



Course unit English denomination	Mechanics of Turbulence
Teacher in charge (if defined)	Paolo Peruzzo
Teaching Hours	24
Number of ECTS credits allocated	4
Course period	January – February
Course delivery method	<input checked="" type="checkbox"/> In presence <input type="checkbox"/> Remotely <input type="checkbox"/> Blended
Language of instruction	English
Mandatory attendance	<input checked="" type="checkbox"/> Yes (75% minimum of presence) <input type="checkbox"/> No
Course unit contents	<p>The course aims to provide a detailed overview of turbulence phenomena, described mathematically through the Navier-Stokes equations. Initially, the mathematical description of turbulence is introduced, focusing on the concept of turbulent flow and its characteristics.</p> <p>Subsequently, the course moves on to the statistical analysis of turbulence, where mean values, turbulence intensity, and spatiotemporal correlation functions are discussed, which are useful for describing the evolution of turbulent flow in time and space.</p> <p>Another important part of the course covers the stationarity and homogeneity of turbulence, two fundamental properties for understanding the behavior of such flows. Additionally, turbulence scales are introduced, which help classify the various regimes and phenomena related to turbulence.</p> <p>A significant portion of the course is dedicated to the numerical solution of the Navier-Stokes equations, which describe fluid motion. In particular, the Reynolds equations, the kinetic energy of the mean flow, and the turbulent kinetic energy equation are studied, essential tools for modeling and understanding the behavior of turbulent flows. The dynamics of vorticity are also explored in detail, analyzed through the Navier-Stokes equations and the vorticity equation, with a reference to Kelvin's circulation theorem and the vortex stretching phenomenon.</p> <p>Finally, the course addresses advanced topics such as the turbulence energy spectrum, Taylor's hypothesis, and the energy cascade, key elements for understanding the distribution of energy across different scales within a turbulent flow.</p>
Learning goals	<p>The course aims to provide a solid foundation for understanding the complex concepts of turbulence and the Navier-Stokes equations, offering a comprehensive and detailed overview of these phenomena, which are useful in various fields of applied and theoretical research. A second objective is to equip students with a critical approach to modeling and analysis problems in this area.</p>
Teaching methods	<p>Lectures with continuous interactions with the students. Specifically:</p> <ul style="list-style-type: none"><li>• critical thinking</li><li>• group work</li><li>• interactive teaching</li></ul>



- 
- authentic and easy relationships among participant
  - cooperation and support among peers
- 

Course on transversal, interdisciplinary, transdisciplinary skills

- Yes  
 No

Available for PhD students from other courses

- Yes  
 No

Prerequisites (not mandatory)

Basic knowledge of fluid mechanics

Examination methods (in applicable)

Discussion of project work

Suggested readings

- Lanzoni, S. 2010. Advanced Fluid Mechanics
- Batchelor, G. K. (1953). The theory of homogeneous turbulence. Cambridge university press.

Additional information

---