Course unit English denomination	Advanced Tools in Fluid Mechanics
Teacher in charge	Stefano Lanzoni
Teaching Hours	24
Number of ECTS credits allocated	4
Course period	May
Course delivery method	☒ In presence ☐ Remotely ☐ Blended
Language of instruction	English
Mandatory attendance	☒ Yes (75% minimum of presence) ☐ No
Course unit contents	The course addresses various aspects of fluid dynamics, focusing on the analysis of the transition to turbulence and flow stability. It begins with an introduction to the transition to turbulence, a key phenomenon in fluid dynamics, and then examines linear stability through analytical tools. The stability of plane-parallel flows, both uniform and stratified, is analyzed, with particular attention to the Orr-Sommerfeld equation. The solutions of the Orr-Sommerfeld equation are explored in depth, both for ideal and stratified flows, and general criteria for the stability of stratified flows are introduced under the assumption of a perfect fluid. The course includes practical examples of linear and weakly nonlinear stability analysis applied to a model problem, as well as considerations of stability in morphodynamics. Additionally, the course explores low and high Reynolds number flows. In particular, the Stokes equations are studied, with the Stokes and Oseen solutions for flow around a sphere. The course covers the flow potential and stream function, with the resolution of the Laplace equation using the method of conformal mappings.
Learning goals	The learning objectives of the course aim to develop an advanced understanding of transition and turbulence phenomena, and to gain in-depth knowledge of transition mechanisms and their implications in fluid dynamics. Furthermore, students will acquire specific skills to enhance their critical analysis of fluid system stability, both through mathematical models and analytical methods. In this way, candidates will develop problem-solving abilities and practical application of theories, allowing them to translate theoretical concepts into real-world applications.

Teaching methods	Lectures with continuous interaction between and with students and the development of group work.
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	Discussion of project work
Suggested readings	Lanzoni, S. 2010. Advanced Fluid Mechanics
Additional information	---