UNIVERSITÀ DI PAVIA

Anno Accademico 2020/2021

HYDRAULICS

Enrollment year	2019/2020
Academic year	2020/2021
Regulations	DM270
Department	DEPARTMENT OF CIVIL ENGINEERING AND ARCHITECTURE
Course	CIVIL AND ENVIRONMENTAL ENGINEERING
Curriculum	PERCORSO COMUNE
Year of study	2°
Period	Annual (28/09/2020 - 14/06/2021)
ECTS	12
Language	Italian
Prerequisites	Fundamentals of calculus (limits, derivatives, integrals), mechanics (equilibrium, energy, conservation principles), vector calculus.
Learning outcomes	The Course teaches the fundamental aspects of hydraulics, in order to tackle the main hydraulic issues in the coputation of pipe and open-channel flows in steady-state conditions.
Course contents	The Course plans to teach the fundamentals in hydraulics which are needed to tackle the main practical problems in pipe and open-channel flows. In this frame, the Course consists of two parts: in the introductory part, all the basic knowledge in fluid dynamics and in the hydraulics of pipe flows is explained; in the second part, the focus is on open-channel hydraulics and on the computation of the free-surface elevation in steady state conditions.
Teaching methods	Lectures, practical classes and laboratory classes
Reccomended or required readings	Gallati M., Sibilla S. . Fondamenti di Idraulica. Carocci editore, Roma. Citrini D., Noseda D.. Idraulica. Tamburini, Milano.
Assessment methods	Two separate written tests on the contents of the two parts of the Course

The activity is split

502543 - **FUNDAMENTALS OF HYDRAULICS**

502938 - **APPLIED HYDRAULICS**

UNIVERSITÀ DI PAVIA

Anno Accademico 2020/2021

FUNDAMENTALS OF HYDRAULICS

Enrollment year	2019/2020
Academic year	2020/2021
Regulations	DM270
Academic discipline	ICAR/01 (HYDRAULICS)
Department	DEPARTMENT OF CIVIL ENGINEERING AND ARCHITECTURE
Course	CIVIL AND ENVIRONMENTAL ENGINEERING
Curriculum	PERCORSO COMUNE
Year of study	2°
Period	1st semester (28/09/2020 - 22/01/2021)
ECTS	6
Lesson hours	52 lesson hours
Language	Italian
Activity type	WRITTEN TEST
Teacher	SIBILLA STEFANO (titolare) - 5 ECTS FENOCCHI ANDREA - 1 ECTS
Prerequisites	Fundamentals of calculus: limits, derivatives, integrals. Mechanics: equilibrium, energy, conservation principles. Analytical mechanics: vector calculus.
Learning outcomes	At the end of the Course, the student should know and understand the basic principles which regulate the liquid motion in pipes and open channels. He must also be able to apply these principles to the solution of simple hydraulic engineering problems, such as the evaluation of the force exerted by the liquid on the rigid walls, the determination of discharge and head losses in pipe flows, the evaluation of energy exchanges between liquid flows and hydraulic machines.
Course contents	Fluids as a continuum. Pressure and viscous stress. Hydrostatics: Stevin's Law and pressure distribution in liquids. Preassure measurement. Hydrostatic forces on plane and curved walls.

	Kinematics of liquids: Eulerian and Lagrangian point of view. Definition of flow lines, fluxes, flow rate and mean velocity. Hydrodynamics: conservation principles. Continuity equation and Bernoulli's Theorem. Head losses: laminar and turbulent flows. Pipe flows: smooth wall and roughness, Moody's chart. Effects of geometry variation. Valves. Hydraulic machines: pumps and turbines. Typical layout of hydropower plants.
Teaching methods	Lectures and practical classes
Reccomended or required readings	Gallati M., Sibilla S. . Fondamenti di Idraulica. Carocci editore, Roma. Citrini D., Noseda D.. Idraulica. Tamburini, Milano.
Assessment methods	The evaluation will be obtained through a written test, which will include in general the solution of two exercises, the first on the evaluation of hydrostatic forces and the second on the solution of a problem on pipe flows (e.g.: determination of the flow rate and of head losses, energy exchanges in hydropower or pumping plants, etc.) The test will last for 2 hours: the use of textbooks, tables and computing machines is allowed. The evaluation will be given in a 0-30 grade scale.
Further information	
Sustainable development goals - Agenda 2030	$lbl_legenda_sviluppo_sostenibile

