

# AEROSPACE ENGINEERING (LM52)

(Brindisi - Università degli Studi)

## Insegnamento FLUID DYNAMICS (MOD. 1) C.I.

GenCod A005143

Docente titolare Mario DI RENZO

**Insegnamento** FLUID DYNAMICS (MOD. 1) C.I. **Anno di corso** 1

**Insegnamento in inglese** FLUID DYNAMICS (MOD. 1)C.I.

**Lingua**

**Settore disciplinare** ING-IND/06

**Percorso** CURRICULUM AEROSPACE DESIGN

**Corso di studi di riferimento** AEROSPACE ENGINEERING

**Tipo corso di studi** Laurea Magistrale

**Sede** Brindisi

**Crediti** 6.0

**Periodo**

**Ripartizione oraria** Ore Attività frontale: 54.0 **Tipo esame** Orale

**Per immatricolati nel** 2022/2023

**Valutazione**

**Erogato nel** 2022/2023

**Orario dell'insegnamento**

<https://easyroom.unisalento.it/Orario>

### BREVE DESCRIZIONE DEL CORSO

The course provides the basic tools to understand the motion of a fluid. The conservation equations that describe the dynamics of a fluid are analyzed in the case of inviscid and viscous flows. During this process, a description of the main fluid properties is provided as well as the continuum assumption and the definition of Eulerian and Lagrangian frames of reference. The derived equations are used in order to describe the motion of fluid in canonical configurations such as the Poiseuille flow (flow between flat plates), the Couette flow (flow between flat plates in relative motion), and the Hagen-Poiseuille flow (flow inside a pipe). The forces exchanged between the fluid and an immersed body are analyzed by means of the potential flow theory and boundary layer theory. During this course, the Buckingham PI theorem will be applied to canonical flows in order to derive a dimensionless description of the dynamics of the fluid. An outline about the main phenomena involving turbulence will also be provided.

### PREREQUISITI

Knowledge of calculus (derivatives and integrals), algebra (basic vector and tensor operations), dynamics of a rigid body and thermodynamics.

### OBIETTIVI FORMATIVI

After the course, a student should know:

- the main properties of a fluid;
- the basic equations that describe the static, kinematics and dynamics of a fluid;
- the principal physical phenomena involved in the motion of a fluid;
- the main interactions between a fluid and an immersed body.

### METODI DIDATTICI

54 hours of lecture

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## MODALITA' D'ESAME

The exam consists of a written and an oral test.

During the written test, students have two hours to solve two or three problems about the topics analyzed during the course.

Students will be admitted to the oral test upon successful completion of the written test. Knowledge about the main theoretical aspects of the course will be assessed during this second part of the exam.

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## PROGRAMMA ESTESO

Recap of basic knowledge: definitions of a scalar, vector, tensor, divergence operator, gradient operator, curl operator, divergence, and Stokes theorems (1.5 hours).

Properties of a fluid: definition of a fluid, continuum hypothesis, density and thermal expansion, compressibility, viscosity, vapor tension, surface tension, and capillary action (1.5 hours).

Statics of a fluid: pressure distribution in a steady fluid, standard atmosphere, pressure forces on a flat and curved surface, buoyancy, stability of a buoyant body, pressure gauges (6 hours).

Kinematic of a fluid: Lagrangian and Eulerian frames of reference, definitions of pathlines, streamlines and streaklines, material derivative, e. Local flow analysis: simplified two-dimensional case, general three-dimensional case (3 hours).

Dynamic of a fluid: Reynolds transport theorem; integral and differential form of the conservation equations for mass, momentum, and total energy; stress tensor; constitutive relations; Navier–Stokes equations; several expressions of the energy conservation equation (12 hours). Bernoulli Equation: the second law of the dynamics for an ideal fluid, the Bernoulli equation, the Crocco theorem, the Pitot tube, the Venturi tube (3 hours).

Potential flow theory: Kelvin and Helmholtz theorems, two-dimensional potential flows (uniform flow; source/sink; vortex, doublet), superposition of simple flows, flow past a circular cylinder without and with circulation (9 hours).

Exact solutions of the Navier–Stokes equations: flow between two parallel flat plates, the Couette flow, the Hagen–Poiseuille flow (3 hours).

Boundary layer theory: Boundary-layer equations, integral equations, and approximate solutions (7 hours).

Turbulence: description of the phenomenon, a short overview of the Reynolds equations (6 hours).

Dimensional analysis and similitude: Buckingham PI theorem, dimensional analysis, dynamic similarity, particular flow classes (immersed bodies; with a free surface) (2 ore).

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## TESTI DI RIFERIMENTO

[1] Irving H. Shames, Mechanics of Fluids, McGraw-Hill International editions

[2] Barnes W. McCormick, Aerodynamics, Aeronautics and Flight Mechanics, Wiley.