COURSE: Fluid Mechanics			
ACADEMIC YEAR: 2019/2020			
TYPE OF EDUCATIONAL ACTIVITY: Basic			
TEACHER: dr. Marilena Pannone			
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phone: 0971 205147		mobile (optional):	
Language: Italian			
ECTS: 9	n. of hours: 90	Campus: Potenza Dept./School: School of Engineering Program: Mechanical Engineering	Semester: 1/2

EDUCATIONAL GOALS AND EXPECTED LEARNING OUTCOMES

The course aims at transferring know-how about the basic Statics and Dynamics of fluids, their application fields and the suitable mathematical methods to be used for their treatment.
The expected learning outcomes are represented by: the acquisition of the basic fluid-mechanical concepts and analysis tools; the acquisition of the capability to use them for the solution of technical-practical problems where their application is required, resorting to analytical methods and simple numerical codes; the acquisition of the capability to autonomously investigate course's topics as well as to clearly present and discuss them.

PRE-REQUIREMENTS

Passing the exams of Mathematical Analysis I and Physics I before beginning with the Fluid Mechanics classes is highly recommended.

SYLLABUS

A. Fluid properties and dimensional analysis

Dimensions and units. Density and specific gravity. Fluids compressibility. Viscosity. Non-viscous fluids. Non-Newtonian fluids. Surface tension and capillarity. Physical quantities and dimensional independency. Homogeneity criterion. Buckingham's theorem; applications: resistance to uniform flow in horizontal, circular cross-section conduits. The dimensional analysis in Fluid Mechanics. Mechanical similitude between fluid-dynamical phenomena. Outline of the fluid-dynamical models.

B. Fluid stress state

The pressure. Pressures' tensor. Principal pressures. Isotropic pressure. Pressures' tensor invariants.

C. Hydro-statics

Undefined equilibrium equations: fluids in rigid, accelerated or non-accelerated flow conditions. Pascal's law. Pressure measurements. Hydro-static pressure on flat or open curved surfaces. Hydro-static pressure on curved closed surfaces. Fully submerged bodies. Floating bodies.

D. Kinematics of fluids

Steady/unsteady, uniform/non uniform flows. Velocity. Trajectories and streamlines. The concept of total derivative. Acceleration. Kinematics of fluids. The deformation.

E. Fluid flow integral analysis

Fluid system and control volume. Mass balance referred to a fluid system and a control volume. Transport theorem. Momentum conservation equations. Fluid streams. Applications of the momentum conservation equations for steady flows and incompressible fluids: dynamical pressure of a free jet on a plain wall; Pelton action turbine; jet propulsion; reaction turbines and pumps.

F. Fluid flow differential analysis

Differential continuity equation. Differential momentum conservation equation: Cauchy's equation. Constitutive relation for non-viscous fluids and for linear viscosity fluids. Flow equation for non-viscous fluids: Euler's equation. Flow equation for linear viscosity fluids: Navier-Stokes' equation. Flow equations boundary conditions.

G. Non-viscous flows

Complete equations system for the study of a non-viscous fluid flow. Applications: Bernoulli's theorem. Extension of Bernoulli's theorem to the whole stream. Basics of phoronomy; stagnation pressure; Pitot's tube; Venturi's tube; elementary propeller theory; abrupt cross-section widening in confined streams.

H. Rotational and irrotational flows

Vorticity. Irrotational flows: velocity potential. Bernoulli's theorem for irrotational flows. Stream function for a two-dimensional irrotational flow. Basic two-dimensional irrotational flows. Combinations of basic two-dimensional irrotational flows: dipoles, uniform flow around a cylinder with and without circulation and related drag and lift. Conformal mapping. Joukowski's transformation and airfoils.

I. Laminar and turbulent flows

Transition from laminar to turbulent flow regime. Laminar regime: uniform flow in conduit. Turbulent regime: from Navier-Stokes' to Reynolds' flow equations. Turbulent steady and uniform flow. The logarithmic velocity wall distribution. Turbulent flow for smooth and rough wall. Flow resistance equations in uniform confined streams flow: Colebrook's formula. Moody's diagram. Laminar two-dimensional boundary layer. Wall shear stress for laminar and turbulent boundary layer. Boundary layer separation and flow resistance due to the unbalanced pressures.

L. Steady flow in pipe systems

Resistance formulas and evaluation of energy losses. Conduit connecting two reservoirs. Problems characterizing the long conduits. Hydraulic nodes and networks. Power absorbed or supplied in a conduits system by (action-reaction) turbines and pumps.

M. Confined incompressible unsteady flows

Oscillations of mass and elastic oscillations within an hydro-electric power plant.

TEACHING METHODS

The course consists of 90 hour teaching subdivided in lectures (70 h) and classroom tutorials (20 h). The classroom tutorials follow the lectures focused on each specific topic. Specifically, classroom tutorials are expected for sections **C** (4 h),**E** (4 h),**I** (2 h),**L** (6 h), **M** (4 h). The tutorial classes include learning tests at the blackboard.

EVALUATION METHODS

The 2nd year students can take the exam by 2 partial written verifications (February-intermediate verification and May-completion). Each verification includes 2 theoretical questions and 1 practical question. Additionally, for all the students, the regular sessions consist of oral examinations on theory and applications and concern the topics of the course. The test intends to evaluate the understanding of the different topics and the ability to link and compare the different approaches.

TEXTBOOKS AND ON-LINE EDUCATIONAL MATERIAL

Lecture notes provided by the teacher.
Specific topics can be explored on the following textbooks:

A.Ghetti: Idraulica, Ed. Libreria Cortina – Padova
E.Marchi-A.Rubatta: Meccanica dei Fluidi, UTET – Torino
M. Mossa-A.F. Petrillo: Idraulica, CEDAM – Milano

INTERACTION WITH STUDENTS

At the beginning of the course, after the presentation of objectives, program and methods of verification, the teacher collects the list of students who intend to attend the course. The students provide their name, ID number and e-mail.
Office hours: Tuesday 11:00 to 13:00 at teacher's office (5th floor School of Engineering).
Additionally, the teacher is available every time to keep in touch with the students by e-mail.

EXAMINATION SESSIONS (FORECAST)[1]

Previous years: 6/02/20, 20/02/20, 16/04/20.
17/06/20, **15/07/20**, **17/09/20**, **18/11/20** (besides the intermediate and completion tests)

SEMINARS BY EXTERNAL EXPERTS YES □ NO □ x

FURTHER INFORMATION

[1] Subject to possible changes: check the web site of the Teacher or the Department/School for updates.