Syllabus
Course description

Course title	Applications of fluid mechanics to energy engineering
Course code	45538
Scientific sector	ICAR/01
Degree	Master in Energy Engineering
Semester	2
Year	2
Academic year	2017/18
Credits	6
Modular	no

Total lecturing hours	36
Total lab hours	
Total exercise hours	24
Attendance	
Prerequisites	Basic knowledge of fluid mechanics
Course page	Reserve Collection

Specific educational objectives	Applications of fluid mechanics to energy engineering is an optional course within the master in Energy Engineering and is aimed to the students showing particular interest in fluid mechanics. Some specific topics addressed only marginally in the basic courses of hydraulics and fluid mechanics will be addressed, in order to provide the students with the fundamental knowledge about turbulent flows, physical modelling and CFD (Computational Fluid Dynamics). Within the tutorials and the homework the students will have the opportunity to compare some commercial codes applied to practical applications relevant to energy engineering.

Lecturer	Michele Larcher
Scientific sector of the lecturer	ICAR/01 (08/A1)
Teaching language	English
Office hours	Whole week, on appointment
Teaching assistant *(if any)*	Roman Gabl
Office hours	Whole week, on appointment
List of topics covered	The course will cover the following topics: • Fundamentals of fluid turbulence - Interest of turbulent flows - Turbulent viscosity - Boundary layer

	- Free turbulence - Vortex dynamics - Homogeneous and isotropic turbulence - Direct and Large Eddy Simulation - Statistical models of turbulence - Overview of the major experimental techniques • Computational fluid dynamics - Numerical simulation versus scale model test - 1D, 2D and 3D models, with focus on 3D - Detached Eddy Simulation (DES), Large Eddy Simulation (LES) and Reynolds-Averaged Navier-Stokes (RANS), including Reynolds stress - Role of boundary conditions, mesh and time step - Quality standards - Introduction into CFX, comparison to FLOW-3D - Application of CFX to energy engineering problems • Similarity analysis and physical models - Basics of the dimensional analysis - Common Dimensionless Groups - Applications of the Pi-theorem - Applications to flow in pipes - Applications to flow in channels • Hydrodynamic lubrication - Mathematical foundations - Slider bearings - Externally pressurized bearings - Squeeze films - Journal bearings
Teaching format	Lectures and tutorials in class; homework on the numerical solution of a fluid mechanics application.

Learning outcomes	By the end of the course, students are supposed to be able to: - *Knowledge and understanding:* show the equations and explain the main principles relevant to turbulence, CFD, similarity and lubrication; develop an intuitive comprehension. - *Applying knowledge and understanding:* give examples of real applications and practical problems to underline how the topics treated in the course are used within engineering activity. - *Making judgements:* the ability to make autonomous judgements in the choice and comparison of the suitable tools and for the solution of problems involving the mechanics of fluids. - *Communication skills:* communication skills to correctly and properly present the concepts acquired in the course and the results of the homework. - *Learning skills:* Ability to autonomously extend the knowledge acquired during the study course by reading and understanding scientific and technical documentation.

Assessment	The examination of the course is based on oral questions about the contents of the course and on the presentation and discussion of the homework, consisting in the numerical solution of a fluid mechanics application. The candidates are requested to apply the main principles and equations of fluid mechanics in order to solve technical problems. The oral examination includes questions to assess the knowledge and understanding of the course topics and the communication skills.
Assessment language	English
Evaluation criteria and criteria for awarding marks	Students will be evaluated on the base of an oral discussion (60%) and of the presentation and discussion of the homework (40%). At the oral part, knowledge and understanding of the topic (60%), the communication skills (20%) and the ability to summarize (20%) are assessed. At the presentation and discussion of the homework, applying knowledge and understanding (30%), making judgments (25%), the communication skills (25%) and the learning skills (20%) will be assessed.

Required readings	The topics will be sampled out of different books. Attending regularly the classes is highly recommended. Some material will be made available in the reserve collection.
Supplementary readings	C. Bailly & G. Comte-Bellot, Turbulence, Springer, 2015 H. Tennekes & J.L. Lumley, A First Course in Turbulence. MIT Press, Cambridge 1972 J.O. Hinze, Turbulence, McGraw-Hill International Book Company, New York, 1975 D. C. Wilcox, Turbulence modeling for CFD, DCW Industries, 2006 H. Oertel (ed.), Prandtl-Essentials of Fluid Mechanics, Applied Mathematical Sciences 158, Springer, 2010 Y.A. Çengel, & J.M. Cimbala, Fluid Mechanics – Fundamentals and Applications, 2006, McGraw-Hill J.C. Gibbings, Dimensional Analysis, Springer, 2011 B. Zohuri, Dimensional Analysis and Self Similarity Methods for engineers and Scientists, Springer, 2015 L.P. Yarin, The Pi-Theorem. Applications to Fluid Mechanics and Heat and Mass Transfer, Springer, 2012 A. Adami, I modelli fisici nell'idraulica, CLEUP, 1994 W.E. Langlois and M.O. Deville, Slow Viscous Flow, Springer, 2014