UNIVERSITÀ DI PISA

FLUID DYNAMICS

FULVIO CORNOLTI

Anno accademico	2020/21
CdS	PHYSICS
Codice	289BB
CFU	6

Moduli	Settore/i	Tipo	Ore	Docente/i
FLUIDODINAMICA	FIS/03	LEZIONI	48	FRANCESCO CALIFANO FULVIO CORNOLTI WALTER DEL POZZO

Learning outcomes

Knowledge
Kinematics of continuous media, principles of constitutive equations of the dynamics of continuous media . Transport in simple and composite continuous media. Navier-Stokes equations. Applications to different fields of fluid dynamics: lift and drag, sound waves, gravity waves, non linear waves, simple waves, shocks, instabilities.

Assessment criteria of knowledge
Oral exam.

Skills

Acquisition of the mathematical tools typical of basic fluid dynamics and applocations to simple problems.

Assessment criteria of skills
Oral exam

Prerequisites
Complex analysis,multidimensional analysis, differential operators, tensorial calculus.

Syllabus
The concept of fluid element, limits due to granularity of matter: diffusion. Thermodynamic description of surface forces. LTE hipothesis and its limits.
Kinematics of continous media as one parameter maps of the space in itself. The Jacobian and volume variations. Lagrangean and Eulerian represetation of fluid variables. Velocity in eulerian representation, tensor of infinitesimal deformations. Time derivatives of integrals on moving domains. volumes, surfaces and lines. Material derivative. Transport of intensive quantities. Mass and momentum transport for simple, composit with external sources. Macroscopic mass and momentum diffusion. link tu microscopic transport. Microscopic interpretation of mass and momentum transport. Examples.
Transport of kinetic and internal energy. Entropy transport in irreversible processes: matter, momentum and heat fluxes.
Euler equation for ideal fluids in external potential.Equilibrium in static fluids: stratification of thermodynamic quantities.
Fluid dynamics in isoentropic approximation.Vorticity and its transport in ideal fluids. Beroulli function, and Bernoulli theorem in different configurations.
Time derivative of surfale and line intehrals on moving domaains. Thomson and Kelvin theorem on velocity circuletion. Helmoltz theorems about vorticity.
2D ideal incompressible fluid dynamics The complex potential, Blasius and Kutta- Joukowsky theorems on lift and drag. Conformal mapping and calculus of lift and drag on symmetrical wings.
Motions and stabiòlity of linear vortices.
Viscous fluid, Couchy tensor, Navier- Stokes equations for incompressible fluids. Boundary layer separation in Prantl theory. Application to symmetric wings.Waves in fluids: sound in homogeneous media, dissipative decay; nonlinear effects: frequency doublng, many waves interaction, Manley-Rowe relations for three wave dacay. Wave breaking. Simple waves, dissipative and dispersive solitons.
Shock wave, Hugoniot adiabat, burning shocks and detonation shocks. Waves in inhomogeneous media: cutoff and resonance.

Serface waves, Kelvin-Helmoltz and Rayleigh-Taylor instabilities.
Waves in shallow water. Applications.

Bibliography

Notes of the lactures by the teacher (on demand).
Mechanics of continuous media , Landau and Lifchitz

Assessment methods

oral exam

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