NOTICE OF TEACHING VACANCY
FOR THE FALL 2019
TO BE CONFERRED WITH A PAID CONTRACT

The Department of Civil, Environmental and Architectural Engineering (I.C.E.A.), of the University of Padova

OPENS

a comparative evaluation procedure to confer a teaching commitment for the course of **Advanced Fluid Mechanics** to be delivered in the framework of the Mathematical Engineering master degree program, Academic Year 2019/20 - Fall 2019, under a private law agreement in accordance with Art. 23, paragraph 1 of Law no. 240 of 30 December 2010.

ADMISSION REQUIREMENTS

The participants, in accordance with Art. 1, paragraph 3, letter C of the University of Padua Regulation governing the stipulation of teaching agreement, must demonstrate an excellent knowledge of the English language and a documented international teaching experience developed for several years at Universitary master level.

Applicants must send their *curriculum vitae* at the following e-mail address: didattica@dicea.unipd.it and as CC to the Chair of the Mathematical Engineering Degree Course Council (stefano.lanzoni@unipd.it)

BY NO LATER THAN APRIL 15, 2019 AT 12:00

The mail subject must be specified as: **TEACHING VACANCY ICEA-ME 2019/20**

Applications shall be evaluated by a commission appointed by the Head of Department.

The evaluation will be based on the applicant's academic CV and will also take into account applicant's previous teaching experience at master level.

The commission will evaluate the applications and draw up a proposal that will be submitted to the Board of Administration of the University of Padova. After the Board of Administration has made its decision, the selected candidate will be notified by email.

The name of the selected candidate will be published on the Department website at:

http://www.dicea.unipd.it

DUTIES

Teaching period: Fall semester, October 1st, 2019 - December, 20th, 2019. Six hours per week of frontal lessons
Examination period: January 20th 2020 - February 20th, 2020; June 2020-July 2020; September 2020.

The winner shall prepare the text of the exams and evaluate them.
He is also invited to propose to the students possible topics for their Master thesis concerning advanced fluid mechanics applications. The thesis work can be developed in Padua and/or within an erasmus project.

SYLLABUS

Navier-Stokes (NS) equations; scaling and relevant dimensionless groups. Kinematic and Dynamic boundary conditions. Solutions procedures for low, intermediate and high Reynolds number flows. Hydrodynamic stability and transition to turbulence. Mechanics of turbulence. Wall bounded flows. Turbulence closure models. Shallow water equations.

EDUCATIONAL MATERIAL

Stefano Lanzoni, 2018. Advanced Fluid Mechanics. See Contents on Annex A.

CONSIDERATION

The consideration shall be paid once the Head of the Department of Civil, Environmental and Architectural Engineering (I.C.E.A.) has ascertained that teaching duties have been completed fully. See the enclosed table for the consideration.

COURSE TITLE	*SSD*	*Credits (CFU)*	*Hours*	*Credits (CFU)*	*Hours*	*YEAR*	*PERIOD*	*BASED IN*	*LANGUAGE*	*HEAD OF COURSE*	*Consideration (gross amount)*
		Total		*Appointed for*							
Advanced Fluid Mechanics	*ICAR/01*	*9*	*72*	*9*	*72*	*II*	*I sem.* (October 1st, 2019 - December, 20th, 2019)	*Padova*	*English*	*Yes*	*€ 22.844*

Should teaching duty be completed partly, the payment shall be proportional to the amount of hours actually taught.

ANNEX A

UNIVERSITY OF PADUA

Department of Civil, Architectural and Environmental Engineering

Advanced Fluid Mechanics

Prof. Stefano Lanzoni

January 9, 2019

Preface

The present notes have been developed for the course of Advanced Fluid Mechanics given to Mathematical Engineering students. It contains more material than will ordinarily be covered in a half-year course. The major aim is to help the students to exert their critical sense when describing a physical process through a mathematical model, paying attention to the intrinsic limitations embedded in any description of the real world. This is why dimensional analysis and a proper scaling of the relevant equations are widely adopted to tackle the various topics.

Chapter 1 describes the conventions and notation used throughout the notes. In particular, tensorial notation is widely used in the calculations, to reduce as much as possible the algebraic computations and to better emphasize the physical meaning of the terms appearing in the various equations.

Chapters 2-4 summarize some basic concepts of continuum mechanics, tackled in previous courses, integrating them with fundamental information specifically pertaining to fluid mechanics (e.g., a more detailed assessment of the main properties of fluids, a description of the local variations of velocity, the analysis of the relative motion near a point, the conditions at the interface between two fluids, the kinematics leading to the definition of a stream function and a velocity potential, the boundary conditions to be applied at moving surfaces).

Chapter 5 introduces the Navier-Stokes equations, with specific attention to the case of incompressible viscous flows (either homogeneous or stratified). The scaling of these equations is used to highlight the different types of flows they describe and the possible simplifications.

Chapter 6 describes the basis of hydrodynamic stability, with applications to linear stability of plane-parallel flows of homogeneous and stratified fluids. The Chapter closes with an examples of stability analysis applied to a model problem, tackled first through a linear perspective and then through a weakly-nonlinear approach. The use of a model problem allows the student to afford it analytically with a reasonable amount of algebra, thus learning how to manage the mathematical procedure and interpreting the results.

Chapter 7 addresses the description of turbulence and the main fundamental of its mechanics. The description is by far not exhaustive: only the main aspects are treated to give to the student an overall idea of the complexity embedded in turbulent flows. Rather, the Chapter intends to stimulate the students to further deepen through additional reading their knowledge of a fascinating, not yet fully solved process.

Chapters 8 and 9 treat wall-bounded and shear flows, applying the knowledge gathered in the previous Chapters.

Chapter 10 is devoted to the turbulence models used to close the additional terms that appear in the Reynolds averaged Navier-Stokes equations (RANS), with particular attention to the limitations entailed by the various treatments.

Chapter 11 describes the basic assumption leading to the shallow water equations, that are derived for both two-dimensional and one-dimensional flow conditions.

In conclusion, it is hoped that the these notes will be useful for stimulating the students' rigour and constructive criticism when developing new models or applying existing ones to non-standard problems, as those usually implied by the complexity of many natural systems.