# 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.

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

**Settore disciplinare** ING-IND/06

**Corso di studi di riferimento** AEROSPACE ENGINEERING

**Tipo corso di studi** Laurea Magistrale

**Crediti** 6.0

**Ripartizione oraria** Ore Attività frontale: 54.0

**Per immatricolati nel** 2024/2025

**Erogato nel** 2024/2025

**Anno di corso** 1

**Lingua**

**Percorso** AERONAUTICS DESIGN

**Sede** Brindisi

**Periodo** Primo Semestre

**Tipo esame** Orale

**Valutazione**

**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 Poisseuille flow (flow between flat plates), the Couette flow (flow between flat plates in relative motion), and the Hagen-Poisseuille flow (flow inside a pipe). The viscous forces exchanged between the fluid and an immersed body are analyzed by means of boundary layer theory. Elements of the gas dynamics in one and two dimensions are discussed with applications to convergent divergent nozzles. Moreover, during this course, the Buckingam PI theorem will be applied to canonical flows in order to derive a dimensionless description of the dynamics of the fluid.

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.<br>During the written test, students have two hours to solve two or three problems about the topics analyzed during the course.<br>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. |
| PROGRAMMA ESTESO | Recap of basic knowledge: definitions of a scalar, vector, tensor, divergence operator, gradient operator, curl operator, divergence, and Stokes theorems (1 hour).<br>Properties of a fluid: definition of a fluid, continuum hypothesis, density and thermal expansion, compressibility, viscosity, vapor tension, surface tension, and capillary action (2 hours).<br>Statics of a fluid: pressure distribution in a fluid without shear stress, standard atmosphere, pressure forces on a flat and curved surface, buoyancy, stability of a buoyant body, pressure gauges (6 hours).<br>Fluid kinematics: 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).<br>Fluid dynamics: 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).<br>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).<br>Exact solutions of the Navier-Stokes equations: flow between two parallel flat plates, the Couette flow, the Hagen–Poiseuille flow (3 hours).<br>Boundary layer theory: Boundary-layer equations, integral equations, and approximate solutions (10 hours).<br>Steady quasi-one-dimensional flow: general properties of quasi-one dimensional flows, total and critical quantities, area-velocity relation, mass flux, shock waves and Rankine–Hugoniot relations, convergent nozzles, convergent-divergent nozzles (7 hours)<br>Elements of Two-dimensional gas dynamics: oblique shocks, Prandtl-Meyer expansions, interactions between different waves flow past a convergent-divergent nozzle (5 hours) Dimensional analysis and similitude: Buckingham PI theorem, dimensional analysis, dynamic similarity, particular flow classes (immersed bodies; with a free surface) (2 hours). |
| TESTI DI RIFERIMENTO | [1] Irving H. Shames, Mechanics of Fluids, McGraw-Hill International editions<br>[2] Barnes W. McCormick, Aerodynamics, Aeronautics and Flight Mechanics, Wiley. |