## *International Doctorate in Civil and Environmental Engineering*
*DOCTORAL COURSE*

# Fundamental of Fluid Mechanics

Teachers: Prof. **Federico Domenichini -** Prof. **Luca Solari**

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| Calendar | |
|---|---|
| 01/04/2022- 11,00-13,00 | Solari (2 hours) |
| 05/04/2022- 17,00-19,00 | Solari (2 hours) |
| 08/04/2022 - 11,00-13,00 | Solari (2 hours) |
| 12/04/2022 - 17,00-19,00 | Solari (2 hours) |
| 14/04/2022 - 17,00-19,00 | Solari (2 hours) |
| 20/04/2022 – 14:30-18,30 | Domenichini (4 hours) |
| 21/04/2022 - 9,00-13,00 | Domenichini (4 hours) |
| 21/04/2022 - 15,00-17,00 | Domenichini (2 hours) |
| *Total* | 20 hours – 10 credits |

| Program |
|---|
| The aim of the lectures is to give an introduction to fluid mechanics. Basic definitions about fluid dynamics are recalled. Afterwards, the mathematical definition of kinematics and dynamics of fluids is developed in a rigorous manner. |

Fluid properties. Lagrangian and Eulerian approaches. The time derivatives. Flow descriptions. Some basic integral-differential identities. Integral and differential laws of conservation of mass, momentum, angular momentum, kinetic energy. Reynolds transport theorem. Kinematic boundary conditions. Cauchy's hypothesis and law. Dynamic boundary conditions. The influence of the surface tension. Euler approximation (inviscid flows). Stokes fluids and Newtonian ones. The Navier Stokes equations. Analytical and approximate solutions. Low Reynolds number flows (creeping flows). Vorticity definition and dynamics, incompressible and barotropic flows. Circulation, definition and equations. Helmholtz theorems. Irrotational flows. Biot-Savart law. Singularity in the vorticity distribution. Image vorticity. Effect of viscosity (Lamb-Oseen, Burger's solution). The boundary layer concept. Solutions of the Navier Stokes equations (Rayleigh, Stokes, Couette). Prandtl's approximation. The separation of the boundary-layer, experimental evidences. Examples.

Material (slides, books) will be available in the institutional repository of the course

The course will be approved after an oral examination of the students based on the description and discussion of a paper in a peer-reviewed journal agreed in advanced with the teachers.

Examination Committee: Professors Domenichini, Francalanci, Solari.