boost your professional profile in the field of CFD Techniques, with the help of the best experts in the field, the experts at TECH Technological University"

Management

Dr. García Galache, José Pedro

- Doctor in Aeronautical Engineering from the Polytechnic University of Valencia
- Degree in Aeronautical Engineering from the Polytechnic University of Valencia
- Research Master's Degree in Fluid Mechanics by the Von Kármán Institute for Fluid Dynamics
- Programa de formación breve en el Instituto Von Kármán de Dinámica de Fluidos

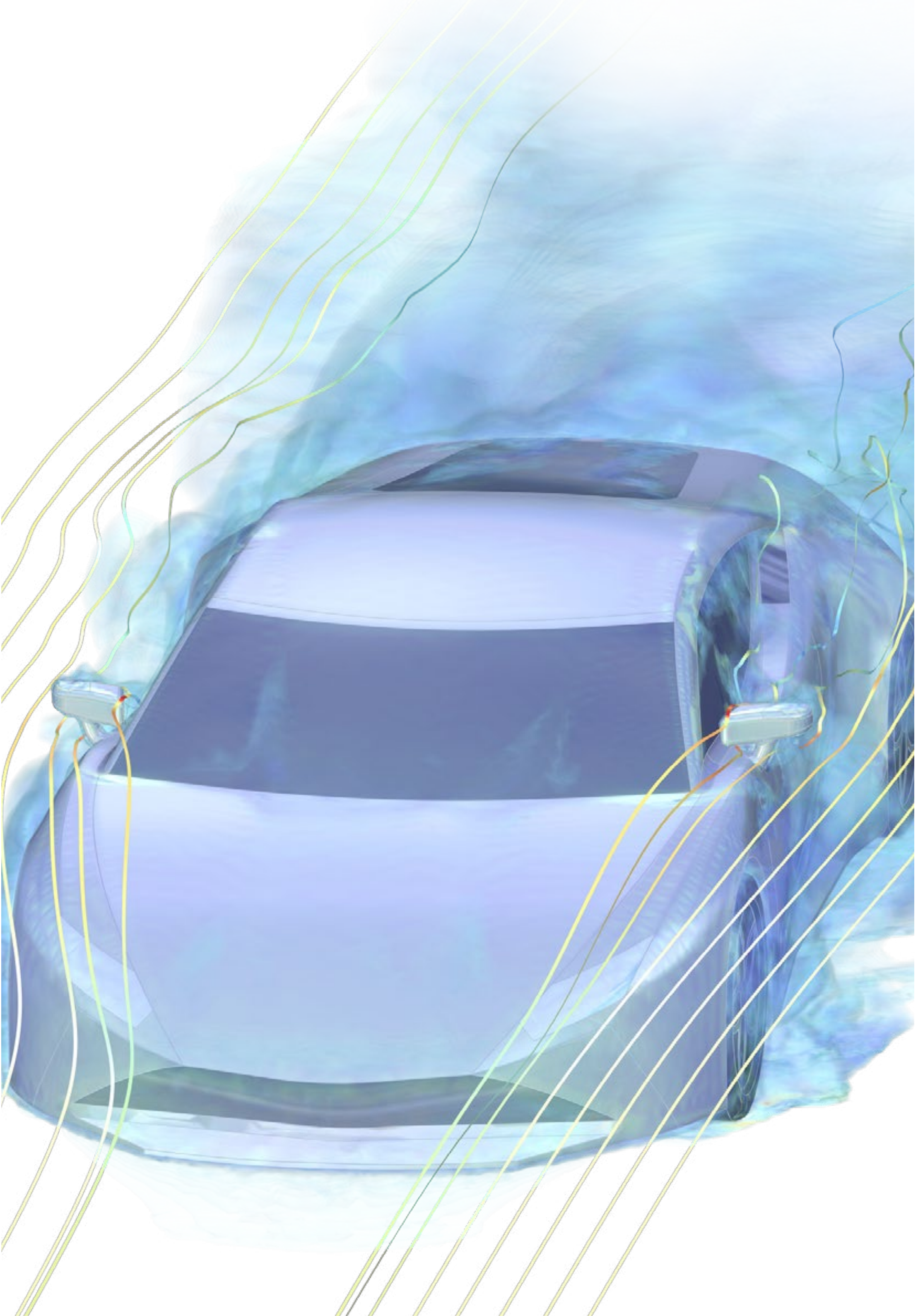
Professors

Dr. Espinoza Vásquez, Daniel

- 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
- D. in Aeronautical Engineering from the University of Strathclyde.
- Master's degree in Computational Fluid Mechanics from Cranfield University
- Degree in Aeronautical Engineering from the Polytechnic University of Madrid

