# Laurea Magistrale
# Atmospheric Science and Technology (LMAST)

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| **SUBJECT TITLE** | Fundamentals of Fluid Mechanics |
| **TEACHER NAME(S)** | Giovanni Cannata |
| *Teacher e-mail (s)* | giovanni.cannata@uniroma1.it |
| *Teacher phone* | +390644585062 |
| *Teacher meeting* | Tuesday *h 10.00-12.00* |
| *Teacher office address* | Via Eudossiana 18, Rome. Building D, second floor, room 12 (S.Peter in chains site) |
| **DISCIPLINE (SSD)** | ICAR/01 |
| *Semester (1-4)* | 1 (first), Rome |
| *Credits (CFU/ECTS)* | 6 |
| *Lecture hours (h)* | *60 (45 Lectures + 15 exercise)* |
| *Prerequisite and learning activity* | Physics, Algebra |
| *Teaching language and method* | English, Lectures and exercises |
| *Assessment method* | Oral examination |
| **SUBJECT WEBSITE** | https://www.dicea.uniroma1.it/user/106/ |

**OBJECTIVES**

Main goals are to provide the student with:
- the foundations of fluid mechanics;
- basic concepts of fluid flow dynamics;
- basic concepts of mass, momentum and energy conservation in fluid flows;
- an introduction to turbulence and turbulence models

**OUTCOMES (Dublin descriptors: knowledge, understanding, explain, skill, ability)**

After the successful completion of this module, the student should be able to:
- know the fundamental concepts of fluid mechanics including: continuum, velocity field; viscosity, surface tension and pressure (absolute and gage); flow visualization using timelines, pathlines, streaklines, and streamlines; flow regimes: laminar, turbulent and transitional flows; compressibility and incompressibility; viscous and inviscid;
- use of conservation laws in integral and differential forms and apply them to determine velocities, pressures and acceleration in a moving fluid;
- understand the kinematics of fluid particles, including the concepts of substantive derivatives, local and convective accelerations, vorticity and circulation;
- use Euler's and Bernoulli's equations and the conservation of mass to determine velocities, pressures, and accelerations for incompressible and inviscid fluids

**PROGRAM CONTENT**

BASIC CONSIDERATIONS.
Dimensions, Units and physical quantities. fluid properties.
Continuum hypothesis. Local and material derivatives.
CONSERVATION LAWS IN FLUID MECHANICS. Integral and differential forms of conservation laws in fluid mechanics. Reynolds transport theorem. Mass conservation equation. Momentum balance equation. Stress tensor. Equations of motion.
KINEMATICS. Strain rate tensor. Acceleration. Lagrangian and Eulerian Descriptions of Motion. Pathlines, Streaklines and Streamlines. Stokes Potentials. Stream function. Vorticity.
FLUID STATICS.
The mechanical equations of fluid statics. Equilibrium in geopotential field.
IDEAL FLUID DYNAMICS
Mechanical equations in ideal fluids. Bernoulli's theorem.
VISCOUS FLOW DYANMICS.
The stress tensor in viscous flows. Constitutive equation for a Newtonian fluid. The Navier-Stokes equations.
INTRODUCTION TO TURBULENCE.
Reynolds averaging. Mechanical equations of the mean flow. Reynolds stress tensor Turbulence closure relations.

**REFERENCES AND MATERIAL**

Kundu P.K, Cohen I.M, Dowling D.R. Fluid Mechanics, fifth edition. Elsevier 2012.