Professors: Francesco Ballio
Stefano Malavasi

POLITECNICO DI MILANO

Fluid Labs (10cfu)

Numerical Fluid Lab (6cfu)

A.Y.2014-2015

Master Degrees in Mathematical and Civil Engineering

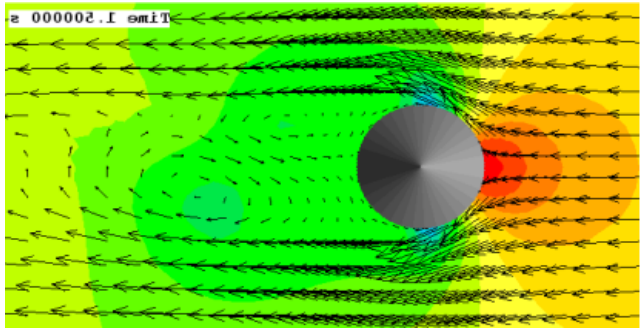
Topics of the course

Fluid Labs

Numerical Fluid Lab

Basic concepts

Differential and integral forms of the continuty equation
State of stress
Differential form of the momentum equation
Introduction to numerical schemes
Introduction to experimental methods

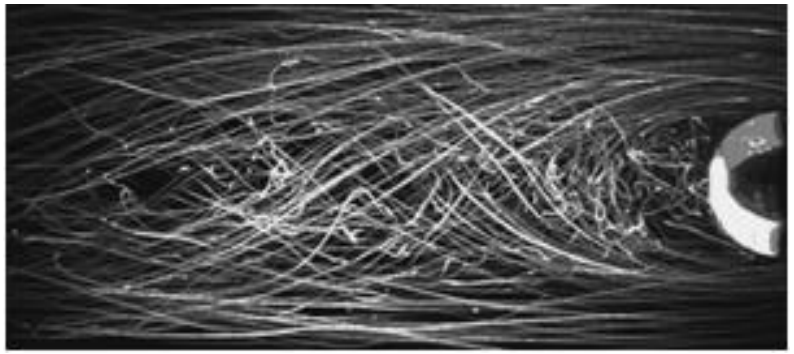


Laminar flows

Fluid kinematics
Constitutive equations of Newtonian fluids
Navier-Stokes Equations (NSE)
Euler Equations (EE)
Integral forms of the NSE and the EE
Bernoulli theorem, head losses
First principle of thermodynamics
Benchmark cases (internal/external flows)

Turbulent flows

Introduction to turbulence
Differential and integral forms of the Reynolds equations
First principle of thermodynamics
Wall functions (boundary layer)
Drag and lift forces
Benchmark cases (internal/external flows)



The logical structure

Physical phenomena and levels of complexity

Laminar/turbulent flows

2D / 3D

Steady/unsteady

Hydraulically smooth/rough walls

Approaches

theoretical

numerical

experimental

Benchmark cases

Internal flows (channel, pipe)

External flows (bluff bodies)

Learning goals and objectives

- Analysis and phenomenological interpretation
- Problem solving
- Engineering approach

Course organization

Fluid Labs

Numerical Fluid Lab

Frontal lessons

- Fluid mechanics theory
- Introduction to the CFD code used
- Introduction to the experimental methods used

Num. Labs

- CFD theory
- Numerical methods
- CFD benchmark cases

Experimental Labs
(Fantoli Lab)

- Team experimental projects (5-10 people per team)
- Discussion / collective demonstrations (groups of 10 people)

Students' proposals regarding the topic of their projects will be taken into consideration.

