Università degli Studi della Basilicata
Scuola di Ingegneria

COURSE: Computational Thermo-Fluid Dynamics for Machinery			
ACADEMIC YEAR: 2019/2020			
TYPE OF EDUCATIONAL ACTIVITY: Characteristic			
INSTRUCTOR: Annarita Viggiano			
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phone: +39.0971.205204			
Language: Italian			

ECTS: 9	n. of hours: 81 (lessons 48, tutorials/practice 33)	Campus: Potenza Dept./School: School of Engineering Program: Mechanical Engineering Master's Degree	Spring Semester

EDUCATIONAL GOALS AND EXPECTED LEARNING OUTCOMES

The purpose of this course is to provide advanced knowledge of applied thermo-fluid dynamics and of Computational Fluid Dynamics (CFD) and to introduce students to the use of CFD for design, analysis and optimization of energy and propulsion systems. At the end of the course, the students will be able to use advanced computational tools, both open source and licensed, to choose the proper mathematical models for the design of a specific component and the numerical methods for the solution of the equations.

PRE-REQUIREMENTS

Fundamentals of fluid machinery are needed.

SYLLABUS

Mathematical models for the study of turbulent reacting flows (41 hours)

Fundamentals of fluid dynamics: conservation equations. Compressible and incompressible flows. Reacting flows of multicomponent mixtures. Introduction to turbulence. Energy cascade and dissipation at small scales. Kolmogorov's universal equilibrium theory. Kolmogorov scales. Direct numerical simulation of turbulence. Reynolds averaged Navier-Stokes equations. Turbulence models: algebraic models, one-equation models, two-equation models. Favre averaged equations. Introduction to LES and DES. Thermo-fluid dynamics in combustion chambers. Turbulent combustion.

Numerical schemes for computational fluid dynamics (18 hours)

Computational fluid dynamics. Classification of PDE. Equilibrium problems and marching problems. Finite differences. Accuracy, consistency and stability of a numerical scheme. von Neumann analysis. Amplification factor. Modified equation: dissipation, dispersion and diffusion errors. Definition of convergence: Lax's equivalence theorem. Application of numerical schemes to the model equations. Finite volume methods. Computational grids. Initial and boundary conditions.

Applications to design and analysis of propulsion and energy systems (22 hours)

Applications of CFD to design and analysis by using open source software. Computer simulations.

TEACHING METHODS

Theoretical lessons and classroom tutorials (63 hours)
Laboratory tutorials (18 hours)

EVALUATION METHODS

The examination consists of the elaboration of a project and an oral examination. During the development of the project, students have to apply the theoretical knowledge and software skills acquired during the lessons in order to design, analyze and optimize a component of a fluid system. The project is usually developed by a group of students and should be delivered a week before the oral examination. Each student will discuss the project during the oral examination, when the knowledge and skills acquired by the student, as well as his ability to solve problems, will be verified. The overall grade will take into account all stages of the examination.

TEXTBOOKS AND ON-LINE EDUCATIONAL MATERIAL

Instructor's notes available at http://docenti.unibas.it/site/home/docente.html?m=004204

J.C. Tannehill, D. A. Anderson, R. H. Pletcher, Computational Fluid Mechanics and Heat Transfer, Taylor & Francis, 1997.

Other textbooks

1. D.C. Wilcox, Turbulence Modeling for CFD, Dcw Industries, 2006 (turbulence models)
2. J.D. Anderson, Modern Compressible Flow: with Historical Perspective, McGraw-Hill, New York, 2002 (fluid dynamics)
3. J.B. Heywood, Internal Combustion Engine Fundamentals, McGraw–Hill, New York, 1988 (internal combustion engines)

INTERACTION WITH STUDENTS

All the necessary information about the course and the evaluation methods, as well as the contact details of the instructor, are provided to students during the first lesson and made available on the instructor web site.

As regards the office hours, please, refer to the following link:

http://docenti.unibas.it/site/home/docente.html?m=004204

TENTATIVE EXAMINATION SCHEDULE[1]

05/02/2020; 04/03/2020; 01/04/2020; 06/05/2020; 03/06/2020; 15/07/2020; 30/09/2020; 21/10/2020; 25/11/2020

SEMINARS BY EXTERNAL EXPERTS YES x NO □

FURTHER INFORMATION

The seminar will be confirmed during the spring semester.

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