UNIVERSITÀ DI PAVIA

Anno Accademico 2020/2021

APPLIED HYDRAULICS

Enrollment year	2019/2020
Academic year	2020/2021
Regulations	DM270
Academic discipline	ICAR/01 (HYDRAULICS)
Department	DEPARTMENT OF CIVIL ENGINEERING AND ARCHITECTURE
Course	CIVIL AND ENVIRONMENTAL ENGINEERING
Curriculum	PERCORSO COMUNE
Year of study	2°
Period	2nd semester (08/03/2021 - 14/06/2021)
ECTS	6
Lesson hours	51 lesson hours
Language	Italian
Activity type	WRITTEN TEST
Teacher	SIBILLA STEFANO (titolare) - 3 ECTS PERSI ELISABETTA - 3 ECTS
Prerequisites	Mathematical Analysis: functions of one or more real variables, limits, derivatives, integrals. Physics: measurement of physical quantities and units of measure. Principles and fundamental equations of mechanics. Energy. The energy conservation principle. Mathematical physics: scalars and vectors. Fundamental elements of vector calculus. Geometry of the masses.
Learning outcomes	The "Applied Hydraulic" is the second module of "Hydraulics" course. In the "Applird Hydraulic" module, the student must acquire the concepts and operational tools needed to solve the hydraulic problems of steady motion in free surface flows running into artificial channels. The student must be able to qualitatively and numerically sketch the free surface profiles in natural or artificial open channels as a function of the boundary conditions which characterize the flow and of any singularities.

Course contents	Flow basic notions: the flow concept. Flow spatial and temporal characteristics. Continuity equations and momentum equations. Free surface flows geometrical characteristics Geometrical characteristics of free surface flows for cross section. Geometrical characteristics of free surface flows for longitudinal profiles. Representation of natural open channels geometry. Normal flow in free surface flow Normal flow. Free surface flow resistance and roughness coefficients. Flow rate versus normal depth. Flow rate versus normal depth for closed sections. Flow rate versus normal depth for composed sections. Verification and design problem under the condition of normal flow: graphical methods (specific and normalized flow rate versus normal depth) and numerical method (Bisection). Unstable normal flow (rapid flow). Free surface flows energetic characteristics Specific-energy considerations. Water depth versus specific-energy with constant flow rate. Flow rate versus water depth with constant specific-energy. Critical state. Open channel flow: mild, critical and steep slope. General considerations for the profiles of gradually varied flow Gradually varied flow equation. Gradually varied flow for five classes of channel slope (mild, critical, steep, horizontal and adverse), showing basic solution curves. Control sections. Composite-flow profiles: solution curves between two regimes Passing through the critical depth. Hydraulic jump. Total force. Water depth versus total force with constant flow rate. Flow rate versus water depth with constant total force. Hydraulic jump placement. Backwater profiles Backwater concept and its upstream/downstream propagation. Integration of the steady gradually varied flow equations in prismatic channel. Open channel flow singularity Abruptly varied flow considerations. Characteristic scale (singularities scale and scale of steady flow profile). Properly filleted steps on the bottom. Flow measurement and control by weirs. Flow over wide weirs. Filleted and abrupt lateral contractions. Hydraulic jump modeler: sharp-crested weirs/ broad-crested weirs. Backwater caused by the bridge piers.
Teaching methods	Lessons (hours per year in the classroom): 34 Exercises (hours per year in the classroom): 18
Reccomended or required readings	The lesson slides and the exercises solutions are available on KIRO Platform. Further investigations are available in:

	Citrini D., Noseda D. “Idraulica” Tamburini, Milano AA.VV. “Sistemi di fognatura-Manuale di progettazione” (Capitolo 12), CSDU-Hoepli
Assessment methods	The exam of "Applied Hydraulic" will be held in a written form. The positive result of the test (vote equal or greater than 18/30), if accepted by the student, will be used, with the result of the exam of “Hydraulics Fundaments”, for the final result of the Cours “Hydraulics” course.
Further information	==
Sustainable development goals - Agenda 2030	$lbl_legenda_sviluppo_sostenibile