

Fundamental of Fluid Mechanics

Professors

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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.

https://drive.google.com/drive/folders/1iqOPwYfa7nLxUK0_EkbzYgWKCE2O0Q1R

Schedule

Dates	Teacher	Classroom/link	Topic
05 March 2024 – 17:00-19:00	Solari	https://meet.google.com/ktk-zwwz-hzb	Kinematics
07 March 2024 – 17:00-19:00	Solari	https://meet.google.com/ktk-zwwz-hzb	Dynamics

Dates	Teacher	Classroom/link	Topic
12 March 2024 – 17:00-19:00	Solari	https://meet.google.com/ktk-zwwz-hzb	Navier-Stokes equations
14 March 2024 – 17:00-19:00	Solari	https://meet.google.com/ktk-zwwz-hzb	Dimensionless equations
19 March 2024 – 17:00-19:00	Solari	https://meet.google.com/ktk-zwwz-hzb	Stokes I and II, Couette flow
22 March 2024 – 15:00-17:00	Domenichini	https://meet.google.com/gyr-bhri-ohp	Vorticity dynamics
25 March 2024 – 15:00-17:00	Domenichini	https://meet.google.com/gyr-bhri-ohp	Irrotational flows
29 March 2024 – 15:00-17:00	Domenichini	https://meet.google.com/gyr-bhri-ohp	Irrotational flows
05 April 2024 – 15:00-17:00	Domenichini	https://meet.google.com/gyr-bhri-ohp	Low Reynolds number flows
09 April 2024 – 15:00-17:00	Domenichini	https://meet.google.com/gyr-bhri-ohp	Boundary layer
17 April 2023 – 15:00-17:00	Cappietti	https://meet.google.com/zkg-cjye-yyo	Wave motion, linear wave theory (Airy solution)
18 April 2023 – 15:00-17:00	Cappietti	https://meet.google.com/zkg-cjye-yyo	Wave transformation from deep- to shallow-waters (shoaling, refraction, breaking)
			Total 24 Hours - 4 Credits

Other information

Location: School of Engineering, Via di S. Marta 3, Firenze. The classrooms will be announced according to their availability.

The lectures can be also followed on-line, 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, Simonetti, Solari.