# Fundamental of Fluid Mechanics

## Professors

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## Institution

Dpt. Civil and Environmental Engineering, University of Florence

## General Information

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. Wave motion, linear wave theory (Airy solution). Wave transformation from deep- to shallow- waters (shoaling, refraction, breaking). 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.

## Materials

Material (slides, books) will be available in the institutional repository of the course, upload is in progress.

[Didattica INDICEE - Google Drive](#)

**https://drive.google.com/drive/folders/1Kcq4TTa3SPycY8g7lg1vEAFdDhG6HMAK?usp=share_link**

## Schedule

| Dates | Teacher | Classroom/link | Topic |
|---|---|---|---|
| **20 March 2025 – 17:00-19:00** | Solari | https://meet.google.com/ktk-zwwz-hzb | Kinematics |
| **24 March 2025 – 17:00-19:00** | Solari | https://meet.google.com/ktk-zwwz-hzb | Dynamics |
| **27 March 2025 – 17:00-19:00** | Solari | https://meet.google.com/ktk-zwwz-hzb | Navier-Stokes equations |
| **31 March 2025 – 17:00-19:00** | Solari | https://meet.google.com/ktk-zwwz-hzb | Dimensionless equations |
| **03 April 2025 – 17:00-19:00** | Solari | https://meet.google.com/ktk-zwwz-hzb | Stokes I and II, Couette flow |
| **04 April 2025 – 17:00-19:00** | Domenichini | https://meet.google.com/mai-yonj-zvd | Vorticity dynamics |
| **07 April 2025 – 17:00-19:00** | Domenichini | https://meet.google.com/mai-yonj-zvd | Irrotational flows |
| **10 April 2025 – 17:00-19:00** | Domenichini | https://meet.google.com/mai-yonj-zvd | Irrotational flows |
| **11 April 2025 – 17:00-19:00** | Domenichini | https://meet.google.com/mai-yonj-zvd | Low Reynolds number flows |
| **14 April 2025 – 17:00-19:00** | Domenichini | https://meet.google.com/mai-yonj-zvd | Boundary-layer |
| **17 April 2025 – 15:00-17:00** | Cappietti | https://meet.google.com/icz-ztso-mtw | Wave motion, linear wave theory (Airy solution) |
| **23 April 2025 – 15:00-17:00** | Cappietti | https://meet.google.com/icz-ztso-mtw | Wave transformation from deep- to shallow-waters (shoaling, refraction, breaking) |
| | | | **Total 24 Hours - 12 Credits** |

## Other information

The course is held both **in presence** (room '*Aula riunioni*' at the Dept. of Civil and Environmental Engineering, School of Engineering, Via di Santa Marta 3, Firenze, first floor, east wing) and **online** (google meet, links are given in the table)

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 Cappietti, Domenichini, Francalanci, Solari.

*International Doctorate in Civil and Environmental Engineering*