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	☒ In presence ☐ Remotely ☐ Blended
Language of instruction	English
Mandatory attendance	☒ Yes (75% minimum of presence) ☐ No
Course unit contents	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. 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. 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. 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. 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.
Learning goals	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.

Teaching methods	Lectures with continuos interactions with the students. Specifically: • critical thinking • group work • interactive teaching • 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	--