Mr. Mate Bueso, Enrique

- Senior Engineer for Thermal Conditioning and Aerodynamics 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 Royal Institute of Technology of Stockholm



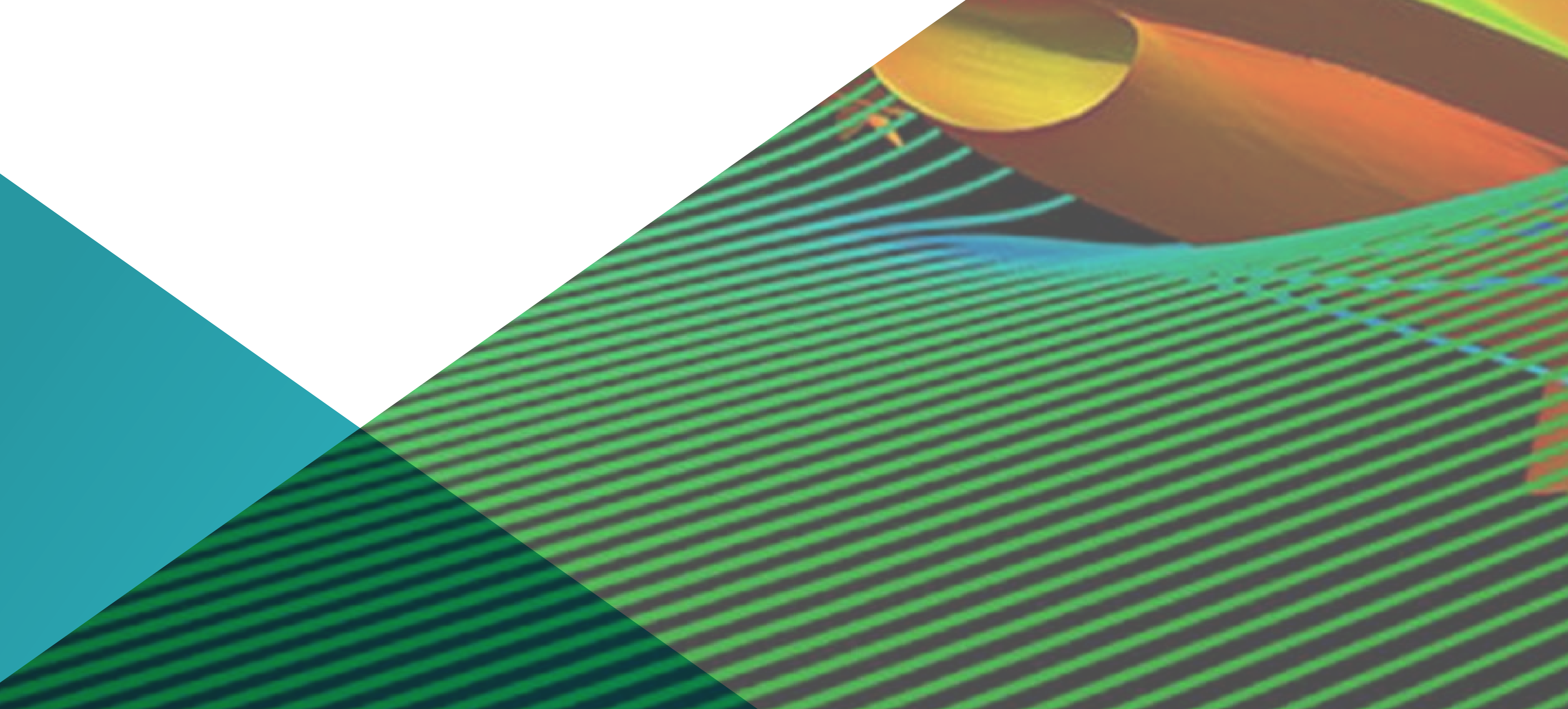
Ms. Pérez Tainta, Maider

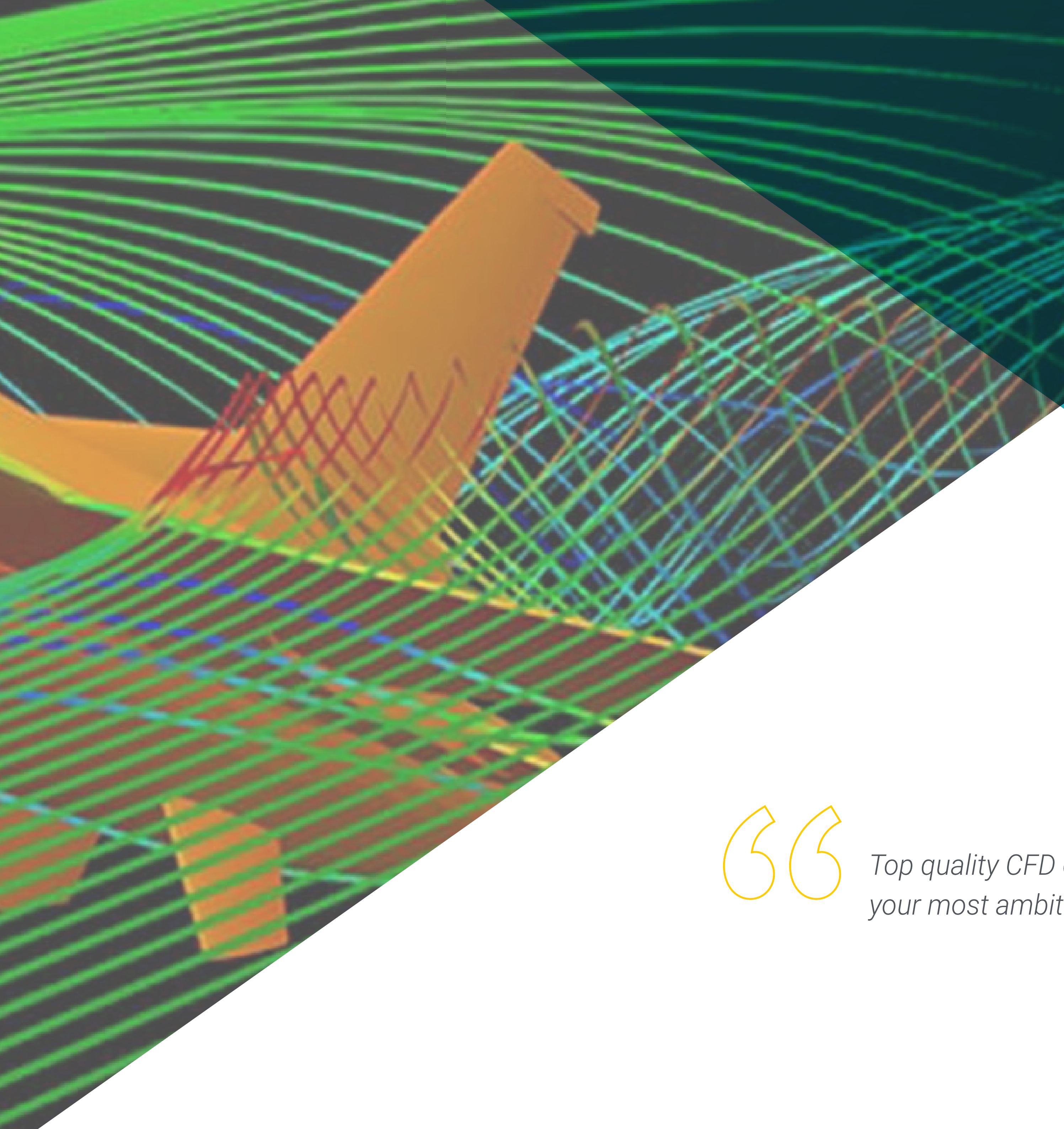
- Process Engineer at J.M. Jauregui
- Researcher in hydrogen combustion at Ikerlan
- Mechanical engineer at Idom
- Graduate in Mechanical Engineering from the University of the Basque Country (UPV)
- Master's Degree in Mechanical Engineering
- Interuniversity Master's Degree in Fluid Mechanics
- Python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

04

Structure and Content

The structure and content of this Postgraduate Diploma have been designed by TECH Technological University renowned experts, who have put their experience and state-of-the-art knowledge into the syllabus. Moreover, they are based on the most rigorous and up-to-date sources, as well as on the most efficient pedagogical methodology, Relearning, which guarantees a correct and natural assimilation of the essential concepts.





