# AEROSPACE ENGINEERING (LM52R)

(Brindisi - Università degli Studi)

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

GenCod A009175

**Docente titolare** Mario DI RENZO

**Docenti responsabili dell'erogazione** Mario Di Renzo, DONATELLA PASSIATORE

**Insegnamento** GAS DYNAMICS (MOD.1) C.I.

**Anno di corso** 1

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

**Lingua**

**Settore disciplinare** IIND-01/F

**Percorso** AERONAUTICS DESIGN

**Corso di studi di riferimento** AEROSPACE ENGINEERING

**Tipo corso di studi** Laurea Magistrale

**Sede** Brindisi

**Crediti** 6.0

**Periodo** Primo Semestre

**Ripartizione oraria** Ore Attività frontale: 54.0

**Tipo esame** Orale

**Per immatricolati nel** 2026/2027

**Valutazione**

**Erogato nel** 2026/2027

Vai a **Orario dell'insegnamento**

### BREVE DESCRIZIONE DEL CORSO

The course provides the basic tools to understand the motion of a gas. 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 gas in canonical configurations such as convergent nozzles, convergent-divergent nozzles. The viscous forces exchanged between the fluid and an immersed body are analyzed by means of boundary layer theory.

### 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 be familiarized with:
- the main properties of a fluid;
- the basic equations that describe the static, kinematics, and dynamics of a fluid;
- the evolution of quasi one-dimensional isoentropic and non-isoentropic flows, including normal shocks;
- the phenomena involved two-dimensional compressible flows, including oblique shocks and Prandtl-Meyer expansions;
- the behavior of laminar boundary layers in compressible and incompressible regimes

### METODI DIDATTICI

54 hours of lecture

### 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 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, pressure gauges (3 hours).<br>Fluid kinematics: Lagrangian and Eulerian frames of reference, definitions of pathlines, streamlines, and streaklines, and material derivative. 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 (10 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>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 (10 hours)<br>Two-dimensional gas dynamics: oblique shocks, Prandtl-Meyer expansions, shock polars, interactions between different waves, bow shocks, isentropic compressions and expansions, flow past a convergent-divergent nozzle, shock-expansion theory, thin-airfoil theory (10 hours)<br>Dimensional analysis and similitude: Buckingham PI theorem, dimensional analysis, dynamic similarity, particular flow classes (immersed bodies; with a free surface) (2 hours).<br>Boundary layer theory: Boundary-layer equations, integral equations, and approximate solutions (10 hours). |
| TESTI DI RIFERIMENTO | Anderson, John David. **Fundamentals of Aerodynamics.** Fifth edition. McGraw-Hill, 2010.<br>Anderson, John David. **Modern compressible flow: with historical perspective.** Fourth edition. McGraw-Hill, 2020. |