Num. report
(by each student)

- Analysis of channel flow data
- Comparison with numerical models
- Benchmark cases

Exp. report
(by each team)

- Results of the experimental projects

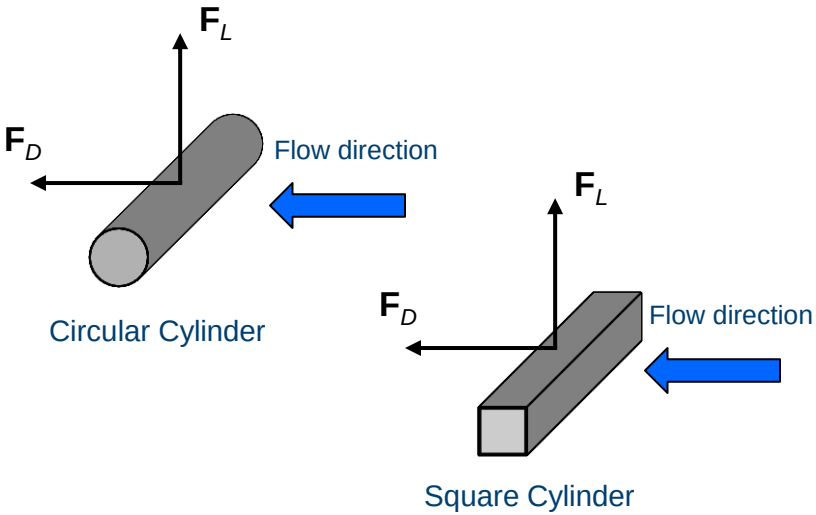
CFD Project
(by groups of up to 3 student)

- **Numerical**
- *(Experimental)*
- *Mixed*

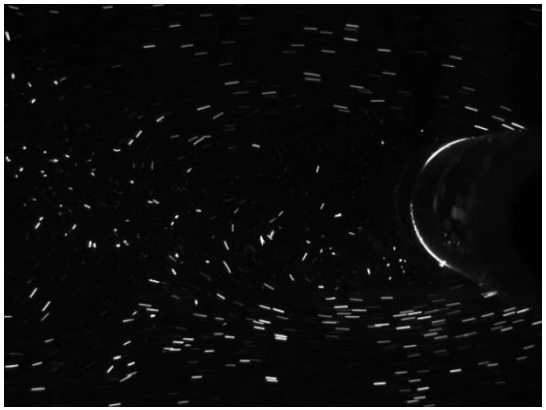
Oral exam (Theory and Reports + presentation of the project)

Experimental Projects

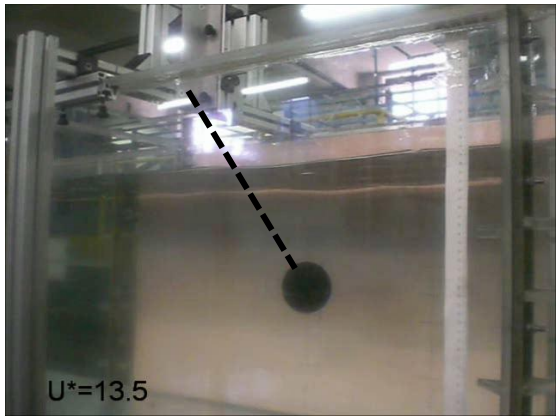
One-dimensional flows on smoothed and rough surfaces (1 team)



Dynamic analysis of cylinders exposed to uniform flow (1 team)



Kinematic analysis of flow downstream cylinders exposed to uniform flow (1 team)



Flow induced vibrations on a sphere (1 team)

Useful information:

Lecturer: **Francesco Ballio** - ph. 02 2399 6236 e-mail: francesco.ballio@polimi.it

Lecturer : **Stefano Malavasi** - ph. 02 2399 6261 e-mail: stefano.malavasi@polimi.it

Reference website : Beep webpage and teachers' webpages

Exam mode : oral (theory and reports + presentation of the project)

Consulting hours: Tuesday on 14:30 -15:30 (preferably by appointment)

Reference's book : Cengel e Cimbala, Fluid Mechanics – Fundamentals and Applications, McGraw-Hill + lecture notes

Time schedule		
Monday	CE3	12.15-15.15 (3 hours)
Wednesday	S15	12.15-14.15 (2 hours)
Thursday	S15	13.15-14.15 (1 hour)
Friday	S14	13.15-18.15 (5 hours)