Top quality CFD content to help you achieve your most ambitious career goals"

Module 1. Fluid Mechanics and High Performance Computing

1.1. Computational Fluid Mechanics Dynamics
- 1.1.1. The Origin of Turbulence
- 1.1.2. The need for modelling
- 1.1.3. CFD work process

1.2. The Equations of Fluid Mechanics
- 1.2.1. The continuity equation
- 1.2.2. The Navier-Stokes equation
- 1.2.3. The energy equation
- 1.2.4. The Reynolds averaged equations

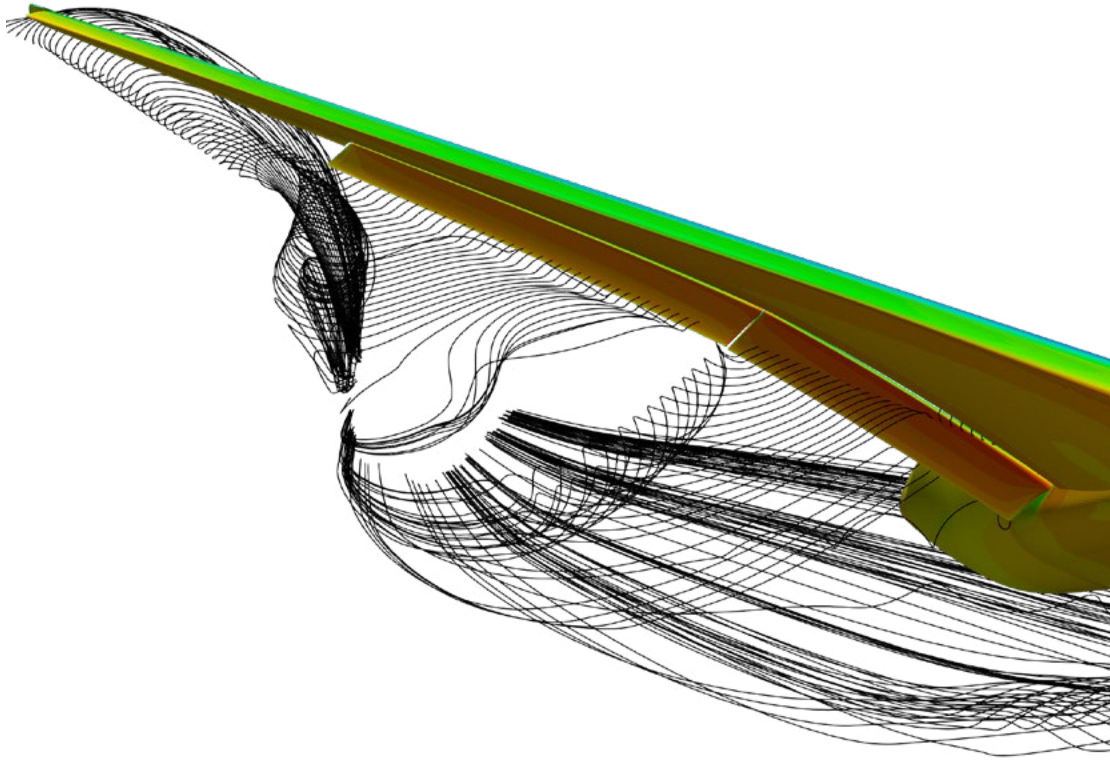
1.3. The problem of the closure of equations
- 1.3.1. The Bousinesq Hypotheses
- 1.3.2. Turbulent viscosity in spray
- 1.3.3. CFD Modeling

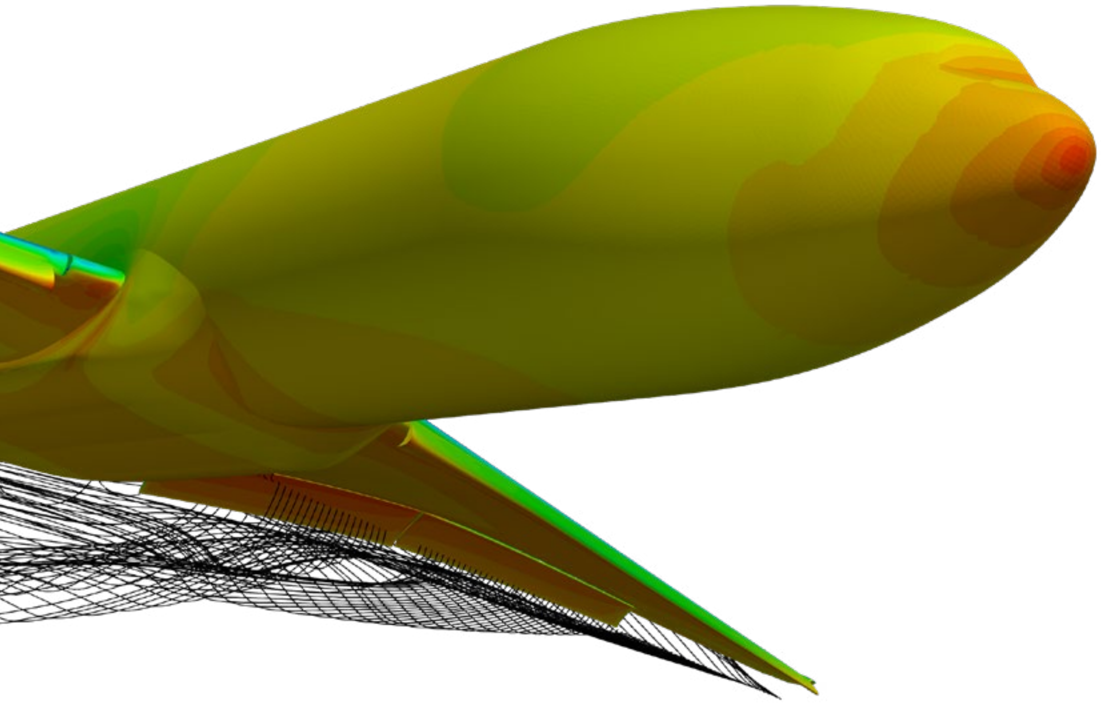
1.4. Dimensionless numbers and dynamic similarity
- 1.4.1. Dimensionless numbers in fluid mechanics
- 1.4.2. The principle of dynamic similarity
- 1.4.3. Practical example: wind tunnel modelling

