UNIVERSITÀ DI PAVIA

Anno Accademico 2019/2020

FLUID MECHANICS

Enrollment year	2019/2020
Academic year	2019/2020
Regulations	DM270
Academic discipline	ICAR/01 (HYDRAULICS)
Department	DEPARTMENT OF CIVIL ENGINEERING AND ARCHITECTURE
Course	ENVIRONMENTAL ENGINEERING
Curriculum	PERCORSO COMUNE
Year of study	1°
Period	1st semester (30/09/2019 - 20/01/2020)
ECTS	6
Lesson hours	48 lesson hours
Language	Italian
Activity type	WRITTEN AND ORAL TEST
Teacher	MANENTI SAURO (titolare) - 6 ECTS
Prerequisites	Basics of vector and tensor algebra. Mathematical foundations. Integral theorems (Stokes and Gauss).
Learning outcomes	At the end of the Course, the student will acquire the fundamental theoretical concepts and mathematical tools for the computer analysis of relevant problems in the hydraulic engineering field, such as: free surface water waves, filtration flows in porous media, transient flows, stationary hydrodynamic forces on surfaces.
Course contents	Review of mathematical foundations: vector and tensor algebra; coordinate systems; Stokes theorem and Gauss theorem. Analysis of stress: the continuum concept; Cauchy stress principle; stress tensor; principal stress; deviator and spherical stress tensor. Deformation and strain: Lagrangian and Eulerian description; small deformation theory; strain tensor; principal strains; spherical and

	deviator strain tensor; plane strain; compatibility equations; velocity gradient tensor; rate of deformation tensor; vorticity tensor. Fundamental laws of continuum mechanics: mass conservation - continuity equation; Reynolds transport theorem; linear momentum conservation; angular momentum conservation; energy conservation. Constitutive equations: Newtonian fluid. Navier-Stokes equations; special cases: perfect fluid; Euler and Bernoulli equations; Kelvin theorem. Global momentum equation. Filtration flows in porous media. Analogy with heat conduction in solids. Common non-Newtonian rheological models. Viscous fluid dampers for vibration control. Small amplitude wave theory: solution of the linearized boundary value problem (BVP); dispersion equation; water particle kinematics and trajectories; pressure field; energy of the wave field; wave propagation on cylindrical bathymetry; mild slope conditions; shoaling and refraction. Spectral wave models and applications.
Teaching methods	Lectures and practical classes
Reccomended or required readings	Aris R. "Vectors, tensors, and the basic equations of fluid mechanics" 1990 Dover pub ISBN-10: 0486661105. Chou P.C. & Pagano N.J. "Elasticity, tensor, dyadic, and engineering approaches" 1992 Dover pub ISBN-13: 978-0486669588. Citrini D., Noseda D. "Idraulica" CEA, Milano 1987 Dean R.G. & Darlymple R.A. "Water wave mechanics for engineers and scientists" 1991 World Scientific ISBN: 978-981-02-0421-1. De Girolamo P., Franco L., Noli A. "Fondamenti di oceanografia e idraulica marittima per ingegneri", dispense del corso (in Italian). Ghetti A. "Idraulica" Libreria int. Cortina - Padova 2004. Prager W. "Introduction to mechanics of continua" Ginn and Co. 1961 Wilkinson W.L. "Non-Newtonian fluids" 1960 Pergamon Press.
Assessment methods	Oral exam on problems proposed during practical classes, with discussion of related theoretical aspects.
Further information	Lecture notes can be downloaded from the course page on the platform KIRO (https://elearning2.unipv.it/ingegneria/)
Sustainable development goals - Agenda 2030	$lbl_legenda_sviluppo_sostenibile