UNIVERSITÀ DEGLI STUDI DI PALERMO

DEPARTMENT	Ingegneria
ACADEMIC YEAR	2023/2024
BACHELOR'S DEGREE (BSC)	ENVIRONMENTAL ENGINEERING FOR SUSTAINABLE DEVELOPMENT
SUBJECT	HYDRAULICS
TYPE OF EDUCATIONAL ACTIVITY	B
AMBIT	50277-Ingegneria civile
CODE	03769
SCIENTIFIC SECTOR(S)	ICAR/01
HEAD PROFESSOR(S)	TERMINI DONATELLA Professore Ordinario Univ. di PALERMO
OTHER PROFESSOR(S)	
CREDITS	9
INDIVIDUAL STUDY (Hrs)	144
COURSE ACTIVITY (Hrs)	81
PROPAEDEUTICAL SUBJECTS	
MUTUALIZATION	
YEAR	2
TERM (SEMESTER)	2° semester
ATTENDANCE	Not mandatory
EVALUATION	Out of 30
TEACHER OFFICE HOURS	**TERMINI DONATELLA** Monday 11:00 13:00 Stanza propria Tuesday 09:00 13:00 Stanza propria Wednesday 09:00 13:00 Stanza propria Thursday 09:00 13:00 Stanza propria Friday 11:00 13:00 Stanza propria

DOCENTE: Prof.ssa DONATELLA TERMINI

PREREQUISITES	The preliminary knowledge which are necessary to deal with the contents of the subject concern the contents of the mathematical analysis, of the analytical geometry and of the physics I
LEARNING OUTCOMES	At the end of the course, the student will have all the knowledge necessary to deal with and resolve, in an original way, problems related to hydraulics and to the hydrodynamic processes for the design and the verification of hydraulic systems/networks. In particular, the student will be able to analyze the basic hydrodynamic phenomena and that the behavior of a pressure current, such as that in pipe networks, and to know and understand the uniform free-surface flows either with open cross-section (ex. drains) or with close cross-sections (ex. sewers) Capacity to apply knowledge and understanding The student will acquire the basic knowledge of the hydraulics required for the application of specific analysis methods which are necessary for the design small supply and recirculation systems and/or of particular portions of hydraulic systems of buildings, to be able to verify the type of motion regime in the various sections of a hydraulic system, perform the hydraulic verification of lifting systems, and evaluate how to manage the presence of any parts of the system in depression. Such knowledge is necessary to identify more and more “smart” systems (infrastructures) and in the light of the optimization of the use of the water resource. Autonomy of judgment Based on the knowledge gained during the course, the student will have the ability of his own analysis necessary to make technical decisions, appropriate to specific and variable needs depending on the spatial scale and time of analysis. The student will be able to interpret the correct way of operation of the hydraulic systems, critically analyzing the best possible intervention and/or improvement solutions from time to time for the sustainable management of the systems. Communication skills The student will be able to communicate, with completeness and competence, the problems associated with the hydrodynamic processes that frequently occur in the designing of a building; the student will be able to hold conversations on energy and plant engineering issues in the field of hydrostatic and hydrodynamics and, therefore, he will be a valid support for the choice of the most appropriate techniques. Learning capability The student will be able to deepen topics related to fluids and their movement. The fundamental equations of fluid dynamicsand of the energetic characteristic of flow. The student will have learned the interactions between the typical themes of fluids in motion and at rest also in relation to the possibility of using hydraulic machines to draw or give energy to the current, and this will allow him to continue his engineering insights with greater autonomy and discernment.
ASSESSMENT METHODS	The student learning will be verified both during the course and at the end of the course. During the course, student learning will be verified by checking the work (individual or group) produced in reference to application cases explained and carried out in the classroom during the laboratory hours. This phase will be positively evaluated by presenting at the end of the course the book (individual or for students groups) containing the application cases (both in printed and in digital formats) discussed and executed in the classroom during the laboratory hours. The positive evaluation of this phase, with the attribution of a score which will be considered with a weight of 10% in the final evaluation, is necessary for conducting the final exam. The final exam at the end of the course aims to evaluate whether the student has acquired knowledge and understanding of the subjects, has acquired interpretative competence and autonomy for judgment of concrete cases. Therefore, this evaluation will be carried out on the basis of two written tests: one relating to problems of verification and/or design of applicative cases regarding both hydrostatics and permanent motion of pressurized currents or open-channel open-flow; the other concerning the basic theoretical concepts. The final vote will be defined on the basis of the oral evaluation and discussion of both tests, which will be considered of equal weigth (45%) in the final evaluation. In particular, for the first test, the sufficient evaluation (vote 18/30) will be reached when the student shows minimum application skills to solve concrete cases of both hydrostatics and hydrodynamics. For the second test, the sufficient evaluation (vote 18/30) will be reached when the student shows to have acquired the knowledge and understanding of the topics at least in the general lines and the minimum explaining ability. For each test, the rating will increase to a maximum of 30/30, eventually cum laude, when the goals are achieved in an excellent manner. In particular, for the first test the maximum rating of 30/30, eventually cum laude, will be obtained when the student demonstrates ability to solve practical problems in an excellent way. For the second test, the maximum rating of 30/30, eventually cum laude, will be obtained when the student demonstrates that he has gained full knowledge of the arguments of the program, with appropriate language properties. The final

