Module Description

Computational Fluid Dynamics

General Information

Number of ECTS Credits

3

Abbreviation

TSM_CFD

Version

21.04. 2011

Responsible of module

Language

	Lausanne	Bern	Zürich
Instruction	X E X F	☐ D ☐ E ☐ F	X D ☐ E
Documentation	X E ☐ F	☐ D ☐ E ☐ F	☐ D X E
Examination	X E X F	☐ D ☐ E ☐ F	X D ☐ 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 offers a comprehensive knowledge of state-of-the-art techniques in numerical flow simulation with an emphasis on flow physics and verification/validation methods.

Aims, content, methods

Learning objectives and acquired competencies

Upon completion of this module, the students will be able to :

- exploit the potential and limits of numerical flow simulation for product development
- verify simulation results and validate simulation models critically
- apply a systematic approach to simulation tasks
- understand the characteristic of the numerics behind the code
- is able to analyse engineering problems using CFD and to elaborate solutions or find optimizations

Contents of module with emphasis on teaching content

- **Motivation**: objectives of numerical flow simulation, importance 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, transient, 2D, 3D, symmetry, etc.), geometry-based modeling, flow properties, boundary conditions and loads
- **Verification and Validation**: solving the equations correctly, solving the right equations, interpretation of results from simulation, possibilities and sources of errors

Week	Topics
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 convection-diffusion problems Interpretation, verification and validation
6	Algorithms for pressure-velocity coupling for steady flows
7	Solution of discretised equations
8	Turbulence Physics and Modeling

9	Incompressible vs. compressible flows
10	Unsteady flows
11	CFD applications: Basic cases
12	CFD applications: Errors and uncertainties in CFD modelling
13	CFD applications: mini project
14	CFD applications: mini project

The module is organized by 4 parts.

Part	Title	Weeks
1	Modeling and Numerical methods	1 to 5
2	Fluid dynamics and Flow Physics	6 to 9
3	Applications	10 and 14
4	Introduction to OpenFOAM	2 to 14 (exercises)

Teaching and learning methods

Ex-cathedra teaching, exercises and case studies

Prerequisites, previous knowledge, entrance competencies

- Knowledge in fluid mechanics
- Knowledge in numerical methods
- Basic knowledge in CFD simulation methods

Literature

- Text Book (script): 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: Open book and Calculator