Syllabus

Course Description

Course Title	Fluid Mechanics
Course Code	42149
Course Title Additional	
Scientific-Disciplinary Sector	ICAR/01
Language	German
Degree Course	Bachelor in Industrial and Mechanical Engineering
Other Degree Courses (Loaned)	
Lecturers	Prof. Michele Larcher, Michele.Larcher@unibz.it https://www.unibz.it/en/faculties/agricultural-environmental-food-sciences/academic-staff/person/33885
Teaching Assistant	
Semester	Second semester
Course Year/s	2
CP	6
Teaching Hours	36
Lab Hours	24
Individual Study Hours	90
Planned Office Hours	18
Contents Summary	The course will cover the following topics: • Fluid statics • Fluid kinematics • Fluid dynamics • Integral and differential conservation laws • Bernoulli equation and energy conservation law • Flows in ducts • Hydraulic measures.
Course Topics	Properties of Fluids: Density; dynamic and kinematic viscosity; Newtonian and non-Newtonian fluids; ideal fluid.

	Static Fluids: Pascal's principle; hydrostatic basic equation; communicating vessels; absolute and gauge pressure; liquid manometers (absolute and differential pressure measurement); surface tension; capillary pressure and Jurin's law. Pressure distribution and point of action of hydrostatic fluid forces against flat and curved walls; Archimedes' principle of buoyancy; floating (equilibrium and stability). Fluid Kinematics: Lagrangian perspective and trajectories; Eulerian perspective and streamlines; Lagrangian and Eulerian derivatives; volumetric flow rate; streamtube; Eulerian acceleration in a rectangular laboratory coordinate system; acceleration in an intrinsic coordinate system; transport theorem (or Reynolds theorem). Conservation of mass (analytical derivation); application of the mass conservation principle to a streamtube; differential form of the mass conservation equation; translation, rotation, and deformation of a fluid element. Fluid Dynamics: Conservation of momentum (analytical derivation of volume forces, surface forces, and inertial forces); rheology of Newtonian fluids. Navier-Stokes equations; dimensionless Navier-Stokes equations; dimensionless numbers; Euler equations in a rectangular laboratory coordinate system; Euler equations in an intrinsic coordinate system and related effects; application of Bernoulli's theorem to an airfoil and to the free-surface rise in open channels near a sluice gate; cavitation; Bernoulli's theorem for irrotational flow. Flow from Openings: Opening at the bottom of a container; vena contracta and contraction coefficient; small and large openings in the side wall; overflow (overflow with side contraction, trapezoidal overflow, and triangular overflow); sluice gate. Velocity Measurement Devices: Pitot tube; turbine wheel meter; hot-wire or hot-film anemometer; laser Doppler anemometer. Flow Measurement in Pipes: Orifice, nozzle, and Venturi meter; magnetic-inductive flow meters (MID). Energy Conservation Principle: Analytical derivation of the first law of thermodynamics; application to streamtubes; pipe without

	hydraulic machines (free flow); pipe with hydraulic machines (machine flow); head and useful power of a pump and a turbine; characteristic pump curves. Applications of the Momentum Conservation Principle: Hydrodynamic impact against walls; application to diffusers (gradual cross-section contractions); application to bends; oblique jet impact against a fixed flat wall; jet impact on a single blade; Pelton turbine. Laminar Flow: Flow between parallel plates (Couette flow and Poiseuille flow); laminar pipe flow; Navier-Stokes equations in a cylindrical coordinate system; velocity and volumetric flow rate; friction factor and Darcy-Weisbach equation. Turbulent Pipe Flow: Reynolds experiment and instability according to Prandtl; statistical method; mass conservation; Reynolds equations; closure problem, apparent viscosity, and Boussinesq's diffusion model; turbulence scales; wall turbulence; boundary layer development on a plate; mixing-length model. Uniform Pipe Flow: Rough and smooth walls; distribution of shear stress; hydraulic radius; internal region; external region; mean velocity and flow rate; resistance relationship and friction factor; Moody diagram; Colebrook & White equation; empirical formulas by Chezy-Tadini, Gauckler-Strickler, and Manning; local energy losses (boundary layer separation, sudden expansion, and Borda energy loss). Diffusers and contractions; energy losses due to changes in direction (elbow and curved pipe bend).
Keywords	Fluidmechanics, fluid statics, fluid dynamics, flow in pipes, hydraulic measures.
Recommended Prerequisites	Students regularly enrolled at the 2nd year of the Bachelor in Industrial and Mechanical Engineering. Other exceptional cases have to be discussed with the Professor.
Propaedeutic Courses	
Teaching Format	Fluidmechanik is a lecture course in which topics are presented by the Professor. Practical parts are explained by the Professor and during the exercise and lab hours the students will be requested to solve actively some guided exercises.

