AEROSPACE ENGINEERING (LM52R)

(Brindisi - Università degli Studi)

Teaching AERODYNAMICS (MOD.1) C.I.

GenCod A005137

Owner professor Mario DI RENZO

Teaching in italian AERODYNAMICS (MOD.1) C.I.

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SSD code ING-IND/06

Reference course AEROSPACE ENGINEERING

Course type Laurea Magistrale

Credits 6.0

Teaching hours Front activity hours: 54.0

For enrolled in 2025/2026

Taught in 2025/2026

Course year 1

Language

Curriculum SPACE TECHNOLOGY

Location Brindisi

Semester Second Semester

Exam type Oral

Assessment

Open **Course timetable**

BRIEF COURSE DESCRIPTION

The course aims at providing future aerospace engineers with basic knowledge of aerodynamics. .
The first part of the course deals with the description of irrotational flows. The potential flow theory will be presented and applied to canonical flows using the conformal mapping technique.
The course will continue with the description of the forces generated by an airfoil will be studied using the thin-airfoil theory and panel methods.
Moreover, effects of finite wing span will be considered.
Finally compressibility effects will be considered using the linearized flow theory.

REQUIREMENTS

Knowledge of calculus (derivatives and integrals), algebra (basic vector and tensor operations), dynamics of a rigid body, thermodynamics, and fluid dynamics (properties of a fluid, substantial derivative, Reynolds transport theorem, conservation equation of mass, momentum, and energy).

COURSE AIMS

At the end of this course, students in aerospace engineers should have a good knowledge of:
- basic principles of two-dimensional potential flow theory;
- the behavior of at thin airfoil in an incompressible flow
- the forces generated by a finite wing
- principles of linearized flow theory in subsonic as well as supersonic regimes.

TEACHING METHODOLOGY

54 hours of lecture

ASSESSMENT TYPE

Students will be asked to develop an individual project, which will ne discussed in an oral exam togheter with additional questions on the theoretical part of the program.

FULL SYLLABUS

- Recap of basic knowledge: conservation equation for a fluid, fluid properties (2 hours)
- Potential flow theory: Kelvin and Helmholtz theorems, irrotational acyclic and cyclic flows, analytic functions of complex variables, two-dimensional potential flows (uniform flow; source/sink; vortex, doublet), superposition of simple flows, conformal mapping, potential flow past a Joukowski airfoil (18 hours).
- Source panel methods: Derivation of the source panel method, Implementation of the source panel method in a Python code (5 hours)
- Flow over airfoils: airfoil nomenclature and characteristics, Thin airfoil theory (symmetric and cambered airfoil case), Numerical analysis of an airfoil using the thin airfoil theory (7 hours)
- Vortex Panel Numerical Method: Linear vortex panel method and its numerical implementation (4 hours)
- Flow over finite wings: downwash and induced drag, Vortex filament, Prandtl's Lifting-Line Theory, Numerical non-linear lifting line method (7 hours)
- Linearized flow theory: Linearized potential flow equations, linearized pressure coefficient, linear two-dimensional subsonic flow, compressibility corrections, critical Mach number, linear supersonic two-dimensional flow (5 hours)
- Basics of turbulence: Phenomenological description, Energy cascade in isotropic homogeneous turbulence; the Reynolds averaged Navier Stokes equations in incompressible and compressible regimes; Turbulent viscosity and mixing length. (6 hours)

REFERENCE TEXT BOOKS

Anderson, John David. **Fundamentals of Aerodynamics.** Fifth edition. McGraw-Hill, 2010.

Anderson, John David. **Modern compressible flow: with historical perspective.** Fourth edition. McGraw-Hill, 2020.