UNIVERSITÀ DEGLI STUDI DI PALERMO

DEPARTMENT	Ingegneria
ACADEMIC YEAR	2019/2020
MASTER'S DEGREE (MSC)	MECHANICAL ENGINEERING
SUBJECT	APPLIED FLUID DYNAMICS
TYPE OF EDUCATIONAL ACTIVITY	C
AMBIT	20933-Attività formative affini o integrative
CODE	03439
SCIENTIFIC SECTOR(S)	ICAR/01
HEAD PROFESSOR(S)	TUCCIARELLI TULLIO Professore Ordinario Univ. di PALERMO
OTHER PROFESSOR(S)	
CREDITS	6
INDIVIDUAL STUDY (Hrs)	96
COURSE ACTIVITY (Hrs)	54
PROPAEDEUTICAL SUBJECTS	
MUTUALIZATION	HYDRODYNAMICS OF NETWORKS AND NATURAL BASINS - Corso: CIVIL ENGINEERING HYDRODYNAMICS OF NETWORKS AND NATURAL BASINS - Corso: INGEGNERIA CIVILE
YEAR	2
TERM (SEMESTER)	1° semester
ATTENDANCE	Not mandatory
EVALUATION	Out of 30
TEACHER OFFICE HOURS	**TUCCIARELLI TULLIO** Monday 12:30 13:30 Ufficio in ex Istituto di Idraulica, Viale delle Scienze, Ed.8 Tuesday 12:30 13:30 Ufficio in ex Istituto di Idraulica, Viale delle Scienze, Ed.8 Wednesday 12:30 13:30 Ufficio in ex Istituto di Idraulica, Viale delle Scienze, Ed.8

DOCENTE: Prof. TULLIO TUCCIARELLI

PREREQUISITES	Basic hydraulics
LEARNING OUTCOMES	Knowledge and Comprehension of: The student will get, at the end of the course, the knowledge of the problems related to the numerical simulation of hydrodynamic processes, in the field of transport and distribution pipe networks, as well as to the validation and the design of hydropoer plants. Ability to The student will be able to validate the hydraulic behaviour of transport and distribution networks, as well as of the supporting hydraulic plants, and to design small hydropower plants. Autonomy The student will be able to select the appropriate software for the hydrodynamic process analysis, as well as to evaluate the best management and equipment solution for hydraulic networks. He will also be able to evaluate the quality of the design of an hydropower plant. Communication Ability The student will develop the ability to communicate and discuss the technical problems related to the course topics. He wiil be able to discuss the problems related to transient conditions in hydrulic networks, as well as in hydropower plant design, with the water managers and with other technicians. Specialization ability The student will get all the instruments required for a further specialization in the topics covered by the course. More specifically, he will be able to study and apply scientif programming languages for his own code development, or to study and get more insight of the physical and environmental problems.
ASSESSMENT METHODS	The proficency evaluation is based only on an oral test. To pass the exam and get a score larger or equal to 18/30, the student has to show the achievement of a minimum target. The minimum target is a basic knowledge of the program course topics, the capability of making connection among them and to provide even a limited judgment independency, as well as the use of technically correct terms in order to clearly communicate with the examiners. To get the maximum score of 30/30 and honors, the student has to show to have fully attained the course targets, to have the ability to apply the acquired knowledge also to problems different from the program ones, to be able to discuss with fully correct technical terms the course arguments, to develop and well communicate autonomous judgment based on the acquired knowledge.
EDUCATIONAL OBJECTIVES	A first object of the course is the education in the field of unsteady state hydrodynamic processes, related to pressurized flows. A second object, required for the educational profile of a Mechanical Engineer, is the solution of complex pipe networks in teady-state conditions, as well as the design of hydropower plants.
TEACHING METHODS	Taught and lab classes, laboratory visit.
SUGGESTED BIBLIOGRAPHY	1.Whitham G., B. Linear and non linear waves. Wiley, New York. 1974. 2.Abbott, M., Computational Hydraulics, 2° Ed., Ashgate Publishing. 3. Warnick C.C., Hydropower Engineering, Prentice Hall. 4. De Marsily, G., Quantitative Hydrogeology: Groundwater Hydrology for Engineer, Elsevier. Dispense del corso, in Italiano ed in Inglese per studenti stranieri.

SYLLABUS

Hrs	Frontal teaching
3	Review of numerical analysis and steady-state problems: 1) Review of matrix algebra 2) Gradually varied flow profiles with a changing discharge; the spillways 3) The rating curves in channels with irregular sections.
4	Steady-state water distribution networks: 1) The energy and the mass conservation laws, 2) Water distribution networks. Governing equations with known pressure or demand at the nodes. Head losses compuation. 3) Solution methods: Hardy-Cross, flow and potential methods. Criteria for the method selection. 4) Pumps, valves, restrictions and turbines inclusion. 5) Contaminant transport in pipes.

SYLLABUS

Hrs	Frontal teaching
6	Water hammer in pressurized pipes: 1) Review of the continuity and momentum equations in weakly compressible flows. Basic assumptions. Shock propagation. Space-time propagation of a surge in the case of instantaneous valve closure. Functional analysis for the solution of differential equation systems with shock propagation. Quasi-linear systems, characterisc lines and compatibility equations. Boundary conditions and analytic solutions in the case of homogeneous equations. Elements of numerical solution in the case of non homogeneous equations. 3) Application to the solution of the water hammer problem. Solution in the case of known velocity at the final section (Allievi equation). Solution in the case of known valve flux equation. Solution in the case of not negligible friction forces. 4) Water hammer in pipe networks.
3	Incompessible mass oscillations: 1) Incompressible mass oscillations in tunnels. Piezometric wells, section narrowing validation and design 2) Incompressible mass oscillations in pumping plants. Air tanks, section narrowing validation and design
10	Hydropower generation: 1) Turbines overview. Syncronous and Asyncronous electric generators and their link to the electric european grid. 2) Action and reaction turbines. Cross-flow turbines. 3) Eulero equations for turbomachinery. Relationship among power, discharge and inlet/oulet velocity in the impeller. Maximum power and efficiency. Characteristic curve and discharge regulator. 4) Design of an hydroelectric plant downstream of a weir or at an aqueduct end.

Hrs	Practice
30	Lab classes on all the covered topics