Module description

Computational Fluid Dynamics (CFD)

General information

Number of ECTS Credits

3

Abbreviation

TSM_CFD

Version

19.03.2014

Responsible of module

Prof. Dr. Ernesto Casartelli

Language

	Lausanne	Bern	Zürich
Instruction	X E X F	☐ D ☐ E ☐ F	X D X E
Documentation	X E ☐ F	☐ D ☐ E ☐ F	☐ D X E
Examination	X E X F	☐ D ☐ E ☐ F	X D X E

Module category

☐ Fundamental theoretical principles

X Technical/scientific specialization module

☐ Context module

Lessons

X 2 lecture periods and 1 tutorial period per week

☐ 2 lecture periods per week

Brief course description of module objectives and content

This module provides students with a comprehensive introduction to CFD by imparting knowledge of state-of-the-art techniques in computational fluid dynamics, with the emphasis on fluid physics and verification/assessment.

Aims, content and methods

Learning objectives and acquired competencies

Students who have completed this module are able to:

- employ the potential of computational fluid dynamics for product development and be aware of its limits
- verify simulation results and critically assess simulation models
- systematically approach simulation tasks
- understand the properties of the numerics behind the code

Contents of module with emphasis on teaching content

- **Motivation**: objectives of computational fluid dynamics, meaning and economic benefit of numerical simulation, integration of numerical simulation in product development, possibilities and limits
- **Introduction to physical and technical systems and their describing equations**: fluid mechanics, thermodynamics, others
- **Idealization and modeling:** classification of the simulation tasks (steady-state, transition, 2D, 3D, symmetry, etc.), modeling based on geometry, flow properties, boundary conditions
- **Verification and assessment:** solving equations correctly, solving the correct equations, interpretation of simulation results, error possibilities and sources

Week	Subject areas
1	Introduction to CFD: an overview
2	Conservation laws and behavior of PDE
3	Introduction to OpenFOAM
4	The finite volume method for diffusion problems
5	The finite volume method for the interpretation of convection-diffusion problems, verification and assessment
6	The finite volume method for the interpretation of convection-diffusion problems, verification and assessment
7	Algorithms for linking pressure and flow velocity for steady-state flows
8	Algorithms for linking pressure and flow velocity for steady-state flows
9	Numerics for solving discretized equations
10	Physics of turbulence and modeling
11	Physics of turbulence and modeling
12	Physics of turbulence and modeling

13	Non-steady-state flows
14	Non-steady-state flows

Teaching and learning methods

Ex cathedra, practical exercises and case studies

Prerequisites, previous knowledge, entrance competencies

- Knowledge of fluid mechanics: laminar, turbulent, compressible, incompressible, steady-state and non-steady-state flow
- Knowledge of thermodynamics: conservation of mass and energy, equation of state (ideal gas, incompressible fluid), heat capacity, thermal conductivity
- Basic knowledge of numerical methods
- Basic knowledge of CFD simulation methods and tools is desirable

Literature

- Lehrbuch (Skript) H.K. Versteeg, W.Malalasekera, **An Introduction to Computational Fluid Dynamics**, Pearson Prentice Hall, 2007, Second Edition
- J. H. Ferziger, M. Peric, **Computational Methods for Fluid Dynamics**, Springer, 2002, Third Edition

Assessment

Certification requirements for final examinations (conditions for attestation)

None

Written module examination

- Duration of exam: 120 minutes
- Permissible aids: Lecture notes and electronic devices by agreement