Freie Universität Bozen
Libera Università di Bolzano
Università Liedia de Bulsan

Syllabus
Course description

Course title	Computational Thermo-Fluid Dynamics (CTFD)
Course code	47562
Scientific sector	ING-IND/10
Degree	Master in Industrial Mechanical Engineering
Semester	1
Year	1
Academic year	2025/2026
Credits	5
Modular	No

Total lecturing hours	28
Total lab and exercise hours	18
Attendance	Not mandatory but strongly recommended
Recommended preliminary knowledge	The course integrates and complements topics of thermodynamics, heat transfer and fluid mechanics introduced in previous elective courses.
Connections with other courses	The course supplies some tools useful for the numerical simulation of thermal-fluid systems.
Course page	https://www.unibz.it/en/faculties/engineering/master-industrial-mechanical-engineering/course-offering-2016/?academicYear=2025

Specific educational objectives	The course introduces the fundamentals of computational thermal-fluid-dynamic, by presenting and discussing the governing equations of fluid flow motion and heat transfer. Proper terms and definitions will be introduced, as well as the appropriate conservation principles needed to analyze a complete fluid-flow system. Particular emphasis will be given to the study of practical applications in industrial engineering, such as heat exchangers and cooling fins. Combustion principles and flame dynamics will be also discussed. During the course, both a bottom-up approach (starting from fundamental equations) and a top-down approach (starting from the system level) will be used. The concepts of computational fluid dynamic (CFD) will be presented by means of the application of numerical techniques to the solution of some practical fluid flow and heat transfer problems. A commercial CFD software will be presented and applied to illustrative fluid flow and heat transfer problems. Exercises proposed during the course consist in solving practical design problems with the aim of giving the

	students a deeper comprehension and understanding of the topics.

Lecturers	Prof. Francesco Patuzzi
Scientific sector of the lecturers	ING-IND/10
Teaching language	English
Office hours	Mondays to Thursday, by appointment
Teaching assistant *(if any)*	-
Office hours	-
List of topics covered	The course will cover the following topics: • Fundamental equations of fluid mechanics in differential and integral form and common approximations • Review on turbulence models • Review on modes of heat transfer • Computational thermo fluid dynamics and application to practical examples. • Heat exchangers: types, design principles, performance evaluation, numerical simulation • Cooling fins: fins performance parameters, parametric design, numerical simulation, effects of flow conditions • Combustion principles and introduction to flame dynamics
Professional applications of the covered topics	Engineering professions involving the simulation of thermo-fluid-dynamic systems.
Teaching format	The course consists of lectures in which the topics are presented by the professor. There are also classes (exercises) that will give practical examples of the application of the theoretical topics and the utilization of commercial software for computational fluid dynamic. Course topics will be presented at the blackboard and using electronic slides. Teaching material and additional materials will be provided by the Professor during the semester.

Learning outcomes (ILO)	Through the study and the application of the topics presented during the lessons, students should acquire: 1. the **knowledge and understanding** of the fundamentals of thermo-fluid-dynamic 2. the ability to **apply knowledge and understanding** of the theoretical principles to the analysis of thermal-fluid systems 3. the ability to **make autonomous judgements** in the assessment of numerical solution of thermal-fluid systems 4. **communication skills** to correctly and properly present the concepts acquired in the course and to

	solve simple application problems regarding thermal-fluid systems 5. lifelong **learning skills** through the possession of the tools for the acquisition of technical information on the thermal-fluid systems and to update knowledge.
Assessment	Examination of the course is carried out by means of an oral exam. The oral examination includes questions to assess the knowledge and understanding of the course topics and questions designed to assess the ability to transfer these skills to case studies and practical applications. Questions on practical applications also assess the ability of the student to apply the knowledge and understanding of the course topics, the ability to make judgments and finally, the student communication skills.
Assessment language	English
Evaluation criteria and criteria for awarding marks	Students regularly enrolled at the 2nd year of the Master of Industrial and Mechanical Engineering are eligible for the attendance of the lessons and the exam. Other exceptional cases have to be discussed with the Professors. The student is asked to attend an oral exam. It is relevant for the oral exam to: master the specific language (also with respect to teaching language); prove the understanding of the topics and learning skills; evaluate and establish relationships between topics; grow specific skills in critical thinking. Regarding the practical applications, it is relevant to clearly describe suitable technical solutions and be able to make critical judgments and apply the theoretical concepts. The exam mark will be assessed as follows: oral exam.

Required readings	• Notes taken during lecture • Notes written by the teacher during the lessons, that will be available in the online repository • M. Moran, H. Shapiro, B. Munson, D. DeWitt, Introduction to Thermal Systems Engineering: Thermodynamics, Fluid Mechanics, and Heat Transfer, Wiley • F. Incropera, D. DeWitt, Fundamentals of Heat and Mass Transfer, Wiley • G.F.C. Rogers, Yon Mayhew. Engineering Thermodynamics: Work and Heat Transfer, Pearson Education
Supplementary readings	-