ME-474

Numerical flow simulation

Sawley Mark

Cursus	Sem.	Type
Computational science and Engineering	MA1, MA3	Opt.
Energy Management and Sustainability	MA1, MA3	Opt.
Mechanical engineering	MA1, MA3	Opt.

Language of teaching	English
Credits	5
Session	Winter
Semester	Fall
Exam	During the semester
Workload	150h
Weeks	14
Hours	**4 weekly**
Lecture	2 weekly
Exercises	2 weekly
Number of positions	

Summary

This course provides practical experience in the numerical simulation of fluid flows, comprising the three fundamental phases of pre-processing (geometry and mesh creation), computation (choice of physical models & numerical methods), and post-processing (quantitative analysis and visualization).

Content

Numerical flow simulation (or Computational Fluid Dynamics) is an essential component of modern fluid mechanics. The objective of this course is to use the student's existing knowledge in fluid mechanics and numerical methods as a basis for a global introduction to numerical flow simulation. An overview of the general theoretical concepts - such as mesh generation algorithms, turbulence modelling, resolution of the Navier-Stokes equations, scientific visualization - is provided in the lectures. State-of-the-art commercial and open-source software packages are used to study practical applications via worked flow cases and exercises. Course evaluation is based on written and oral presentations for three projects performed during the semester.

Keywords

Numerical simulation, Fluid mechanics, Mesh generation, Scientific visualization

Learning Prerequisites

Required courses

- Fluid mechanics
- Numerical analysis
- Discretization methods (e.g. finite differences, finite elements, finite volumes)

Recommended courses

- ME-271 Fluid flow
- ME-343 Compressible fluid dynamics
- ME-371 Discretization methods in fluids

Important concepts to start the course

- Computer-aided design (CAD)

Learning Outcomes

By the end of the course, the student must be able to:

- Identify and apply the different steps in a numerical simulation (e.g. geometry and mesh generation, computation, post-processing) and integrate all the essential basic concepts in a numerical flow simulation, AH18
- Choose the appropriate turbulence model for a given turbulent flow, AH27
- Analyze numerical solutions and identify any inconsistencies with respect to physical reality; understand and apply the concepts of verification and validation, AH21
- Perform a numerical simulation with appropriate software; understand the limits of each software in terms of its application domain and accuracy of the results obtained, AH26

Transversal skills

- Plan and carry out activities in a way which makes optimal use of available time and other resources.
- Identify the different roles that are involved in well-functioning teams and assume different roles, including leadership roles.
- Access and evaluate appropriate sources of information.
- Write a scientific or technical report.
- Assess one's own level of skill acquisition, and plan their on-going learning goals.

Teaching methods

Lectures, Worked flows examples, Practical exercises on workstations, Projects.
The goal is to learn "hard skills" through the solving of challenging practical problems. However, significant importance will also be placed on "soft skills" such as writing reports, presenting orally, working in groups, and creativity in visual communication.

Expected student activities

- Participation in classroom (e.g. worked flow cases)
- Practical exercises (for apprenticeship of methods and software)
- Projects in groups (including written reports and oral presentation)

Assessment methods

Three project reports (75%), one project oral presentation (20%), self assessment (5%)

Supervision

Office hours	No
Assistants	Yes
Forum	No

Resources

Virtual desktop infrastructure (VDI)

Yes

Bibliography

Course material is available on Moodle web site. Various reference texts

Moodle Link

- http://moodle.epfl.ch/course/view.php?id=126