1.5. Turbulence Modeling
- 1.5.1. Direct numerical simulations
- 1.5.2. Simulations of large eddies
- 1.5.3. RANS methods.
- 1.5.4. Other Methods

1.6. Experimental Techniques
- 1.6.1. PIV
- 1.6.2. Hot wire
- 1.6.3. Wind and water tunnels

1.7. Supercomputing environments
- 1.7.1. Supercomputers Go to the future
- 1.7.2. Operating a supercomputer
- 1.7.3. Tools for use





1.8. Software on parallel architectures
  1.8.1. Distributed environments: MPI.
  1.8.2. Shared memory: GPU
  1.8.3. Data recording: HDF5
1.9. Grid computing
  1.9.1. Description of computer farms
  1.9.2. Parametric problems
  1.9.3. Grid computing queuing systems
1.10. GPUs, the future of CFD
  1.10.1. GPU Environments
  1.10.2. GPU programming
  1.10.3. Practical Example: Artificial intelligence in fluids using GPUs

Module 2. Advanced mathematics for CFD

2.1. Fundamentals of Mathematics
  2.1.1. Gradients, divergences and rotations. Total derivative
  2.1.2. Ordinary Differential Equations
  2.1.3. Partial derivative equations
2.2. Statistics
  2.2.1. Averages and moments
  2.2.2. Probability density functions
  2.2.3. Correlation and energy spectra
2.3. Strong and weak solutions of a differential equation
  2.3.1. Function bases. Strong and weak solutions
  2.3.2. The finite volume method. The heat equation
  2.3.3. The finite volume method. Navier-Stokes
2.4. Taylor's Theorem and Discretisation in Time and Space
  2.4.1. Finite differences in 1 dimension. Error order
  2.4.2. Finite differences in 2 dimensions.
  2.4.3. From continuous equations to algebraic equations
2.5. Algebraic problem solving, LU method
  2.5.1. Algebraic problem solving methods
  2.5.2. The LU method on full matrices
  2.5.3. The LU method in sparse matrices

2.6. Algebraic Problem Solving, Iterative Methods I
- 2.6.1. Iterative methods. Waste
- 2.6.2. Jacobi's method
- 2.6.3. Generalization of Jacobi's method

2.7. Algebraic problem solving, iterative methods II
- 2.7.1. Multi-mesh methods: V-cycle: interpolation
- 2.7.2. Multi-grid methods: V-cycle: extrapolation
- 2.7.3. Multi-grid methods: W-cycle
- 2.7.4. Error estimation

2.8. Eigenvalues and eigenvectors
- 2.8.1. The algebraic problem
- 2.8.2. Application to the heat equation
- 2.8.3. Stability of differential equations

2.9. Nolinear evolution equations
- 2.9.1. Heat equation: explicit methods
- 2.9.2. Heat equation: implicit methods
- 2.9.3. Heat equation: Runge-Kutta methods

2.10. Stationary nolinear equations
- 2.10.1. The Newton-Raphson method
- 2.10.2. 1D Applications
- 2.10.3. 2D Applications

Module 3. CFD in Application Environments: Finite Volume Methods

3.1. Finite Volume Methods
- 3.1.1. Definitions in FVM
- 3.1.2. MVF in Structures

3.2. Source Terms
- 3.2.1. External volumetric forces
  - 3.2.1.1. Gravity, centrifugal force
- 3.2.2. Volumetric (mass) and pressure source term (evaporation, cavitation, chemical)
- 3.2.3. Scalar source term
  - 3.2.3.1. Temperature, species

