UNIVERSITÀ DI PAVIA

Anno Accademico 2021/2022

CONTINUUM MECHANICS

Anno immatricolazione	2021/2022
Anno offerta	2021/2022
Normativa	DM270
SSD	ICAR/01 (IDRAULICA)
Dipartimento	DIPARTIMENTO DI INGEGNERIA CIVILE E ARCHITETTURA
Corso di studio	CIVIL ENGINEERING FOR MITIGATION OF RISK FROM NATURAL HAZARDS
Curriculum	Hydrogeological risk assessment and mitigation
Anno di corso	1°
Periodo didattico	Primo Semestre (20/09/2021 - 13/10/2021)
Crediti	6
Ore	48 ore di attività frontale
Lingua insegnamento	English
Tipo esame	ORALE
Docente	MANENTI SAURO (titolare) - 6 CFU
Prerequisiti	Basics of vector, matrix and tensor algebra. Mathematical foundations: vector and tensor fields; differential operators; differential of a scalar valued function of vector variable. Integral theorems of Stokes and Gauss.
Obiettivi formativi	The course will provide the fundamental theoretical concepts and mathematical tools for the analysis of Continuum Mechanics problems. These concepts and tools will be applied for computer analysis and solution of basic problems, involving: heat conduction and thermal induced stresses in massive concrete structures; filtration flow in porous medium and static equilibrium of hydraulic structures; viscous fluid damper as structural passive control device.
Programma e contenuti	Review of vector, tensor and matrix algebra; coordinate systems; fundamental integral theorems. The continuum postulate.

	Analysis of stress: Cauchy stress principle; normal and shear stress components; static equilibrium of finite continuum, static equilibrium equation and symmetry of stress tensor; deviator and spherical stress tensors. Outline of Mohr's representation for the state of stress. Local deformation and strain: material and spatial coordinate systems; displacement gradient tensor, small deformation theory, linear strain and rotation tensors; Saint-Venant compatibility equations; Lagrangian and Eulerian description of flow, material derivative; velocity gradient tensor, rate of deformation tensor and vorticity tensor. Reynolds transport theorem. Fundamental laws of Continuum Mechanics: mass conservation principle, continuity equation; linear momentum conservation principle, Cauchy equation of motion; angular momentum conservation principle; mechanical energy conservation principle; first principle of Thermodynamics, energy equation. Constitutive equations: generalized Hooke's law for the linear elastic solid continuum; Newtonian fluid, Stokes assumption. Governing equations of Fluid Mechanics: Navier-Stokes equation; Euler and Bernoulli equations; Laplace equation. Kelvin theorem. Viscosity of Newtonian fluids: basic concepts; flow curve. Non-Newtonian rheological models: apparent viscosity, shear thinning and shear thickening fluids. Applications to engineering problems: finite difference solution of 1D heat eq. for the analysis of thermal induced stresses in massive concrete; filtration flow in porous media; analytical and numerical modelling of annular viscous fluid damper as a passive energy dissipation system.
Metodi didattici	Lectures on: basics of vector, tensor and matrix algebra; fundamental concepts of Continuum Mechanics; compatibility equations; development and applications of general balance equations, constitutive equations for linear elastic solid and Newtonian fluid. Practical classes on: analytical/numerical solution of partial differential governing equations for practical problems in the field of fluid and solid mechanics.
Testi di riferimento	# Aris R. "Vectors, tensors, and the basic equations of fluid mechanics" 1990 Dover pub ISBN-10: 0486661105. # Bear J. & Buchlin J-M. "Modelling and Applications of Transport Phenomena in Porous Media" Springer Science+Business Media, B.V. 1991. ISBN 978-94-010-5163-7 # Chou P.C. & Pagano N.J. "Elasticity, tensor, dyadic, and engineering approaches" 1992 Dover pub ISBN-13: 978-0486669588. # Kundu P. K., Cohen I. M., Dowling D. R. "Fluid Mechanics" 6th Ed. 2016 Elsevier A.P. # Kundu P. K., Cohen I. M., Dowling D. R. "Fluid Mechanics" 6th Ed. 2016 Elsevier A.P. ISBN: 9780124059351. # Liu, G-R. and Liu, M.B. "Smoothed Particle Hydrodynamics: a Meshfree Particle Method". World Scientic, 2003. ISBN 981-238-456-1 # Prager W. "Introduction to Mechanics of Continua" Ginn and Co. 1961. # Wilkinson W.L. "Non-Newtonian Fluids". 1960 Pergamon Press. Lecture notes downloadable from https://elearning2.unipv.it/ingegneria/?lang=en.
Modalità verifica	The final examination will consist of an oral discussion, with the

apprendimento	possibility for each student to carry out in-depth analysis about a peculiar topic within the course contents
Altre informazioni	Lecture notes can be downloaded from the course page on the platform KIRO (https://elearning2.unipv.it/ingegneria/)
Obiettivi Agenda 2030 per lo sviluppo sostenibile	$lbl_legenda_sviluppo_sostenibile