	evaluation will be obtained as the weighted average of the evaluations obtained in the two tests above and in that obtained in the first phase (during the course).
EDUCATIONAL OBJECTIVES	The student will be able to deepen issues related to fluids and their movement. Hydrostatic: Calculating of the force on a flat surface and a curved surface. Kinematics: deformation velocity. Basic equations of fluid dynamics. Bernoulli's theorem and fluid dynamics. Pressure flows. Resistance laws. Verification problems and design problems: short pipes. Long pipes. Depressed flows. Power exchange between the flow and the hydraulic machine (pump, turbine). Various motion phenomena in pressure flows. Uniform motion and profiles in steady motion in open channel flows. Hints on the filtration motion. Main formulas in foronomy.
TEACHING METHODS	The course will include frontal lessons regarding both on the theoretical bases and the application cases. Hours of didactic laboratory and exercises will be provided with case study sessions in the classroom.
SUGGESTED BIBLIOGRAPHY	•Citrini D.-Noseda G.; “Idraulica”. Casa editrice Ambrosiana – Milano-ISBN 978-88-408-0588-7 •Alfonsi G.C., Orsi E., “Problemi di idraulica e meccanica dei Fluidi”, Casa Editrice Ambrosiana – Milano-ISBN 978-88-08-08008-0 . - Dispense didattiche del docente sugli argomenti trattati durante il corso

SYLLABUS

Hrs	Frontal teaching
1	Physical properties of fluids (dynamic and kinematic viscosity, density, specific gravity). Newtonian and nonNewtonian fluids.
4	Rheological laws The Cauchy tetrahedron theorem. The strain tensor. Hydrostatic. Hydrostatic tensor state. Static equation in local (indefinite) and global form. Stevin's law and tracing of the pressure diagram. Pressure measuring instruments (e.g. simple, metallic, differential pressure gauge). Thrust calculation on flat and curved surfaces. The component method for calculating thrust on curved surfaces
4	Kinematics of fluids. Eulerian rule. Locative derivative and convective derivative (Lagrangiana). Trajectories and current lines. Definition of flow tube Mass conservation equation (continuity equation) in local (indefinite) and global form Perfect fluids. Dynamic equation in local (indefinite) and global form. Euler equation. Distribution of pressures for linear and non-linear currents (effect of the curvature of the pipeline). Bernoulli's theorem. Trinomio of Bernoulli. Definition of piezometric line and total loads. Various motion (start of motion in the duct).
4	Real fluids. Dynamic equilibrium equation (the Navier Stokes equations) in local (indefinite) and in global form. Laminar flow regime and Hagen-Poiseuille law of velocity distribution. Action of carrying a current. Viscous tangential stress profile. Turbulence and equilibrium equation dynamic in local form (indefinite) and in global form. Velocity profiles in the presence of turbulence. Profile of tangential stresses and difference between viscous and turbulent tangential stresses Localized pressure drops (e.g.,abrupt widening - Borda, entrance, exit). Trend of the total and piezometric loads lines. Read of resistance to motion. Expression of the tangential stress to the wall by laminar motion regime, purely turbulent and turbulent transition. Reynolds number. Abacus by Moody and comparison with Harp by Nikuradse.
4	Hydraulic verification of the engine speed in the pipeline. Hydraulic generating and operating machines inserted in a current Currents in depression. "Channel" motion and cavitation phenomenon. Performance of a "siphon" pipe. Various motion phenomena in pressure pipes. The water hammer. Overpressure for instantaneous closing maneuver. Temporal trend of pressures and speeds at the shutter and in a generic section of the duct for instantaneous closing operation. Fast and slow closing maneuvers Various motion phenomena in pressure pipes. The function of the air tanks in building lifting systems for the damping of excessive pressures and depressions following the pump stop
4	Uniform motion in open channel flows
4	Steady motion in open channel flows
3	Hints on the filtration motion
3	Hints on foronomy

Hrs	Practice
6	Resistance laws: study case
6	Long pipes: study case

Hrs	Workshops
10	Hydrostatic and force on flat surfaces and curves surfaces: study case
10	Bernoulli’s Theorem: study case
10	Real fluid: study case
10	Uniform motion in open-channel flows: study case