3.3. Applications of boundary conditions
- 3.3.1. Input and Output
- 3.3.2. Symmetry condition
- 3.3.3. Wall condition
  - 3.3.3.1. Tax values
  - 3.3.3.2. Values to be solved by parallel calculation
  - 3.3.3.3. Wall models

3.4. Boundary Conditions
- 3.4.1. Lateral boundary conditions. Dirichlet
  - 3.4.1.1. Scalars
  - 3.4.1.2. Diseases
- 3.4.2. Boundary conditions with known derivative: Neumann
  - 3.4.2.1. Zero gradient
  - 3.4.2.2. Finite gradient
- 3.4.3. Cyclic boundary conditions: Born-von Karman
- 3.4.4. Other boundary conditions: Robin

3.5. Temporary integration
- 3.5.1. Explicit and implicit Euler
- 3.5.2. Lax-Wendroff time step and variants (Richtmyer and MacCormack)
- 3.5.3. Runge-Kutta multi-stage time step

3.6. Upwind schemes
- 3.6.1. Riemman's Problem
- 3.6.2. Main upwind schemes: MUSCL, Van Leer, Roe, AUSM
- 3.6.3. Design of an upwind spatial scheme

3.7. High order schemes
- 3.7.1. High-order discontinuous Galerkin
- 3.7.2. ENO and WENO
- 3.7.3. High Order Schemes. Advantages and Disadvantages

3.8. Pressure-velocity convergence loop
- 3.8.1. PISA
- 3.8.2. SIMPLE, SIMPLER and SIMPLEC
- 3.8.3. PIMPLE
- 3.8.4. Transient loops

3.9. Moving contours
 3.9.1. Overlocking techniques
 3.9.2. Mapping: mobile reference system
 3.9.3. Immersed boundary method
 3.9.3. Overlapping meshes
3.10. Errors and uncertainties in CFD modeling
 3.10.1. Precision and accuracy
 3.10.2. Numerical errors
 3.10.3. Input and physical model uncertainties

Module 4. Advanced Methods for CFD

4.1. Finite Element Method (FEM)
 4.1.1. Domain discretization. Finite Elements
 4.1.2. Form functions. Reconstruction of the continuous field
 4.1.3. Assembly of the coefficient matrix and boundary conditions
 4.1.4. Solving the system of equations
4.2. FEM Case Studies Development of a FEM simulator
 4.2.1. Form functions
 4.2.2. Assembling the coefficient matrix and applying boundary conditions
 4.2.3. Solving the system of equations
 4.2.4. Post-Process
4.3. Smoothed Particle Hydrodynamics (SPH)
 4.3.1. Fluid field mapping from particle values.
 4.3.2. Evaluation of derivatives and particle interaction
 4.3.3. The smoothing function. The kernel
 4.3.4. Boundary Conditions
4.4. SPH: Development of a simulator based on SPH
 4.4.1. The kernel
 4.4.2. Storage and sorting of particles in voxels
 4.4.3. Development of boundary conditions
 4.4.4. Post-Process
4.5. Direct Simulation Monte Carlo (DSMC)
 4.5.1. Kinetic-molecular theory
 4.5.2. Statistical mechanics
 4.5.3. Molecular equilibrium
4.6. DSMC: Methodology
 4.6.1. Applicability of the DSMC method
 4.6.2. Modeling
 4.6.3. Considerations for the applicability of the method
4.7. DSMC: Applications
 4.7.1. Example in 0-D: Thermal relaxation
 4.7.2. Example in 1-D: Normal shock wave
 4.7.3. Example in 2-D: Supersonic cylinder
 4.7.4. Example in 3-D: Supersonic corner
 4.7.4. Complex example: Space Shuttle
4.8. Lattice-Boltzmann Method (LBM)
 4.8.1. Boltzmann equation and equilibrium distribution
 4.8.2. De Boltzmann a Navier-Stokes. Chapman-Enskog Expansion
 4.8.3. From probabilistic distribution to physical magnitude
 4.8.4. Conversion of units. From physical quantities to lattice quantities
4.9. LBM: Numerical approximation
 4.9.1. The LBM Algorithm. Transfer step and collision step
 4.9.2. Collision operators and momentum normalization
 4.9.3. Boundary Conditions
4.10. LBM: Case Study
 4.10.1. Development of a simulator based on LBM
 4.10.2. Experimentation with various collision operators
 4.10.3. Experimentation with various turbulence models

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 has been the most widely used learning system among the world's leading Information Technology schools for as long as they have existed. 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 course, students 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