Mandatory Attendance	Core
Specific Educational Objectives and Learning Outcomes	Fluidmechanik is a core course within the bachelor in Industrial and Mechanical Engineering. The course consists of frontal lectures and hours of practical part. The lectures introduce the fundamental concepts of the fluid statics and dynamics. The practical part will describe the methods used for the solution of the fluid dynamics engineering problems. The fluid dynamics course is intended to give the students the basics to approach the analysis and the modelling of the fluid behaviour. The core of the course will be the study of the fluid statics and the dynamics of non- compressible fluids. By the end of the course, students should be able to: Knowledge and understanding: 1. show the equations and the main principles relevant to the mechanics of fluids; 2. develop an intuitive comprehension of fluid mechanics. Applying knowledge and understanding: 3. give examples of real applications and practical problems to underline how fluid mechanics is used in the engineering activity, as for example the functioning and the design of fluid machines. Making judgements: 4. the ability to make autonomous judgements in the choice of the suitable tools for the solution of problems involving the mechanics of fluids. Communication skills: 5. communication skills to correctly and properly present the concepts acquired in the course. Learning skills: 6. ability to autonomously extend the knowledge acquired during the study course by reading and understanding scientific and technical documentation.
Specific Educational Objectives and Learning Outcomes (additional info.)	
Assessment	The examination of the course consists in a written and an oral exam. The written (120 minutes) consists in two exercises about fluid statics and dynamics. The candidates are requested to apply the main principles and equations of fluid mechanics in order to

	solve technical problems and so show their ability in applying knowledge and understanding and making judgements (ILOs 1, 3, 4, 5). The oral examination (20-30 minutes) includes questions to assess the knowledge and understanding of the course topics, the learning skills and the communication skills. ILOs 1, 2, 3, 5, 6 are assessed. During the written exam, students will have access to books, notes, a dictionary, and a non-programmable calculator. To allow the completion of the session in a single day, in the case of a large number of candidates, the theoretical part of the exam will also be conducted in written form.
Evaluation Criteria	The two parts of the exam are weighted as follows: written 65%, oral 35%. To pass the exam a sufficient mark will be needed in each of the two parts. At the written part, both the ability to describe of the solution method (65%) and the correctness of the solution (35%) are evaluated. At the oral part, knowledge and understanding of the topic (60%), the communication skills (20%) and the ability to summarize are assessed (20%).
Required Readings	The topics will be sampled out of different books. Attending regularly the classes is highly recommended.
Supplementary Readings	• P. von Böckh & C. Saumweber, Fluidmechanik, 2013, Springer. • H. Sigloch, Technische Fluidmechanik, 2011, Springer. • Y. A. Çengel, & J. M. Cimbala, Fluid Mechanics –Fundamentals and Applications, 2006, McGraw-Hill (English book). • D. C. Wilcox, Basic Fluid Mechanics, 2007, DCW Industries (English book). • F. M. White, Fluid Mechanics, 2003, McGraw-Hill (English book).
Further Information	The professor will make available the content written on the digital whiteboard as well as the recording of the lessons.
Sustainable Development Goals (SDGs)	Clean water and sanitation, Affordable and clean energy, Responsible consumption and production, Sustainable cities and communities, Industry, innovation and infrastructure