ESTACA
ECOLE D'INGENIEURS

ESTACA CFD SUMMER PROGRAM 2025 IN PARIS

Learn and practice modeling techniques for Fluid Dynamics

Discover Paris & Study in English for 4 weeks!

Further information :
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AIMS AND BENEFITS

- Learn and operate **CFD** (Computational Fluid Dynamics) **tools** to understand and predict **aeronautical systems performances** and **behavior**
- Work with industrially relevant computation software and methods
- Study in a multicultural environment

PROGRAM & COURSES

- Aeronautical History
- Fluid Mechanics
- Introduction to Turbulence
- Aerodynamics
- Computational Fluid Dynamics
- Wind Tunnel

- **Company visits:** ONERA, Safran…
- **Cultural visits:** Versailles Castle, Cruise on the Seine river…

PRACTICAL INFORMATION

- **Dates:** From June 16th to July 11th, 2025
- **Credits (ECTS):** 10 ECTS
- **Price:** 3700€ (for free-movers) – 1800€ (for partner universities) – *Includes housing and all academic activities and visits (meals, visa and travel costs are not included)*
- **Required Level:** Minimum 3rd year of Bachelor degree in Engineering

CURRICULUM

COMPUTATIONAL FLUID DYNAMICS

- **Objectives:** This course provides a comprehensive introduction to the key steps involved in producing accurate computational fluid dynamics (CFD) simulations. It offers a simplified explanation of the finite volume method and demonstrates various meshing strategies essential for obtaining reliable simulation results. Students will gain hands-on experience using ANSYS Fluent, a widely used CFD software, to set up and analyse various CFD cases, with a focus on aeronautical applications.
- **Courses:** 4h CM + 8h TP = 12h
  - Computational Fluid Dynamics (Lecture)
  - CFD with ANSYS Fluent (Labwork)
- **Exam:** Labwork
- **ECTS:** 2 ECTS

FLUID MECHANICS

- **Objectives:** This course is focused on basic knowledge about fluids and flows (Newtonian fluid, laminar and turbulent flow regimes, liquid and gas…).
  - Fluid statics: this chapter is focused on basic equation governing fluid static (pressure in a fluid at rest, static equation, hydrostatic pressure on plane and curved surfaces, pressure variation in a fluid with rigid-body (linear and rotation) motion)
  - Kinematics of fluids: this chapter is focused on a mathematical approach of fluid mechanics to describe some basic flow properties of ideal fluids (stream function, streamlines, irrotational flow, velocity potential, potential flows…)
  - Elementary fluid dynamics (Euler, Bernoulli and Navier Stokes equations): this chapter is focused on fundamental equations governing motions of incompressible fluids (viscosity, Euler and Navier Stokes equations, Bernoulli equation)
- **Courses:** 15h
  - Fluid statics (3h) (Lecture)
  - Kinematics of fluids (3h) (Lecture)
  - Elementary fluid dynamics (Euler, Bernoulli and Navier Stokes equations) (9h) (Lecture)
- **Exam:** Multiple-choice exam
- **ECTS:** 2 ECTS

WIND TUNNEL

- **Objectives:** The aim of this course is to explore the effectiveness of vortex generators in improving aerodynamic performance by analyzing the flow characteristics over a NACA Airfoil surface using particle image velocimetry (PIV) technique. The work will involve comparisons of wing geometries with and without VGs, focusing on the modification of recirculation zones, vortex generation, and flow separation. PIV will be used to visualize the flow structure and quantify changes in velocity fields, vorticity, and recirculation zones, particularly at higher angles of attack. The results will be interpreted by correlating these flow characteristics with results obtained from numerical simulations to assess the effectiveness of vortex generators.
- **Courses:** 4h Labwork + 4h post-processing
- **Exam:** Multiple-choice exam
- **ECTS :** 1 ECTS

INTRODUCTION TO TURBULENCE

- **Objectives:** Most fluid flows occurring in nature as well as in engineering applications are turbulent. The scope of this course is to introduce some of the basis of the turbulence theory and its statistical analysis. The Emphasis will be put on turbulent flow features that are of primary interest for turbulent flow prediction and modelling. The concepts will be illustrated by a fair set of representative examples issues from both the automotive and aeronautic industry.
- **Courses :** 15h
  - Basic concepts (Turbulent Flows, Control Parameters, Some Practical Consequences of Turbulence)
  - Statistical Description of turbulent Flows (Reynolds Averaged Navier Stokes equations, Kinetic energy budget)
  - Wall-bounded Flows and Free Jets (Boundary Layer, Mixing Layer)
  - A glimpse at simulation of turbulent flows (RANS turbulence models, LES, DNS, Hybrid RANS/LES)
- **Exam :** Multiple-choice exam
- **ECTS :** 2 ECTS

AERODYNAMICS

- **Objectives:** This aerodynamics course focuses on the study of the flow of air about a wing, but many of the concepts explored are relevant to a wide variety of applications. Learners completing this aerodynamics course will gain a fundamental understanding of concepts and models used to aerodynamically analyze and design subsonic, transonic, and supersonic vehicles.
- **Courses :** 21h
  - Inviscid, Incompressible Flow
    - Incompressible flows over airfoils
    - Incompressible flows over finite wings
    - Three-dimensional Incompressible flows
  - Inviscid, Compressible Flow
    - Compressible flows : some preliminary aspects
    - Normal shock waves and related topics
    - Oblique shock and expansion waves
    - Compressible flows through nozzles, diffusers and wind tunnels
    - Subsonic compressible flow over airfoils : Linear theory
    - Linearized supersonic flow
    - Elements of hypersonic flow
  - Viscous Flow
    - Introduction to boundary layers
    - Laminar boundary layers
    - Turbulent boundary layers
- **Exam :** Multiple-choice exam
- **ECTS :** 2 ECTS

AERONAUTICAL HISTORY

- **Objectives:** Learn how today aerospace world has evolved. The pioneers : from Icare to Clément Ader, World War I, the interwar period, the World War II and the modern age. This course will concentrate on technical evolutions which allowed the aeronautical development.
- **Courses:** 9 h
  - Conference and visits
  - Until the interwar period (Lecture)
  - Until our time (Lecture)
- **Exam:** Quitus
- **ECTS:** 1 ECTS