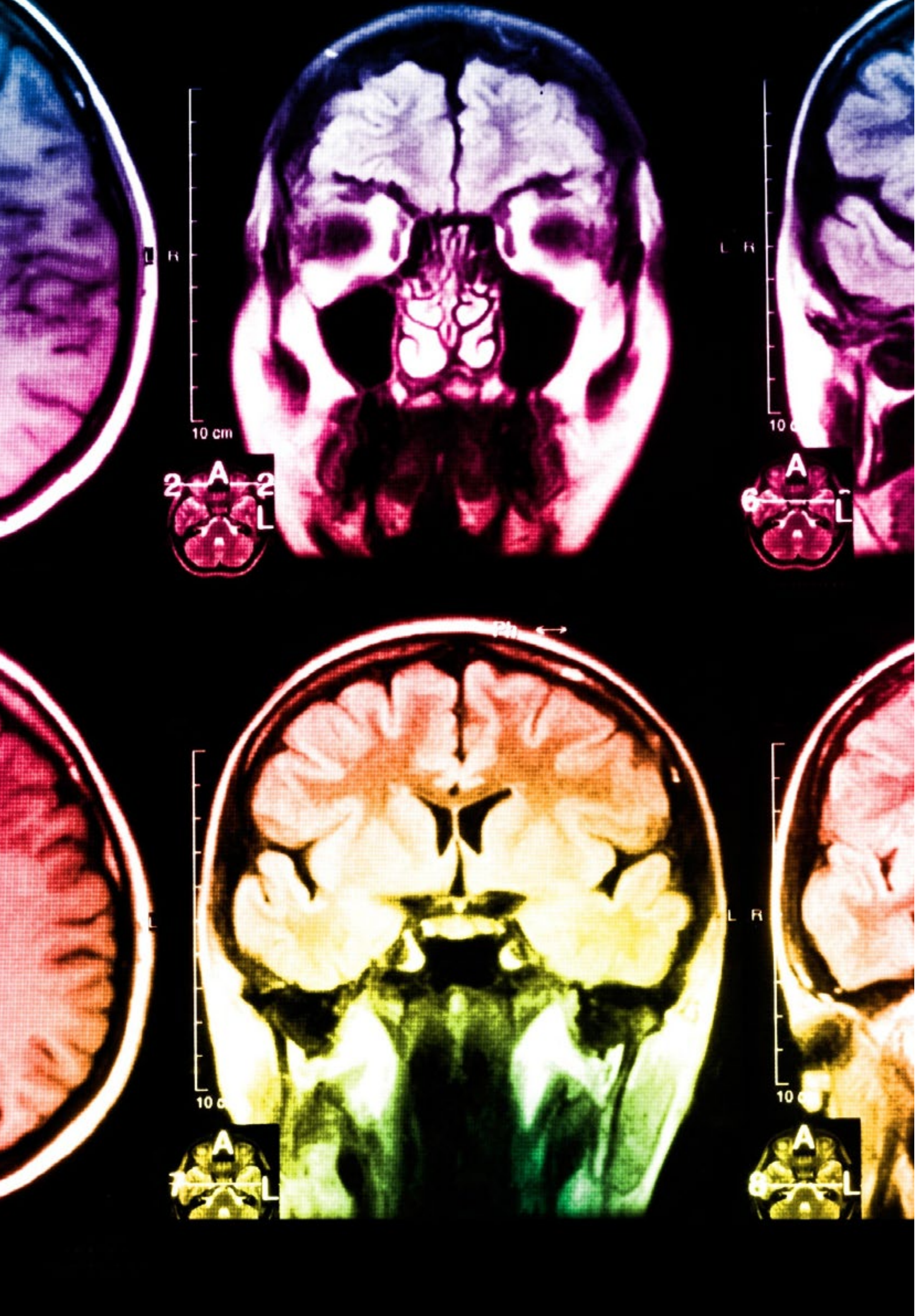
TECH effectively combines the Case Study methodology with a 100% online learning system based on repetition, which combines different teaching elements in each lesson.

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.

