AEROSPACE ENGINEERING (LM52)

(Brindisi - Università degli Studi)

Teaching FLUID DYNAMICS (MOD. 1)C.I.

GenCod A005143

Owner professor Mario DI RENZO

Teaching in italian FLUID DYNAMICS (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 Ore-Attivita-frontale: 60.0

For enrolled in 2018/2019

Taught in 2018/2019

Course year 1

Language INGLESE

Curriculum AEROSPACE DESIGN

Location Brindisi

Semester Primo-Semestre

Exam type Orale

Assessment

Course timetable https://easyroom.unisalento.it/Orario

BRIEF COURSE DESCRIPTION

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 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 Buckingam 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.

REQUIREMENTS

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

COURSE AIMS

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.

TEACHING METHODOLOGY

54 hours of lecture

ASSESSMENT TYPE	The exam consists of a written test and an oral exam. During the written test, the student has two hours to solve two or three problems about the topics analyzed during the course. If the score in the first part of the exam is sufficient to pass, the student will be admitted to the oral exam where his knowledge about the main theoretical aspects of the course will be tested.
FULL SYLLABUS	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 path lines, 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: 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, irrotational acyclic and cyclic motions, two-dimensional potential flows (uniform flow; source/sink; vortex, doublet), superposition of simple flows, flow past a circular cylinder without and with circulation, analytic functions of complex variables, conformal mapping, potential flow past a Joukowski airfoil (12 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, short overview on the Reynolds equations (3 hours). Dimensional analysis and similitude: Buckingham PI theorem, dimensional analysis, dynamic similarity, study of particular classes of flows (immersed bodies; with a free surface) (2 ore).
REFERENCE TEXT BOOKS	[1] Irving H. Shames, Mechanics of Fluids, McGraw-Hill International editions [2] Barnes W. McCormick, Aerodynamics, Aeronautics and Flight Mechanics, Wiley.