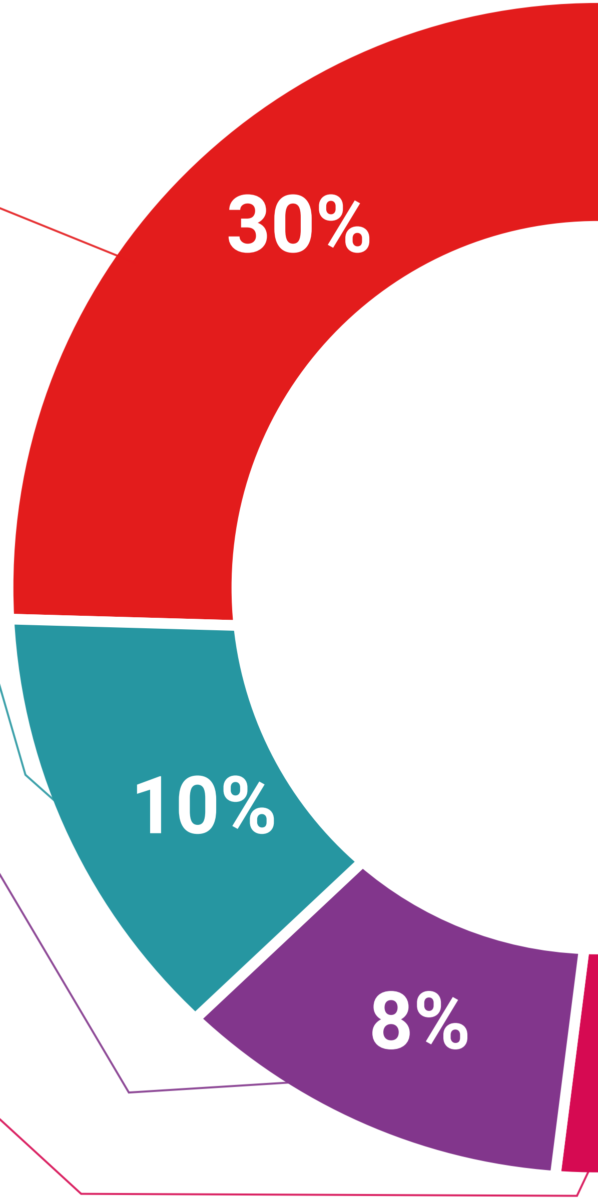
Learning from an Expert strengthens knowledge and memory, and generates confidence in future difficult decisions.

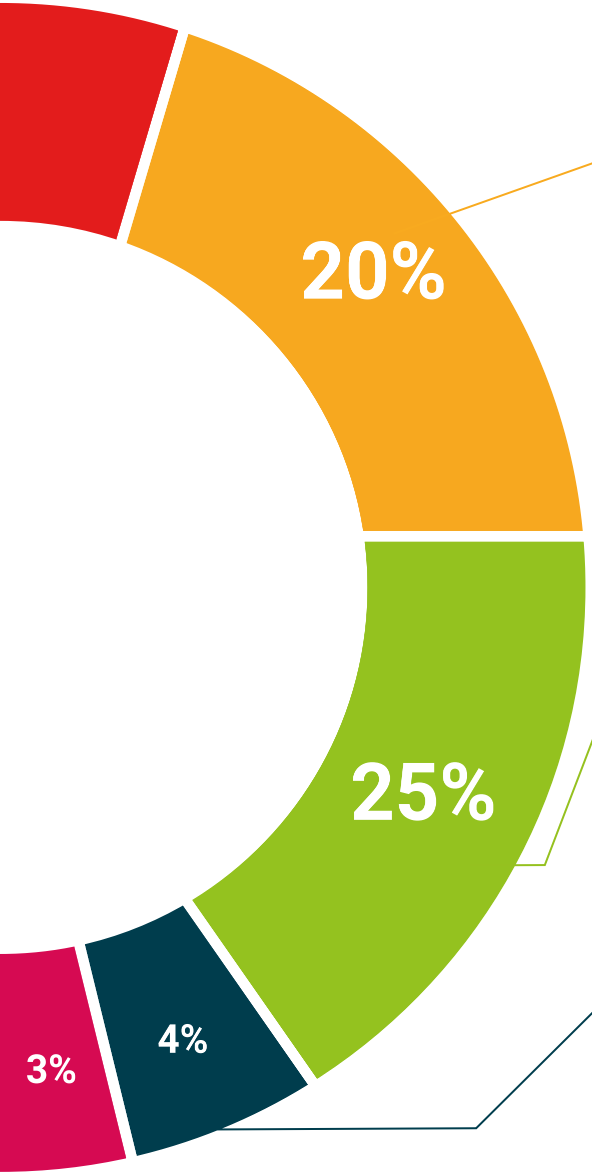
Practising Skills and Abilities

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 Technique 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 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 CFD Techniques**

Official Nº of Hours: **450 h.**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Awards the following

CERTIFICATE

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Mr./Ms. ________________, with identification number ____________.

For having passed and accredited the following program

POSTGRADUATE DIPLOMA

in

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

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.

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Postgraduate Diploma
CFD Techniques

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

Postgraduate Diploma
CFD Techniques

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